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Scale Development for the Meaningful Utilization of Generative Artificial Intelligence in Education Through Exploratory Factor Analysis: Meaningful Utilization of GenAI in Education

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Abstract.

As generative AI technologies rapidly reshape education worldwide, higher education institutions face urgent concerns about how to integrate these tools meaningfully and ethically. This study developed and validated a contextualized measurement scale to assess the meaningful use of generative artificial intelligence (GenAI) in a Philippine higher education institution. Employing an exploratory sequential mixed-method design, qualitative analysis of institutional policies identified six themes: ethical use, academic integrity, institutional support, user responsibility, data privacy, and research integration. These informed the creation of 53 scale items, refined through expert validation. The scale was administered to 257 faculty members at Rizal Technological University, and exploratory factor analysis revealed a four-factor structure: Ethical AI Awareness, AI-Enhanced Engagement, Transparency and Disclosure, and Operational Readiness. These factors explained 64.5 percent of the variance, with strong internal consistency, averaging a Cronbach's alpha of 0.903. Model fit indices, including RMSEA at 0.065 and TLI at 0.874, indicated acceptable structural validity. The resulting instrument offers a reliable framework for evaluating GenAI integration in classrooms, providing insights for policy formulation and capacity building. By grounding the tool in local context and empirical data, the study contributes to responsible, inclusive, and transparent AI adoption in Philippine higher education and offers a foundation for future research and institutional governance.

Keywords: capacity building, engagement, faculty, governance, psychometrics, validation

1. Introduction

Modern education has been revolutionized by the infiltration of generative artificial intelligence (GenAI) technologies such as ChatGPT, Gemini, and Claude (Genc, 2024; Daraio et al., 2025; Xiaoyu et al., 2025). These technologies have altered how knowledge is acquired, processed, and applied in education. According to Berengueres (2025) and Hariyanti et al. (2025), these technologies have rapidly progressed from being mere novelties to being widely adopted platforms for academic support. As a result, they have implications for how students approach writing, problem-solving, and research. GenAI tools are causing fresh queries to be made not just about their practical applications, but also about the deep ethical, cognitive, and pedagogical implications of their impact on learning due to the widespread accessibility of these tools (Nguyen, 2025).

The response from educational institutions worldwide has been a mix of enthusiasm and caution. According to Meletiadou (2025) and Khojah et al. (2025), GenAI is earning praise for its ability to improve student customization, reduce effort, and improve academic success.

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On the other hand, concerns regarding equity, academic integrity, and reliance on content generated by artificial intelligence continue to exist (Eaton, 2025; Munaye et al., 2025). Educational institutions are currently facing the challenge of adopting GenAI into their frameworks while simultaneously maintaining academic integrity and encouraging digital literacy. This is a combination of challenges that they must overcome. There are a variety of ways to artificial intelligence governance in education that are emerging in order to address these complex requirements (Sposato, 2025; Li & Zhang, 2024). Best examples are the guidelines and frameworks established by various international organizations. According to the European Parliament (2025), the AI Act categorizes AI systems based on risk levels and introduces transparency obligations for generative models like ChatGPT. Complementing this regulatory approach, UNESCO's Recommendation on the Ethics of Artificial Intelligence promotes a value-based framework focused on ensuring fairness, accountability, and human dignity in AI deployment. It bans harmful practices such as social scoring and mass surveillance, while promoting data protection, environmental sustainability, and inclusive digital development across sectors like education, health, and labor (UNESCO, 2022). At the international level, the OECD AI Principles, updated in 2024, provide the first intergovernmental standard for trustworthy AI. They offer a combination of values-based guidelines and practical recommendations aimed at ensuring human-centric, transparent, and robust AI systems that can be implemented flexibly across countries (OECD, 2024).

In the Philippine context, the incorporation of GenAI into education remains in its nascent phase (Elinzano & Ching, 2025; Barrot, 2024). Educators recognize its promise; nonetheless, there is an urgent requirement for more explicit institutional norms, ethical policies, and professional training (Pepito et al., 2025; Qian et al., 2025). Recent research indicate that Filipino students are using GenAI tools mainly for convenience, frequently lacking comprehensive understanding of their ethical implications or optimal practices (Kumar, 2025; Kelder et al., 2025). Local academic institutions are initiating discussions regarding the proper use of AI; nevertheless, implementation varies inconsistently across different regions and educational tiers. The inequity in access to infrastructure and AI-compatible educational resources emphasizes the necessity for focused research that tackles regional issues (Frana, 2024). To address these challenges, several known higher institutions in the Philippines have crafted and implemented their Artifical Intelligence Utilization Guidelines in their respective campuses. The University of the Philippines (2023) has articulated its own Principles for Responsible and Trustworthy AI, a comprehensive ethical framework emphasizing cultural sensitivity, empowerment, privacy, and educational integration. These principles are institutionalized through dedicated committees to ensure implementation, governance, and stakeholder collaboration. Collectively, these models accentuate the global and local effort to align AI innovation with public good, ethical values, and human-centered development. Similarly, Mindanao State University (2024) institutionalized its Policy on the Fair and Ethical Use of AI, which sets clear boundaries on AI use in research and teaching. It highlights accountability, data privacy, non-discrimination, and prohibits unethical academic practices, such as submitting AI-generated work without disclosure or using AI to evaluate student submissions. MSU's framework is particularly notable for addressing institutional responsibilities, accessibility, and capacity building in a developing country context where digital divides persist. These two universities set the standard among all other State Universities in the Philipines in utilizing AI, particularly Generative AI in the context of Education.

