

A Hybrid SEM-Artificial Neural Network Study on Students' Usage and Perceptions of ChatGPT: Exploring Academic Work Engagement

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Abstract

The emergence of artificial intelligence (AI), particularly ChatGPT, has become widely used to aid students in educational tasks. This study investigated students' usage and perceptions of ChatGPT in academic work engagement using a revised Technology Acceptance Model (TAM) and Theory of Planned Behavior (TPB). An online questionnaire with 55 items was distributed, collecting 315 responses. Eleven latent variables were examined: technology readiness, user engagement, perceived ease of use, perceived usefulness, social influence, academic work engagement, attitude towards using ChatGPT, self-efficacy, response quality, intention to use, and actual use of ChatGPT. Structural Equation Modeling (SEM) revealed that technology readiness positively correlated with user engagement. User engagement significantly influenced social influence, affecting academic work engagement. Intention to use was significantly influenced by attitude towards using, response quality, and was related to the actual use of ChatGPT. Integrating Artificial Neural Networks (ANN) indicated the intention to use it as the most influential factor. The findings provide insights into the factors influencing ChatGPT adoption in academic environments and enhance the platform's performance.

Keywords: ChatGPT, SEM, ANN, Academic Work Engagement

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Introduction

ChatGPT is an artificial intelligence-based chatbot developed by OpenAI that uses natural language processing (NLP) to generate human-like responses to text-based inputs. Its emergence became a topic of interest, especially in the academic field, emphasizing its benefits and challenges. It has gained 100 million monthly active users in the two months since its release, marking it the fastest-growing consumer application in history (Dempere et al., 2023). Previous studies highlight the diverse benefits of ChatGPT in education, including research support and automated grading; however, issues such as online testing security, plagiarism, and broader societal and economic impact also arise (Robledo et al., 2023).

In the Philippines, ChatGPT has shown transformative effects on the education system. It became a tool that helps educators create educational content, as it offers suggestions and aids them in answering learners' questions, promoting collaborative work (Malik, 2024). Students in the Philippines utilize ChatGPT to generate and explore new concepts and ideas for their academic work (Antivola, 2023).

However, there are issues regarding its usage, such as the possibility of providing wrong and misleading information and plagiarism (Yu, 2024). However, despite these issues, integrating ChatGPT in academic environments positively impacts teaching-learning (Abderahman, 2024). Integrating ChatGPT in education has advantages and disadvantages; thus, educating teachers and students about its capabilities and restrictions is crucial (Agariadne, 2024).

An artificial neural network (ANN) is a computational model based on the structure and functions of biologically derived neural networks like humans' brains. It comprises interconnected nodes or neurons divided into layers: input, hidden, and output. Each neuron processes input data using weights, biases, and activation functions, allowing the network to learn from complex, non-linear relationships in the data through training. In SEM, indicator variables can be integrated with indirectly visible indicators (Shaghayegh, 2023). A new generation that merges SEM with artificial neural networks (ANNs) has emerged and aims to address the issues that cannot be solved solely by SEM analysis.

Contrary to SEM, an ANN is not suitable for hypothesis testing, but further to linear relationships can also deal with non-linear relationships. In addition, the ANN is capable of assessing the non-compensatory procedures. Moreover, the ANN is more reliable and can provide more accurate predictions than linear models (Sol & Baras, 2022). Furthermore, the integration of the SEM and ANNs allows for further validation of the findings of the SEM and the capture of the non-linear interactions between the antecedents and the outcome variables (Ghavifekr & Rosdy, 2015).

The research examines how college students utilize ChatGPT for their academic studies, aiming to fill a significant gap in the existing literature on this subject. The research examines how college students utilize ChatGPT for their academic studies, aiming to fill a substantial gap in the existing literature on this subject. These findings have implications for educators and students and provide valuable insights into teaching methods and strategies that promote deeper learning and responsible technology used in the classroom. By understanding how students engage with ChatGPT, educators can adapt their instructional approaches to integrate better AI-powered tools into the learning environment, ultimately enhancing the overall educational experience for students (Khan & Siddiqui, 2023). By understanding how students engage with ChatGPT, educators can adapt their instructional approaches to

integrate AI-powered tools into the learning environment better, ultimately enhancing the overall educational experience for students.

