Generative AI as a Learning Buddy and Teaching Assistant: Pre-service Teachers' Uses and Attitudes

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Abstract—To uncover pre-service teachers' (PSTs') user experience and perceptions of generative artificial intelligence (GenAI) applications, we surveyed 167 Ghana PSTs' specific uses of GenAI as the learning buddy and teaching assistant and their attitudes towards these applications. Employing exploratory factor analysis (EFA), we identified three key factors shaping PSTs' attitudes toward GenAI, teaching, learning, and ethical and advocacy factors. The mean scores of these factors revealed a generally positive attitude towards GenAI, showing high levels of agreement on GenAI's potential to enhance PSTs' content knowledge and access to learning and teaching resources, this, in turn, reduces their need for assistance from colleagues in their learning and teaching practices. The findings specifically showed that PSTs use GenAI as a learning buddy to access reading materials, in-depth content explanations, and practical examples and as a teaching assistant to enhance their teaching resources, developing assessment strategies and lesson planning. A regression analysis showed that background factors such as age, gender, and year of study do not predict PSTs' attitude towards GenAI, but the age and year of study significantly predict the frequency of their use of GenAI, whereas gender does not. These findings indicate that older PSTs and those further along in their teacher education programs may use GenAI more frequently, but their perceptions of the application remain unchanged. However, the PSTs were concerned about the accuracy and trustworthiness of the information provided by GenAI applications. We, therefore, suggest the need to address the concerns about the accuracy and trustworthiness of GenAI, ensuring that PSTs can confidently rely on these applications in their teacher preparation programs. Additionally, we recommend targeted strategies to integrate GenAI more effectively into both the learning and teaching processes for PSTs.

Index Terms—Generative Artificial Intelligence (GenAI), AI, Use, Attitude, Learning, Teaching, GenAI.

I. INTRODUCTION

GENERATIVE artificial intelligence (GenAI) is artificial intelligence capable of generating new text, images, videos, and other data by responding to human inquiry [1]. GenAI has recently emerged as a promising resource within educational contexts, including teacher education programs.

Numerous studies highlight its potential to enhance personalized learning, lesson preparation, and research for pre-service teachers (PSTs) [2], [3]. GenAI applications can provide real-time feedback, simulate classroom scenarios, and support the development of digital literacy skills, making them valuable assets in the preparation of future educators [4], [5]. By offering tailored educational experiences, PSTs can better understand and apply theoretical concepts to practical use, ultimately improving their academic performance and readiness for the teaching profession. This becomes significant as PSTs possess dual roles both as learners and teachers, which complicates their user experience of GenAI integration.

Research indicates that PSTs utilize GenAI applications in their coursework learning and teaching practice and recognize their potential benefits [6], [7]. However, recent studies also show that the effective use of GenAI applications by PSTs is often hindered by various challenges, such as a lack of training in GenAI integration, the lack of skills to handle ethical and algorithmic biases, and negative attitudes [8]. These challenges lead them to have skepticism toward the use of GenAI applications in their learning and teaching.

Therefore, it is vital and urgent to understand how PSTs use GenAI applications in their learning and practical fields and their attitudes toward GenAI integration. This study explores the various aspects that GenAI applications assist PSTs in their coursework by serving as a learning buddy, how GenAI assists PSTs in their teaching practice by serving as a teaching assistant, and their attitudes towards GenAI. The study further examines the various background factors that predict PSTs attitudes and their use of GenAI as their learning buddy and teaching assistant. The findings present a comprehensive understanding of the dual user experience of GenAI towards the holistic professional development of PSTs in their teacher preparation program. The study answers the following research questions:

1) In what ways do PSTs use GenAI as a learning buddy during their coursework?

2) How do PSTs employ GenAI as a teaching assistant during their teaching practice?
3) What is the attitude of PSTs towards GenAI applications?
4) How do the PSTs' background factors predict their attitudes toward GenAI and the uses of GenAI for learning and teaching?

II. Theoretical Framework: The Dual Role of Generative AI for Pre-service Teachers

Pre-service teachers (PSTs), positioned uniquely as both learners and educators, are increasingly integrating GenAI into their daily practices [3]. These dual roles allow them to exploit GenAI's capacities as a learning buddy, providing personalized learning support, facilitating deeper understanding through interactive dialogues, and offering instant feedback on various tasks. Meanwhile, PSTs leverage GenAI as a teaching assistant, which aids in creating instructional materials, grading homework and assessments, and even simulating classroom interactions to enhance pedagogical skills. These opportunities offered by GenAI not only enrich PSTs' learning experience but also facilitate the development of their instructional strategies, promoting an adaptive and innovative educational environment.