E-ISSN:
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Despite the aforementioned institutions most likely serving as models for others to adopt, there is a notable lack of localized empirical studies examining how students in the Philippines apply artificial intelligence in a relevant and responsible manner in their academic endeavors. This is despite the growing body of global research on the use of advanced artificial intelligence (AI) in education. A major percentage of the existing body of research tends to generalize global viewpoints, ignoring culturally distinct behaviors, attitudes, and constraints (Ocampo & Gozum, 2025; Salem et al., 2025). Furthermore, measurement models evaluating students' involvement with artificial intelligence (AI) have not yet been confirmed in the Philippines and, by extension, in the global context. These models include ethical awareness, transparency, metacognitive application, and technical preparedness. In light of the ongoing implementation of numerous standards on the use of artificial intelligence, it is essential to develop a clear, context-based scale to guide universities in the meaningful use of generative artificial intelligence on a daily basis.

By developing and validating a contextualized measurement scale, this study fills a significant gap in the current literature and will hopefully help Rizal Technological University (RTU) establish its own policies and procedures for effectively using GenAI in the classroom. This study uses exploratory factor analysis (EFA) to identify the factors that influence the incorporation of GenAI into classroom instruction and other academic endeavors. With this methodology, we may learn about AI applications based on facts rather than speculation, drawing on the real-world experiences of both teachers and students. This study adds to the growing body of knowledge on the responsible, intentional, and inclusive use of artificial intelligence (AI) in the classroom by situating its findings within the specific framework of the Philippines' higher education system. Its contributions to institutional policy formulation are equally noteworthy. By conducting this study, RTU hopes to foster an environment where all members of its academic community may use AI to their advantage, promoting empowerment, academic integrity, and innovation.

2. Method

2.1 Study Design

The study utilized an Exploratory Sequential Design, a mixed-methods approach that effectively combines qualitative exploration and quantitative assessment to develop and validate a scale to assess the significant application of generative AI in education (Sarmiento-González et al., 2025). The study commenced with a qualitative phase employing documentary analysis to scrutinize published AI-related frameworks, guidelines, and policy papers from chosen higher education institutions (HEIs) in the Philippines (Strittmatter et al., 2024). Coded data, comprising statements and words that delineate ethical principles, educational applications, institutional obligations, and learner conduct, were retrieved and subjected to thematic analysis (Naz et al., 2025; Lillywhite & Wolbring, 2022). Codes were created inductively, categorized into overarching themes, and employed to develop preliminary scale items (Boztas et al., 2025; Overton & Christou, 2025; Angulo et al., 2024). This dual approach ensured contextual depth and theoretical significance, grounded in institutional discourse and regulatory structures (Varzeshi et al., 2025; Jastrzębska & Piwowarczyk, 2023).

A total of fifty-three (53) items were initially created without predefined factor groups, enabling empirical patterns to emerge during analysis. Expert validation was conducted with 10 panelists specializing in educational technology, evaluation, and AI ethics (Caruso et al.,

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2025). Each item received evaluations for clarity, relevance, and necessity, resulting in high Content Validity Index (CVI) ratings of 0.96, 0.99, and 0.99, respectively, alongside corresponding Content Validity Ratio (CVR) values of 0.98, 0.99, and 0.98, all above the 0.62 standard established for ten experts (Sancar & Cavus, 2023). These indices exhibited strong agreement over the items' aptness. As a result, all the item variables were preserved, with some modifications to improve clarity and conformity with educational and ethical norms.

The expertly validated tool was subsequently disseminated via an online survey to the faculty at Rizal Technological University (Bartuś et al., 2025) during the second semester of the 2024-2025 school year. This quantitative phase aimed to identify the latent constructs influencing utilization attitudes and behaviors regarding generative AI in education (Ni et al., 2025). Exploratory factor analysis (EFA) was used to examine the data and identify the scale's underlying structure, as no factors had been previously designated (Van et al., 2025). This empirical method facilitated the development of a genuine, data-driven scale rooted in faculty experiences, thus enhancing the construct validity of the scale. The study's sequential methodology yielded a theoretically grounded, psychometrically robust, and contextually relevant instrument for assessing significant GenAI use in a Philippine higher education institution.