The study offers insights into the potential challenges and opportunities associated with AI-powered writing assistants, particularly in developing regions such as the Philippines. By shedding light on adopting the technology acceptance model (TAM) at the academic level, this research contributes to an expanding body of knowledge on the utilization of AI tools in educational settings (Kamalov et al., 2023). Understanding the unique challenges and opportunities presented by AI-powered writing assistants in developing regions can inform the development of tailored strategies to maximize their benefits and address potential barriers to adoption, thereby contributing to advancing educational practices and technologies in these contexts.

The research aims to comprehensively investigate the factors consistently motivating college students to utilize ChatGPT within educational settings. By exploring elements such as perceived usefulness in academic tasks, convenience in accessing information, efficacy in resolving queries, and broader impacts on academic advancement, the study seeks to uncover the fundamental motivations underlying students' recurrent engagement with the platform. Through this thorough examination, the research endeavors to attain a holistic understanding of what encourages students to persistently employ ChatGPT as a valuable resource in their educational pursuits.

The research investigates accessibility and ongoing user engagement, particularly among college students, to facilitate effective utilization of AI tools for deeper learning and responsible technology use. This endeavor highlights the importance of adopting a holistic strategy, including implementing innovative pedagogical practices integrating AI tools into educational approaches. By offering dynamic learning experiences tailored to diverse learning styles, educators can address potential disinterest or boredom that may lead to persistent usage of AI tools (Nguyen, 2023).

Moreover, ethical considerations are pivotal, necessitating open discussions on responsible technology use to empower students to make informed decisions and navigate ethical dilemmas associated with AI tools. Adopting student-centered approaches allows educators to understand better and address motivations driving persistent usage, fostering a sense of ownership and accountability among students (Iversen et al., 2015). Additionally, promoting critical thinking skills through activities that stimulate analysis, evaluation, and synthesis of information enables students to approach AI tools thoughtfully, minimizing the potential for over-dependence. Maintaining a balance between technology use and traditional pedagogical approaches ensures a comprehensive education encompassing varied learning experiences, diminishing the risk of excessive reliance on AI tools (Yu, 2024).

Methodology

Participants

The researchers implemented a hybrid methodology for disseminating survey questionnaires, integrating digital and conventional approaches. Google Forms served as the principal platform for distributing survey inquiries across diverse social media channels, complemented by face-to-face surveys wherein participants were provided with physical copies of the questionnaires. Before participation, each respondent provided informed

consent. The study was conducted at Occidental Mindoro State College (OMSC), encompassing eight distinct college departments with a population exceeding 5,000 individuals as of 2024. A simple random sampling technique was employed, and a sample size of 315 respondents was determined, exceeding the typical requirement of 200 respondents, especially in studies involving Structural Equation Modeling (SEM) (Khan & Siddiqui, 2023). These selected participants actively engaged in online and physical surveys, responding to a comprehensive questionnaire comprising 55 items.

The data gathered indicates that among the 315 participants surveyed, 54.3% identified as female, while 45.7% identified as male. Most respondents fell within the age range of 20-22 years (44.1%). Additionally, 33.7% were between 18-20 years old, 16.2% were aged 22-25, and only 6.0% were 25 years old and above. Regarding academic affiliation, the College of Business and Administration accounted for the most significant proportion of respondents, comprising 23.8% of the total. The School of Architecture had the lowest representation at 5.1%. Regarding educational attainment, 52.4% of respondents held a bachelor's degree, 34.9% had not completed high school, 8.3% had undergone college or vocational training, and 4.4% held a master's or doctorate. When examining monthly income, most respondents reported earning less than Php 10,000, constituting 60.6% of the sample. Additionally, 22.5% earned Php 20,000 or more monthly, 10.5% earned between Php 15,000 and Php 20,000, and only 6.3% earned between Php 10,000 and Php 15,000 monthly.

Structural Equation Modeling

The variables were drawn from a variety of research sources in literature. Observable factors were assessed using a Likert scale ranging from 1 to 5, where 1 signified "strongly disagree" and 5 signified "strongly agree", as shown in Figure 2. Data analysis was performed using AMOS software. The theoretical model data were confirmed through Structural Equation Modeling (SEM). SEM is especially effective for constructing a theoretical causal model that includes anticipated covariances among variables (Cruz-Cárdenas et al., 2021). This facilitates the exploration of covariances and provides valuable insights.