A. Generative AI as a Learning Buddy

When GenAI plays the role of a learning buddy, it can facilitate PSTs' learning activities by offering personalized instruction, real-time feedback, and interactive engagement, essential for skill acquisition and conceptual understanding [9], [10]. First, GenAI offers a transformative potential for PSTs by extending their perspectives and knowledge. This technology harnesses vast datasets to provide access to diverse viewpoints, comprehensive information, and various educational paradigms beyond traditional textbooks and lectures [11]. PSTs can leverage GenAI to explore a multitude of educational theories, pedagogical methods, and cultural contexts, enriching their understanding and broadening their intellectual horizons [12]. By presenting nuanced perspectives on complex educational issues, GenAI encourages critical thinking and helps future educators develop a more inclusive and multifaceted approach to teaching [13].

In addition to broadening perspectives, GenAI excels in offering in-depth content explanations. PSTs often grapple with complex theories and concepts that require detailed, tailored explanations [14], [15]. GenAI-powered applications can break down intricate subjects into more digestible segments, providing explanations customized to the learner's pace and level of understanding [16]. This individualized learning approach ensures that PSTs can thoroughly comprehend essential educational theories and practices [17], [18]. GenAI can also facilitate a dynamic learning environment where PSTs can ask questions and receive immediate, detailed feedback [19], enhancing their grasp of challenging content and promoting a deeper engagement with the material.

GenAI also plays a crucial role in finding practical examples illustrating theoretical concepts, which is vital for effective teacher training. By synthesizing a wide array of real-world scenarios and case studies, GenAI can provide PSTs with relevant examples demonstrating the application of educational theories in practice [20]. This contextual learning bridges the gap between theory and practice, making abstract ideas more tangible and easier to comprehend. Furthermore, GenAI continually updates its repository of examples, ensuring that PSTs are exposed to the latest developments and best practices in the field of education [3]. This exposure helps them stay current with contemporary educational trends and methodologies [21], [22].

Another significant advantage of GenAI is its ability to assist PSTs in finding relevant reading materials. GenAI can efficiently search through vast digital libraries and databases to curate lists of scholarly articles, books, and other resources tailored to specific learning needs and interests [23]. This capability saves time and ensures that PSTs have access to high-quality, up-to-date literature essential for their academic and professional development [21]. By providing a curated selection of reading materials, GenAI supports PSTs in building a robust theoretical foundation and staying informed about current research and debates in education.

Finally, GenAI can greatly enhance the reflective practices of PSTs, which are crucial for their professional growth [24]. GenAI applications can facilitate structured reflection by prompting PSTs to analyze their experiences, assess their understanding, and identify areas for improvement [25]. These applications can also provide feedback on reflective writings, suggesting further areas for contemplation and helping PSTs develop critical self-awareness [26], [27]. By guiding reflective practices, GenAI fosters a habit of continuous self-assessment and improvement, which is essential for effective teaching. Moreover, GenAI can compile and analyze data from multiple reflections over time [19], [24], offering insights into PSTs' development and progression, thus supporting ongoing professional growth and effective practice.

Despite the great potential of GenAI for PSTs' learning, there is a need for well-defined guidelines and policies to support the responsible and effective integration of GenAI in learning [28], [29]. Holland and Ciachir [28] posited that learners appreciated the immediacy and validation provided by GenAI, but concerns about equity and academic integrity emerged, particularly in group work where misuse of the application could lead to academic misconduct. Likewise, Rasul et al. [29] identified academic integrity as a significant challenge in their examination of GenAI roles in higher education and emphasized the need for clear institutional policies and transparency to mitigate these risks and ensure ethical GenAI uses.

B. Generative AI as a Teaching Assistant

As a teaching assistant, GenAI offers significant advantages for PSTs in identifying effective assessment strategies. Traditional assessment methods often lack the flexibility and adaptability needed to address diverse student needs and learning styles [30]. GenAI can analyze extensive educational data to recommend varied assessment techniques, such as

performance-based tasks and adaptive testing. These AI-driven strategies ensure a more holistic evaluation of student understanding and progress. By leveraging GenAI to develop and implement diverse assessment strategies, PSTs can gain a deeper insight into student learning [2], [31], allowing them to tailor their instructional approaches to better meet individual student needs and improve educational outcomes.