2.2 Locale of the Study

The research was conducted at Rizal Technological University (RTU), a public institution in Mandaluyong City, Metro Manila, Philippines. Founded in 1969, RTU has always adapted to the changing requirements of the higher education industry. Similar to other innovative state universities in the region, RTU aims to establish a unique character as it evolves into a smart and international university in the forthcoming years. Given the swift progress in digital technologies, especially the advent of artificial intelligence (AI), it is imperative to proactively confront the potential and challenges that AI entails. To protect educational quality and ensure the ethical, equitable, and effective integration of AI technologies, the formulation of explicit, context-specific AI Utilization Guidelines is essential (RTU, 2024).

2.3 Population and Sampling

Table 1. Number and Percentage of Respondents per College/Institute

Colleges/Institutes	Number of Respondents	Percentage
College of Business, Entrepreneurship, and Accountancy (CBEA)	110	42.80%
College of Arts and Sciences (CAS)	79	30.74%
College of Education (CEd)	55	21.40%
College of Engineering (CEng)	7	2.72%
Institute of Human Kinetics (IHK)	6	2.33%
Total	***257***	***100.00%***

Table 1 presents the distribution of 257 faculty respondents from diverse colleges and institutes at Rizal Technological University (RTU) during the second semester of the 2024–2025 academic year, all of whom reported using generative AI tools for academic purposes in

E-ISSN:
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their general view of classroom instruction. The College of Business, Entrepreneurship, and Accountancy (CBEA) comprised the largest number of respondents with 110 faculty members (42.80%), succeeded by the College of Arts and Sciences (CAS) with 79 faculty members (30.74%), the College of Education (CED) with 55 faculty members (21.40%), the College of Engineering (CEng) with seven faculty members (2.72%), and the Institute of Human Kinetics (IHK) with six faculty members (2.33%). The research employed purposive sampling, specifically criterion-based sampling, to select RTU faculty rather than other employees, as they directly observe the application of generative AI in the teaching-learning process and possess the requisite maturity to evaluate its utilization in the classroom (Cabrera & Cuenca, 2024). This selection technique ensured the inclusion of individuals with direct, pertinent experience in educational AI engagement, thereby aligning with the study's aim to develop and evaluate a contextually appropriate scale for meaningful GenAI application in learning.

2.4 Data Analysis

This study utilized an exploratory sequential approach (Al-Filali et al., 2023), commencing with a qualitative phase and subsequently using quantitative methods to develop and validate a scale to assess the significant application of generative AI in education. During the qualitative phase, a documentary analysis was conducted of publicly available institutional policies and frameworks from selected higher education institutions in the Philippines (University of the Philippines, 2023; Mindanao State University, 2024; Ateneo De Manila, 2024; UPOU, 2023). Textual elements—sentences and phrases detailing the application of generative AI in teaching, learning, assessment, academic integrity, and institutional governance—were extracted and coded, then further organized into overarching themes via thematic analysis. These themes constituted the conceptual basis for the preliminary collection of scale items. Expert validation was performed with a panel of 10 professionals in educational technology, ethics, artificial intelligence, and instructional design to verify content validity (Wang et al., 2022). The Content Validity Ratio (CVR) and Content Validity Index (CVI) were calculated, employing thresholds of 0.62 for CVR, 0.80 for item-level CVI, and 0.90 for scale-level CVI as criteria for item retention and clarity (Sancar & Cavus, 2023). Items that failed to meet these thresholds were either altered or omitted from subsequent testing.

The modified scale was then administered to the faculty members, with 257 responding (Regnoli et al., 2025). Following data collection, Exploratory Factor Analysis (EFA) was used to explicate the latent structure of the data, initially utilizing the Kaiser-Meyer-Olkin (KMO) test and Bartlett's Test of Sphericity to confirm sample adequacy and factorability (Kirinić et al., 2023; Bazrbachi et al., 2023). After those measures established the acceptable values, factor extraction was employed using Principal Axis Factoring with Varimax rotation, and factor retention was determined by eigenvalues exceeding 1, scree plot examination, and Parallel Analysis, which contrasted observed eigenvalues with those derived from random datasets (Boomer et al., 2022; Lopez-Fornieles et al., 2022). Items with factor loadings of 0.50 or above were considered major contributors (Arantes & Sousa, 2025). Internal consistency was evaluated using Cronbach's Alpha and McDonald's Omega, with reliability coefficients of > 0.70 considered satisfactory and ≥ 0.90 outstanding (Regnoli et al., 2025). The preliminary model fit was assessed using Root Mean Square Error of Approximation (RMSEA) ≤ 0.08 for acceptable fit, ≤ 0.05 for good fit, and Tucker-Lewis Index (TLI) ≥ 0.90, demonstrating structural adequacy (Medina et al., 2024; Galiana et al., 2022).

E-ISSN:
2721-13988

3. Result

3.1 Thematic Analysis

A review of institutional documents identified six primary themes that shape the positioning of generative AI inside higher education regulations in the Philippines, directing the formulation of metrics for effective AI use.