Results and Discussion

Results

This study investigates underlying factors influencing students' behavior and attitude in utilizing ChatGPT in their academic work. Eleven latent variables were examined using the structural equation model (SEM) to assess the relationship between technology readiness (TR), user engagement (US), perceived ease of use (PEU), perceived usefulness (PU), social influence (SI), academic work engagement (AWE), attitude towards using ChatGPT (ATU), self-efficacy (S), response quality (RQ), intention to use (IU), and actual use of ChatGPT (AUC). The SEM results show that out of 14 hypotheses, three were found to be insignificant, namely technology readiness towards perceived ease of use, academic work engagement towards perceived usefulness, and perceived ease of use towards attitude towards using ChatGPT having the p-value above 0.05, which does not meet criteria of the SEM standards on cut off procedures. Thus, a revised SEM was obtained by removing these hypotheses following the previous studies (Khoza et al., 2024).

Significant relationships, evidenced by p-values below 0.05, exist between technology readiness and user engagement (H1), user engagement and social influence (H3), user

engagement and perceived ease of use (H4), social influence and academic work engagement (H5), perceived usefulness and social influence (H6), perceived usefulness and perceived ease of use (H8), perceived usefulness and attitude towards using ChatGPT (H9), self-efficacy and attitude towards using (H11), attitude towards using and intention to use (H12), response quality and intention to use (H13), and intention to use and actual ChatGPT use (H14). Conversely, non-significant relationships, with p-values of 0.05 or higher, were found between technology readiness and perceived ease of use (H2), academic work engagement and perceived usefulness (H7), and perceived ease of use and attitude towards using ChatGPT (H10).

A detailed examination of literature-derived guidelines concerning students' engagement with ChatGPT alongside a compilation of standard model fit statistics obtained from a structural equation model. A thorough evaluation of these model fit indices is essential to ascertain how the proposed model accurately reproduces the observed co-variance matrix among all indicators. The Chi-Square (CMIN) statistic, when normalized by the degree of freedom (DF), yields an estimate of 2.196, indicative of an excellent fit. Moreover, the Comparative Fit Index (CFI), Incremental Fit Index (IFI), and Tucker Lewis Index (TLI) surpass the minimal values recommended for satisfactory fit, boasting respective values of 0.803, 0.805, and 0.792. Researchers have diligently addressed all modification indices within the same variable to enhance model fit, implying room for further refinement. Finally, the Root Mean Square Error of Approximation (RMSEA) meets the established criteria at 0.062, with lower values denoting superior fit (Ekşioğlu & Ural, 2022). The evaluation shows that a well-fitted model, based on positive values for all the fit indices, indicates potential improvements by addressing these modification indices within individual variables.

Artificial Neural Network

An Artificial Neural Network (ANN) operates similarly to the brain's neural structure, processing data through interconnected nodes to recognize patterns and make predictions (Raj, 2023). Similarly, Structural Equation Modeling (SEM) analyzes relationships between variables, making it an applicable tool for assessing how ANNs learn and predict outcomes. The SEM findings indicate that all latent variables positively correlate with each connection, as indicated by p-values > 0.05 . In the context of ANN, input nodes such as RT, US, PEU, PU, SI, AWE, ATU, S, RQ, and IU demonstrate a significant correlation with the dependent variable, representing the actual use and the study's endpoint. The findings from the ANN revealed that the variable Intention to Use (IU) emerged as the most influential factor, followed by the respective parameters as outlined. The consistent findings observed in both SEM and ANN are crucial to consider the indirect effect of SEM, emphasizing its substantial impact on the reported outcomes. This underscores the discovery's significance, validated through the hybrid SEM-ANN methodology (Figure 1).