In addition to enhancing assessment strategies, GenAI can assist PSTs in identifying clear and measurable lesson objectives. Establishing precise objectives is critical for effective lesson planning and delivery, as it ensures that lessons are aligned with educational standards and student learning goals [2], [27]. GenAI can leverage its powerful language analysis and generation capacity to analyze curriculum guidelines, educational standards, and student data to suggest specific and actionable objectives for each lesson [32]. This process not only helps PSTs focus their instruction on key learning outcomes but also provides a structured framework for evaluating student progress. By using GenAI to refine lesson objectives, PSTs can ensure their teaching is purposeful and aligned with broader educational goals.

Creating comprehensive and effective lesson plans is another area where GenAI can significantly aid PSTs. Recent studies have reported that AI-powered systems can generate detailed lesson plans incorporating best practices in pedagogy, differentiated instruction, and classroom management [2]. These plans can include various instructional strategies, activities, and assessment methods, such as analogies [33], designed to engage students and promote deep understanding. By automating the lesson planning process, GenAI allows PSTs to concentrate more on delivering high-quality instruction and addressing the dynamic needs of their students. Additionally, GenAI-generated lesson plans can be easily adapted and personalized, ensuring they remain relevant and effective in diverse classroom settings.

GenAI is also invaluable in providing exemplary lesson samples to PSTs. By analyzing a vast repository of lesson plans and educational resources, GenAI can curate a selection of high-quality lesson examples aligned with specific learning objectives and curriculum standards [34]. These samples serve as valuable references, offering practical guidance and inspiration for designing effective lessons. Access to a diverse array of exemplary lessons helps PSTs expand their instructional strategies and ensures they are equipped with the applications needed to deliver engaging and impactful instruction [2]. This exposure to well-crafted lesson samples enhances the pedagogical skills of PSTs and boosts their confidence in lesson planning and execution [35].

Finally, GenAI can aid PSTs in finding a wide range of teaching resources [23]. From interactive multimedia content to scholarly articles and educational games, GenAI can sift through extensive digital libraries and databases to recommend resources that support various aspects of teaching, learning, and research [3], [36]. This capability not only saves PSTs' time but also ensures them having access to the most relevant and up-to-date materials available. By integrating these resources into their teaching, PSTs can enhance the learning experience, cater to different learning styles, and keep students engaged. The continuous updating of AI databases with new and innovative teaching resources ensures that PSTs always have access to fresh, high-quality materials to enrich their instruction.

III. METHOD

In this study, we employed a quantitative survey approach [37], [38] to systematically investigate the extent to which PSTs engaged with GenAI applications as a learning buddy during their academic coursework and as a teaching assistant during their teaching practice. This approach was not only relevant to addressing the research questions but also appropriate for reaching a larger number of participants to gain insights, especially since they were in different institutions [38].

A. Participants

Utilizing a convenience sampling approach, we recruited 167 pre-service teachers (PSTs) as participants from four teacher education institutions in Ghana to complete an online survey. These PSTs are enrolled in a four-year bachelor's degree program in teacher education, specializing in high school education. The selection of these institutions was deliberate and guided by considerations of convenience for the researchers. The demographic breakdowns of PSTs showed that most of them fall within the 21-25 age group, comprising 61.82% of the sample, followed by the 26-30 age group at 32.12%. The youngest (16-20) and oldest (31-35) age groups are the least represented, with 2.42% and 3.64%, respectively. There is a significant disparity regarding their gender, with males constituting 73.05% and females 26.95%. In terms of the year in their program (level), the largest group was in Level 400 (i.e., year of study), making up 57.49% of the sample, followed by those at Level 300 with 35.93%, and then Level 200 level representing at 6.59%.

B. Instruments

We iteratively developed a survey instrument to assess PSTs' use and attitudes towards GenAI in their learning and teaching. The instrument consisted of four sections with 22 items inspired by the works of Strzelecki (2023) on the 'ChatGPT acceptance and use scale.'