Table 2. Thematic Analysis Results

Themes	Codes	Sample Quotes
Ethical and Responsible Use	Transparency, Accountability, Integrity, No Harm, Fairness	*The use of AI in teaching and learning should not be for harm or illegal purposes.* *The values of integrity, transparency, honesty, accountability, and equity must be upheld in the use of GenAI.* *The responsible and ethical use of AI technologies in academic work is vital for upholding the integrity of scholarship.*
Academic Integrity and Attribution	Citation, Declaration, Plagiarism, Originality, Authorship	*Students must declare and properly cite AI-generated content.* *The verbatim lifting of GenAI-generated text without citation constitutes plagiarism.* *Author(s) must ensure that the use of AI-generated content does not involve plagiarism.*
Institutional Capacity and Support	Training, Monitoring, OER, Faculty Development	*… shall provide support mechanisms, including training on the ethical use of AI.* *The University shall provide AI literacy education for faculty, students, and staff.* *Faculty, staff, and students shall receive training on the responsible use of AI tools.*
Student and Faculty Responsibilities	Disclosure, Respect for Boundaries, Communication, Consent	*Students must disclose the use of AI in data collection as part of the course requirements.* *Students must obtain documented permission before inputting instructors' work into GenAI tools.* *Faculty and staff are responsible for AI-driven outcomes.*
Data Privacy and Protection	Data Security, Confidentiality, Legal Compliance, Informed Consent	*….adheres to policies such as academic integrity and data privacy.* *Use of GenAI must not infringe upon data privacy and intellectual property rights.* *….respects data privacy and upholds standards as the law requires.*
AI Integration in Research and Creative Work	Human Oversight, Research Disclosure, Responsible Development	*Use of GenAI in research must be disclosed to all relevant parties.* *Outputs generated from AI tools must undergo rigorous human scrutiny.* *The use of AI to facilitate learning must align with learning outcomes.*

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The theme, "Ethical and Responsible Use," emerged as fundamental, highlighting principles such as honesty, transparency, responsibility, and non-maleficence, consistent with the conclusions of Lillywhite and Wolbring (2022), who emphasized the ethical imperatives of AI in academic settings. "Academic Integrity and Attribution" highlighted the necessity of accurate citation and transparency to avert plagiarism, particularly in submissions containing AI-generated work, reflecting the apprehensions articulated by Naz et al. (2025) about the indistinctness of authorship in AI-assisted writing.

"Institutional Capacity and Support" emphasized the need for training, resources, and policy frameworks to facilitate responsible AI adoption, aligning with Boztas et al. (2025), who identified institutional preparedness as a vital facilitator of ethical technology integration. "Student And Faculty Responsibilities" emphasizes the need to disclose AI use, secure consent, and maintain accountability for activities conducted by AI, as endorsed by Overton and Christou (2025), who championed collective responsibility in ethical AI practices. "Data Privacy & Protection" demonstrated compliance with legal norms, including the Data Privacy Act of 2012, highlighting the regulatory aspects of AI adoption (Strittmatter et al., 2024). Finally, the "Integration of AI in Research and Creative Works" stressed the importance of transparency, methodological rigor, and human oversight, in line with Varzeshi et al.'s (2025) suggestions for preserving research integrity in the era of generative technologies. Collectively, these themes offer a thorough and experimentally substantiated framework for the responsible and effective integration of generative AI in education.

3.2 Sampling Adequacy Test Results

The findings in Table 3 regarding sample adequacy provide strong statistical justification for conducting a factor analysis to investigate the meaningful use of generative AI in education.

Table 3. Sampling Adequacy Tests Results

Test	Value
Bartlett's Test of Sphericity $\chi 2$	13452.1378
Degrees of Freedom (df)	969
p-value	< 0.001
KMO Measure	0.969

Bartlett's Test of Sphericity produced a χ^2 value of 13,452.14 ($df = 969$, $p < 0.001$), signifying that the correlation matrix is not an identity matrix and that adequate inter-item correlations are present to warrant the use of data reduction methods, which in this case is the Exploratory Factor Analysis. The Kaiser-Meyer-Olkin (KMO) measure of 0.969, which significantly exceeds the 0.6 minimum criterion and is categorized as "marvelous," demonstrates a high degree of shared variance among items, indicating that the dataset is exceptionally favorable for structural recognition (Doven et al., 2025). In the context of educational technologies such as generative AI, strong psychometric properties are crucial for validating dimensions of ethical awareness, user engagement, and perceived utility. The results validate the consistency and reliability of the instrument design and indicate a shared understanding of GenAI use among respondents, reinforcing the scale's capacity to yield contextually relevant and empirically substantiated insights into AI integration in higher education.

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3.3 Extracted Factor Structure

The four-factor structure obtained from the exploratory factor analysis provides a comprehensive understanding of faculty's meaningful engagement with generative AI in education, as illustrated in Table 4.