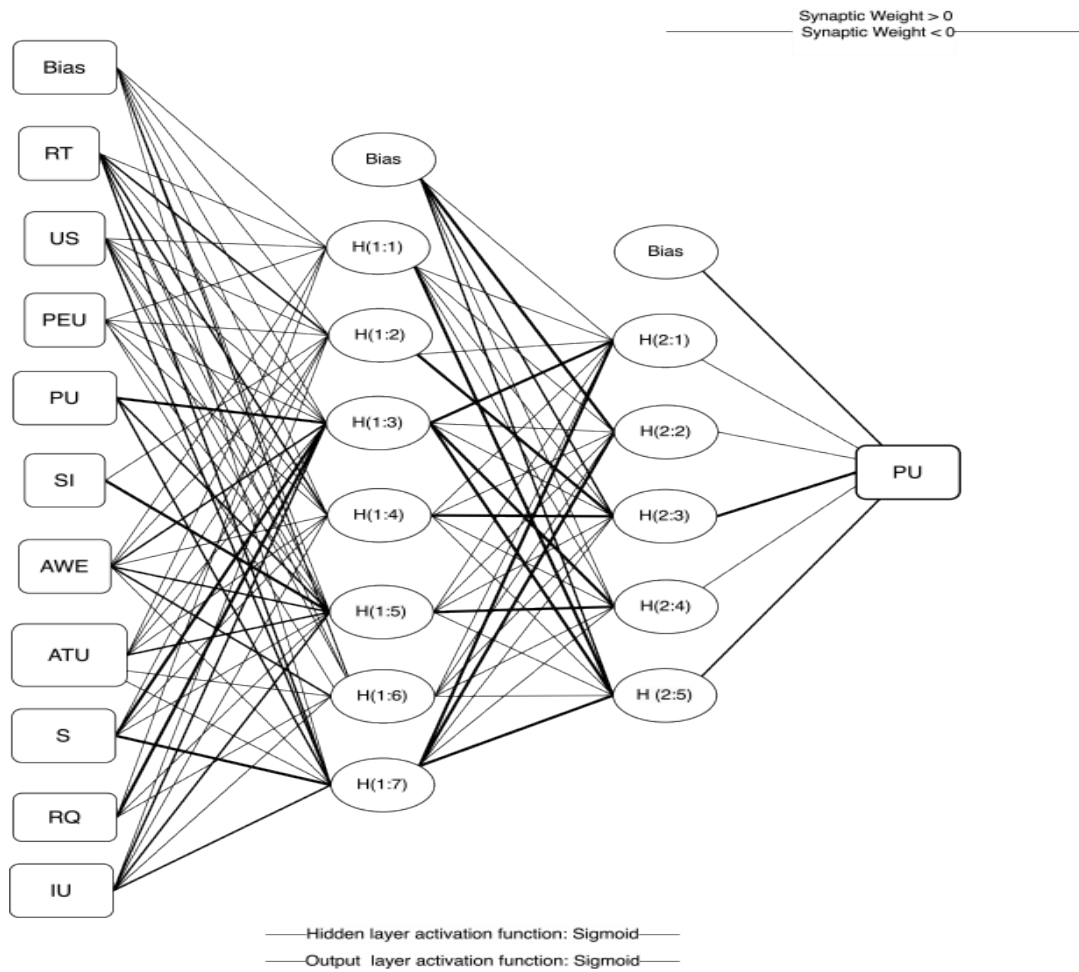


Figure 1: Artificial Neural Network Model

Conclusion

Flash Chat GPT is an artificial intelligence-based chatbot developed by OpenAI that uses natural language processing (NLP) to generate human-like responses to text-based inputs. Its emergence has become a topic of interest, especially in the academic community, emphasizing its advantages and challenges. Hence, the study delved into the intricate relationships among various factors influencing college students' engagement with ChatGPT, including technology readiness, user engagement, perceived ease of use, perceived usefulness, social influence, academic work engagement, attitude towards using ChatGPT, self-efficacy, response quality, intention to use, and actual use of the platform. Utilizing Structural Equation Modeling (SEM), the analysis unveiled significant positive correlations, most notably between technology readiness and user engagement. This finding implies that students with a better grasp of effectively utilizing ChatGPT tend to participate more actively on the platform.

The researchers used digital and traditional methods in distributing survey questionnaires to 300 participants to understand students' attitudes, identify key engagement factors, and evaluate ChatGPT's impact on academic outcomes. The questionnaire, created by the researchers, was divided into 14 sections and covered 11 factors, with 55 questions. They used AMOS software to analyze the data and confirmed their theoretical model with SEM.

To further explore and validate these relationships, an Artificial Neural Network (ANN) model was employed to analyze training and testing datasets related to students' perceptions and usage of ChatGPT. The ANN model, trained on a 70% data sample and tested on a 30% data sample, provided performance metrics such as the Sum of Squared Errors (SSE) and Root Mean Square Error (RMSE), which indicated the accuracy and predictive capability of the models in assessing students' engagement with ChatGPT. Recognizing the limitations of SEM in capturing nonlinear relationships and non-compensatory procedures, the study integrated SEM with ANN. This hybrid approach allowed for a more comprehensive validation of SEM findings and enabled the capture of nonlinear interactions between the antecedent and outcome variables. The combined insights from SEM and ANN offer valuable implications for educators and students, informing the development of tailored strategies to promote deeper learning and responsible technology use in higher education settings.

In conclusion, the study provides researchers, teachers, and educational technology developers with a deeper understanding of factors that affect students' involvement in using AIWriters Writing Assistants, which offers valuable insight on developing effective teaching practices, as well as information on designing and implementing artificial intelligence tools in education settings.

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