The first section contained three items to collect participants' background information (i.e., age, gender, and year in program-level). The second section contained two open-ended items to obtain the areas participants use GenAI applications for their learning and in their teaching (e.g., "Which aspect do you think GenAI is or will be most useful in your teaching?"). The third section contained two items to solicit the frequency at which participants use GenAI within a week (e.g., "How often do you use GenAI for teaching?" "How often do you use GenAI for learning purposes?"). These items were made up of five categories (e.g., never, rarely, sometimes, often, and very often).

The fourth section was developed to measure participants' attitudes towards using GenAI in both their learning and teaching, consisting of 12 items. The development of the attitude scale items was specifically adapted from the 'ChatGPT

acceptance and use scale' by Strzelecki (2023). The scale originally contained eight constructs; however, we adopted items from five constructs relevant to our study to assess "GenAI use and attitude," including "performance expectancy" which consisted of four items, "Effort expectancy" containing four items, "Social influence" with three items, "Facilitating Conditions" with four items, and "Behavioral intention" with three items. Each of the five constructs had Cronbach alpha coefficients (α) as follows: $\alpha = 0.91$, $\alpha = 0.9$, $\alpha = 0.93$, $\alpha = 0.83$, and $\alpha = 0.87$ respectively. Based on these alpha coefficients, we adapted 12 items from these constructs for our study-specific purpose.

We further conducted an exploratory factor analysis to categorize these items. These included five items for measuring PSTs' attitudes towards GenAI for their learning, five items measuring PSTs' attitudes towards GenAI for their teaching, and two items measuring their general view about GenAI on ethics and the possibility of incorporating it into their course of study. Table 1 provides some examples of the original items from Strzelecki (2023) and the modified items for the attitude scale for this study(See Table I).

C. Data Collection

We distributed the survey items through Google Forms for data collection. This method was chosen for its convenience in gathering information from the range of participants from the four teacher education institutions. In each of the institutions, the participants were first oriented about the study, which involved their consent, the voluntary nature of participation, and the purpose of the study. We explained some of the categories in the context of this study such as the use frequency GAI; "Very often" denoting at least Everyday Use of AI in a Week, 'Often' (at most three days within a week), "Sometimes" (at most two days a week), Rarely (Once a Week), Never= (Not at All). We then shared the Google Forms survey link with them via WhatsApp, allowing them to respond at their convenience. Eventually, we collected valid responses from all 167 participants for data analysis.

D. Data Analysis

Before data analysis, we first exported all PSTs' responses in Excel and then checked for data completeness for further processing. We performed descriptive statistics using frequency counts and percentages (%) to analyze the items addressing the ways PSTs use GenAI as a learning buddy and as a teaching assistant to answer Research Questions 1 and 2. To answer Research Question 3 (To assess PSTs attitudes towards GenAI applications), we converted the numerical values of each Likert scale as Strongly Agree (SA) =5, Agree (A) =4, Neutral (N) =3, Disagree (D) = 2, and Strongly Disagree (SD) = 1. We established a binary of positive and negative categories mainly grounded on the mean scores: a mean score above 3 indicated a positive attitude, reflecting agreement or approval of the statement related to GenAI in teacher education. Conversely, a mean score below 3 signifies a negative attitude, indicating disagreement or skepticism towards the statement concerned with GenAI's in teacher education.

To answer research Question 4 on background factors of PSTs that predict their attitudes towards GenAI, we conducted a regression analysis in R Statistical Software (R version 4.3.3) with age, gender, and year in the study as the predictors (See Table VII). The dependent variable, Attitude towards GenAI, was derived from 12 Likert scale items. PSTs rated their attitudes on the 5-point Likert scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree). We calculated a composite score for each participant by averaging their responses across the 12 items:

$$Composite\ Score_i = \frac{1}{n} \sum_{j=1}^{n} Q_{ij}$$

where $Composite\ Score_i$ is the composite score for the i-th participant, Q_{ij} is the response of the i-th participant to the j-th Likert item, and n is the total number of Likert items. These composite scores were standardized to have a mean of 0 and a standard deviation of 1.