Table 4. Extracted Factor Structure through Exploratory Factor Analysis

Item No.	Item Description	Factor 1	Factor 2	Factor 3	Factor 4	Uniqueness
28	I am aware of the limitations of using AI in classroom instructions.	0.825				0.244
29	I am aware of the ethical implications of using AI tools in any academic work.	0.800				0.227
19	I understand the ethical guidelines for using AI in academic work.	0.765				0.251
30	I understand the importance of transparency when AI is used in learning or research.	0.743				0.246
20	I do not use AI tools for harmful or illegal purposes.	0.741				0.398
11	I am aware of how to responsibly use AI tools in academic work.	0.714				0.339
40	I understand the guidelines on using AI tools to maintain academic integrity and avoid plagiarism.	0.695				0.242
35	I understand that AI-generated content in academic work must be properly cited and attributed.	0.691				0.283
21	AI tools help me understand course content more effectively.	0.68				0.270
36	I am aware of how AI tools can influence learning outcomes.	0.667				0.278
22	I use AI tools to brainstorm or improve the structure of my work.	0.647				0.298
53	I validate AI-generated content by double-checking it for accuracy and ensuring it aligns with reliable sources.	0.633				0.361
25	I use AI to summarize or clarify difficult topics.	0.603				0.374
42	I am encouraged to critically evaluate AI-generated content and not rely on it blindly.	0.579				0.362
43	I am aware of the policies in place to ensure that AI tools respect my academic privacy.	0.502				0.363
8	AI helps me personalize my learning path according to my needs.		0.721			0.291
3	AI-enhanced learning platforms provide feedback that improves my instructional performance.		0.705			0.304
2	I feel more motivated to learn when AI tools are used in my classes.		0.705			0.365

E-ISSN:
2721-13988

Item No.	Item Description	Factor 1	Factor 2	Factor 3	Factor 4	Uniqueness
13	AI technologies in school improve my ability to collaborate with peers.		0.703			0.323
24	I actively use AI to engage with learning materials.		0.700			0.278
7	AI tools used in teaching are fair to all students regardless of background.		0.685			0.419
4	The AI systems used in my classes respect my privacy.		0.666			0.442
26	I collaborate with peers while following AI usage guidelines.		0.660			0.346
10	I trust the AI systems used in my school to provide accurate information.		0.648			0.465
9	I feel that AI supports, rather than replaces, my interaction with teachers and students.		0.631			0.473
23	AI tools support my critical and creative thinking.		0.577			0.33
6	I am given the opportunity to understand how AI-generated recommendations are made.		0.574			0.452
27	I feel confident in knowing when AI use is appropriate for academic work.		0.561			0.345
32	I trust that AI technologies in my classes respect my privacy and personal data.		0.542			0.400
38	I feel that AI enhances my educational opportunities regardless of my background.		0.529			0.306
12	I have access to the same AI learning tools as other users in my institution.		0.521			0.484
45	I declare my use of GenAI in my work, whether it's for brainstorming, outlining, sentence generation, or any other task.			0.673		0.315
51	I ensure I have equal access to GenAI as provided by the University and use the tools wisely.			0.648		0.266
50	I reflect on my learning through metacognition to understand how GenAI impacts student thinking and cognitive development.			0.644		0.252
52	I disclose my use of GenAI in any research or creative work to my colleagues, students, and relevant parties.			0.619		0.338
44	I check the course syllabus for guidelines on how I can use GenAI in assignments and assessments.			0.606		0.326
41	I believe AI technologies in education do not exacerbate educational inequalities.			0.541		0.326
47	I require the submission of a Declaration of Originality for major assessments, certifying that any work is original.			0.524		0.494

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2721-13988

Item No.	Item Description	Factor 1	Factor 2	Factor 3	Factor 4	Uniqueness
18	I disclose my use of AI in data collection when required.				0.59	0.370
16	I properly cite AI-generated content used in my research and other academic undertakings.				0.588	0.408
14	I have received training or orientation on how to use AI tools in my teaching and learning.				0.529	0.523

The first factor, labeled "Ethical AI Awareness," encompasses respondents' awareness of the moral, legal, and academic implications of AI use. High item loadings associated with citation, transparency, and responsible usage indicate an increasing ethical awareness among the teachers and students as well, corroborated by studies highlighting the significance of organized AI ethics education in fostering responsible conduct (Lin et al., 2025; Wang et al., 2023; Wang & Zhang, 2023). Nonetheless, this understanding may be superficial in the absence of institutional reinforcement, as Al-Thani (2025) cautions that regulations devoid of contextual depth may promote compliance without authentic ethical involvement. The second factor, "AI-Enhanced Engagement," refers to the respondents' emotional and intellectual benefits from AI, including heightened motivation, customization, teamwork, and perceived equity. These substantiate the findings of Gebhardt et al. (2025), who observe that well-integrated AI systems enhance inclusivity and learning preference. Nonetheless, apprehensions remain regarding access and skill inequalities, which could hinder equitable participation if AI utilization is not adequately facilitated.

The third factor, "Transparency and Disclosure," signifies metacognitive accountability and readiness to disclose AI utilization in academic work, which is associated with institutional clarity and governance (Ilieva et al., 2025). This indicates a developing sense of digital accountability among users; nonetheless, ambiguous or punishing regulations continue to hinder open disclosure, as shown by Wu et al. (2025). The fourth factor, "Operational Readiness," emphasizes the importance of technical assistance, training, and procedural understanding, highlighting proper citation practices and the informed use of AI tools. Galindo-Cuesta (2025) and Martín-Rodríguez and Madrigal-Cerezo (2025) stress that training improves competence and mitigates misuse, asserting that such instruction should be included in educational frameworks to ensure alignment with deeper learning. The four factors provide a comprehensive framework for analyzing faculty-AI interactions and highlight the need for cohesive policies, inclusive pedagogy, and institutional support to optimize the responsible and transformative capabilities of generative AI in education.

3.4 Reliability Results

Upon extraction of the factor structure, reliability analysis was performed, as shown in Table 5, which indicates well-established internal consistency among the four factors derived through Exploratory Factor Analysis.

Table 5. Reliability of the Extracted Factor Structure

Factors	Cronbach's Alpha	McDonald's Omega
Ethical AI Awareness	0.967	0.967
AI-Enhanced Engagement	0.958	0.958

E-ISSN:
2721-13988

Transparency and Disclosure	0.924	0.925
Operational Readiness	0.764	0.779
Average	***0.903***	***0.907***

The overall scale demonstrated exceptional reliability, with average Cronbach's Alpha and McDonald's Omega values of 0.903 and 0.907, respectively. The "Ethical AI Awareness" factor exhibited the highest reliability (α = 0.967, ω = 0.967), indicating a strong correlation among items related to ethical responsibility, transparency, and citation—aligning with the conclusions of Lavanya and Yasanthini (2025) and Davidovitch and Merchán-Cruz et al. (2025), who advocate for systematic ethics education in AI applications. "AI-Enhanced Engagement" showed remarkable reliability (α = 0.958, ω = 0.958), consistent with Castro et al. (2025) and Koukaras et al. (2025), who found that incorporating tailored, motivated AI improves student learning experiences. "Transparency and Disclosure" exhibited comparable high internal consistency (α = 0.924, ω = 0.925), consistent with the findings of Amin et al. (2024) and Jørgensen et al. (2025), who emphasized the significance of policy clarity in fostering disclosure behavior. Lastly, "Operational Readiness" demonstrated acceptable reliability (α = 0.764, ω = 0.779), indicating the impact of diverse institutional training and accessibility, as noted by Popescu-Apreutesei et al. (2025) and Bucea-Manea-Ţoniş et al. (2022). These results collectively confirm the scale's structural integrity and psychometric validity as an instrument for assessing student engagement with generative AI in academic settings.

3.5 Model Fit Measures

Given the remarkable results of the reliability testing, the model fit indices in Table 6 offer an initial, but insightful, evaluation of the alignment between the hypothesized four-factor structure and the observed data, recognizing the exploratory nature of this phase.

Table 6. Model Fit Measures

Model Fit Measure	**Value**
Root Mean Square Error of Approximation (RMSEA)	0.065
90% Confidence Interval (CI) Lower	0.0616
90% Confidence Interval (CI) Upper	0.0688
Tucker-Lewis Index (TLI)	0.874
Bayesian Information Criterion (BIC)	-4055.2448
Chi-square (χ2)	1172
Degrees of Freedom (df)	481
Probability Value (p-value)	< 0.001

The Root Mean Square Error of Approximation (RMSEA) value of 0.065, accompanied by a 90% confidence interval of 0.0616 to 0.0688, signifies an adequate model fit, since values ranging from 0.06 to 0.08 are deemed appropriate in exploratory factor analysis (Makarichev et al., 2022). This indicates that the model provides a plausible representation of the data's fundamental structure. The Tucker-Lewis Index (TLI) of 0.874, although marginally beneath the standard cutoff of 0.90, indicates a reasonable fit and is defensible within the framework of

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exploratory factor analysis (EFA), where the model is unconstrained and vulnerable to penalties associated with complexity (Patel et al., 2025). The Bayesian Information Criterion (BIC) value of -4055.2448 supports the model's relative parsimony, affirming the efficacy of the derived factor solution in the absence of a comparative model. This indicates that the model achieves a good balance between fit and complexity by minimizing unnecessary parameters.

Despite the significance of the Chi-square statistic ($\chi^2 = 1172$, df = 481, $p < 0.001$), such a result is expected in large samples and should be interpreted with caution. In this context, approximation fit indices such as the Root Mean Square Error of Approximation (RMSEA) and the Tucker-Lewis Index (TLI) are considered more reliable indicators of model adequacy. The results of the Exploratory Factor Analysis (EFA) demonstrate that the proposed model possesses strong structural validity and a solid theoretical foundation (Sureshchandar, 2021). Supported by favorable fit statistics, high internal consistency, and conceptual coherence, the model stands as a strong and credible framework for understanding meaningful generative AI utilization in educational contexts (Gelfert, 2019).

3.6 Factor Summary

To further substantiate the model's strength, an examination of its factor composition is presented in Table 7, which illustrates the significant explanatory capacity of the four-factor model obtained via exploratory factor analysis, exhibiting a cumulative variance of 64.5%—a substantial figure for educational and social science research, where constructs frequently possess multidimensional characteristics (Abdennour et al., 2023).

Table 7. Factor Summary

Factor	SS Loadings	% of Variance	Cumulative %
Ethical AI Awareness	12.26	23.14	23.1
AI-Enhanced Engagement	11.18	21.1	44.2
Transparency and Disclosure	7.39	13.94	58.2
Operational Readiness	3.36	6.33	64.5

"Ethical AI Awareness," the most significant factor, accounts for 23.14% of the variation, underscoring the importance of academic integrity, responsible use, and ethical implications in students' understanding of generative AI. This discovery aligns with the assertions of Al-Abdullatif (2025) and Oncioiu and Bularca (2025), who highlight the indispensable importance of ethical literacy in the adoption of AI. Subsequently, "AI-Enhanced Engagement" accounts for 21.1% of the variance, encompassing affective and cognitive elements such as motivation, personalization, and trust, in line with Corubolo and Meroni's (2024) findings, which emphasize the importance of AI alignment with learner requirements. "Transparency and Disclosure" constitutes 13.94% of the variation, indicating procedural accountability and policy understanding, as evidenced by Correia et al. (2024) and Vatamanu and Tofan (2025). Lastly, "Operational Readiness" accounts for 6.33% of the variance, indicating access, training, and practical AI proficiency, which may differ across institutional contexts, as observed by Yaseen and Al-Amarneh (2025) and Gkika et al. (2025). The model exhibits strong conceptual and empirical validity, providing a reliable basis for confirmatory testing and further investigation of GenAI integration in educational contexts.

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3.7 Parallel Analysis Scree Plot

To further support the above results, the parallel analysis scree plot provides essential validation of the four-factor structure obtained from the EFA for the meaningful utilization of generative AI in education.

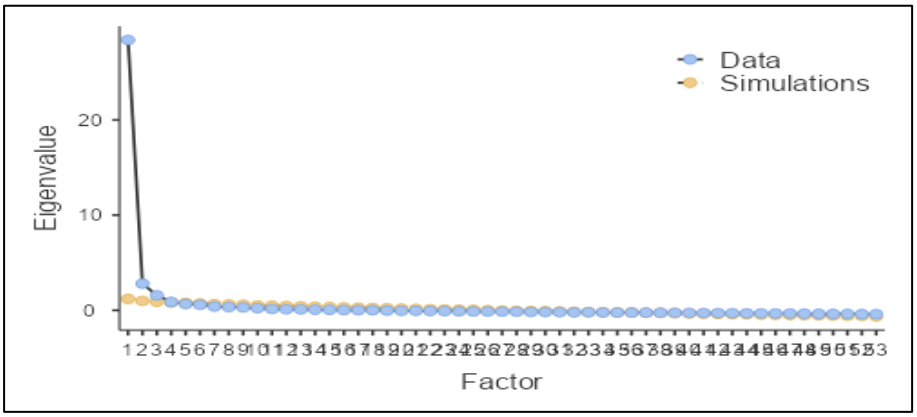

Figure 1. Parallel Analysis Scree Plot

The plot shows that the actual eigenvalues from the dataset (blue dots) significantly exceed those from randomly simulated data (yellow dots) for the four factors, thus confirming their statistical significance. Beyond the fourth factor, the eigenvalues of the actual data are lower than those of the simulated data, suggesting that additional factors are likely to represent random noise rather than significant structures. This validates the retention of four noticeable factors—"Ethical AI Awareness, AI-Enhanced Engagement, Transparency and Disclosure, and Operational Readiness"—which collectively represent 64.5% of the overall variation. Parallel analysis is acknowledged as a more precise and conservative criterion compared to the conventional eigenvalue > 1 rule, particularly in educational and psychological research where clarity of constructs is essential (López-Jiménez et al., 2025; Martusewicz et al., 2024). The concordance between the statistical evidence and the instrument's theoretical framework strongly supports the four-factor model and provides a solid foundation for advancing to confirmatory factor analysis (CFA) to evaluate its stability and generalizability across contexts.

4. Discussion

4.1 Scale of Meaningful Utilization of Generative Artificial Intelligence in Education

As the culmination of all the statistical results above, the Scale for Meaningful Utilization of Generative AI in Education is a proven empirical scale designed to assess and direct the meaningful utilization of GenAI technologies in higher education environments. This scale was not randomly created but was scientifically derived from a thorough exploratory factor analysis (EFA) that included psychometric evaluation, theme validation, and statistical modeling. The EFA yielded a cohesive four-factor structure, accounting for 64.5% of the cumulative variance, and was supported by high internal consistency (average Cronbach's α = 0.903). These findings validate the model's structural integrity and highlight its significance for evaluating GenAI use in educational settings.

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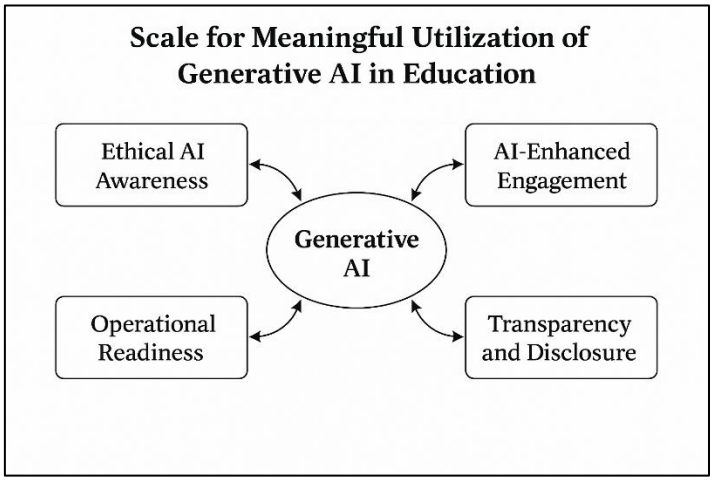

Figure 2. Scale of Meaningful Utilization of Generative Artificial Intelligence in Education

The first factor, "Ethical AI Awareness," emerged as the predominant factor, accounting for 23.14% of the variance. It demonstrates an understanding of the ethical, legal, and academic issues that should govern the use of generative AI among students and faculty. The said factor encompasses recognizing limitations, the significance of citation, preventing harm, and adherence to transparency and honesty in AI-assisted endeavors. This corresponds directly with the thematic category of "Ethical and Responsible Use," which was the most significant in the thematic analysis of various institutional documents. These findings resonate with the appeals made by Biagini (2025) and Nguyen et al. (2022) to prioritize ethical literacy and transparency in the incorporation of AI into educational settings. They contend that in the absence of a profound ethical underpinning, organizations are likely to promote cosmetic compliance rather than authentic ethical involvement.

The second factor, named "AI-Enhanced Engagement," accounts for 21.1% of the variance and encompasses the emotional and cognitive advantages linked to "AI utilization." It encompasses elements such as incentive, peer collaboration, individualized feedback, and equitable access. This factor evidently originates from the empirical factor loadings and the thematic codes identified in "AI Integration in Research and Creative Work" and "Institutional Capacity and Support." Hari et al. (2025) assert that when GenAI is pedagogically aligned with learner needs, it fosters greater engagement and inclusive education. Wang et al. (2021) similarly emphasize the significance of AI in enhancing learning satisfaction and social connectedness, hence validating the conceptual validity of this component.

The third factor, named "Transparency and Disclosure," accounting for 13.94% of the variance, emphasizes users' readiness and ability to reveal their utilization of GenAI products in academic assignments. It encompasses accurate citation, declaration in assignments, and adherence to institutional regulations. This theme is explicitly corroborated by the factor loadings and the qualitative codes associated with "Academic Integrity and Attribution" and "Student and Faculty Responsibilities." These insights are based on studies by Ateriya et al. (2025) and Zhang et al. (2025), which emphasize that explicit policy direction and institutional control promote transparent disclosure and mitigate academic misconduct in AI-assisted outputs. The model's focus on disclosure addresses growing concerns about the ambiguous authorship generated by GenAI techniques, as articulated by Dwivedi et al. (2024).

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The last factor, "Operational Readiness," accounting for 6.33% of the variance, reflects institutional and individual readiness to use AI tools effectively. This encompasses training, access to policies, and awareness of usage protocols. Despite being statistically less variable, it is essential, as no significant AI application can occur without basic access and capacity-building frameworks. This dimension arises from theme patterns in "Institutional Capacity and Support," bolstered by findings from Von Richthofen et al. (2022) and Martín-Rodríguez and Saihi et al. (2024), which underscore the importance of technical assistance and ongoing training for AI adoption. In the absence of operational readiness, ethical awareness and involvement may persist as theoretical concepts rather than tangible practices.

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ETHICAL CONSIDERATIONS

This study complied with ethical requirements for studies involving human subjects. Informed consent was obtained from all participants, and their participation was voluntary and anonymous. The collected data were handled with strict confidentiality and used exclusively for scholarly purposes. No personally identifiable information was collected, thereby ensuring compliance with the Philippine Data Privacy Act of 2012.

DECLARATION OF COMPETING INTEREST

The authors declare that there are no competing interests for any of the authors.

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