Gender was coded as 0 for 'Female' and 1 for 'Male,' with 45 entries identified as female and 122 as male. The variable Year of Study (Level) was treated as categorical with three levels ('200', '300', and '400'), and dummy coding was applied with the lowest level (Level 200) as the reference category. The multiple linear regression (lm()) model was specified as:

$$\begin{aligned} Attitude\_GenAI_i = \beta_0 &+ \beta_1 Age_i + \beta_2 Gender_i \\ &+ \beta_3 Level\_300_i + \beta_4 Level\_400_i + \epsilon_i \end{aligned}$$
$$(1)$$

This regression equation models the attitude towards GenAI as a function of age, gender, and year of study. The coefficients β_1, β_2, β_3, and β_4 provide insights into how each of the factors predicts PSTs' attitude towards GenAI, while the intercept β_0 gives the baseline level of PSTs' attitude towards GenAI when all the predictors are at their reference levels. The error term ϵ_i accounts for the variability in attitudes, which may not be explained by the model.

We used the polr() function from the MASS library in R to do an ordered logistic regression model to answer the second part of research question 4 about the background factors of PSTs that predict how often GenAI will be used as a learning buddy or a teaching assistant. The dependent variable, GenAI use frequency for both learning buddy and teaching assistant was measured on an ordinal scale with five categories: 'Never,' 'Rarely,' 'Sometimes,' 'Often,' and 'Very often.' The predictors included age (16-20, 21-25, 26-30, 31-35), year of study (200, 300, 400), and gender (Male, Female). The ordered logistic regression model was specified as follows:

$$\log\left(\frac{P(Y \leq j)}{P(Y > j)}\right) = \alpha_j - \beta X -$$

$$(\beta_1 \cdot Age + \beta_2 \cdot Year\ of\ Study +$$

$$\beta_3 \cdot Gender)$$

TABLE I: Examples of Modified Items Adapted for both Attitude and Use of GenAI Applications

S/N	Original Item	Adapted Item
1	Using ChatGPT increases your productivity in your studies	GenAI helped me understand various complex areas of my study.
2	My interaction with ChatGPT is clear and understandable	GenAI explained things better to me than we had the time to do in class.
3	I have the resources necessary to use ChatGPT	It is expensive using GenAI applications for studies/teaching
4	I intend to continue using ChatGPT in the future	I suggest GenAI applications be incorporated into our courses and teaching practice
5	I have the knowledge necessary to use ChatGPT	I didn't/don't require much assistance from colleagues for my teaching since I am using GenAI.
6	Please choose your usage frequency for ChatGPT	How often do/did you use GenAI for your studies/teaching practice?

where α_j represents the thresholds between the categories. These thresholds indicate the points on the latent variable scale where the probability of transitioning from one category to the next changes.

After fitting the model, we extracted and summarized the coefficients for each predictor, including their standard errors (SE), t-values, and p-values. This allowed us to interpret the log odds of being in a higher category of GenAI use for each unit change in the predictor variables and determine the statistical significance of each predictor.

To enhance the interpretability of our findings, we created a data frame containing all combinations of the predictor values and predicted the probabilities of each GenAI use frequency category. For an ordered logistic regression model with predictor variables, we calculated the predicted probability as follows:

$$P(Y = j) = P(Y \leq j) - P(Y \leq j - 1)$$

We then used the *ggplot2* package in R (R version 4.3.3) to create a clear and informative visualization of the predicted probabilities. This graphical representation illustrated the distribution of the predicted probabilities across the different background factors of age, year of study, and gender, providing an understanding of each predictor on the frequency of GenAI use as both learning buddy and teaching assistant.

IV. FINDINGS

A. Generative AI as a Learning buddy

This section presents the results on areas where PSTs use GenAI as a learning buddy (See Table II) and how frequently they use it within a week (See Figure 1). The finding shows that PSTs mainly use GenAI in five different areas for their learning. Ninety-three (38.11%) of PSTs specifically indicated that they use GenAI to find reading materials for the courses of study, whereas 62 also indicated they use GenAI to seek in-depth content explanations (25.41%). Finding practical examples was another area in which the PSTs employed GenAI to assist them in the learning of their course (37; 15.16%). About 25 (10.25%) indicated using GenAI to extend their perspectives/knowledge in their courses of study, while 27 (11.07%) indicated using GenAI assists them in conducting reflections in their learning.

Additionally, Figure 1 explains the frequency at which PSTs use GenAI in these areas of their learning. The findings show many of them "Sometimes' (n = 70) use GenAI as their learning buddy, whereas a substantial number of them indicated they use it "Very often" (n = 50). The rest of the use spread within "Often" (n = 25), "Never" (n = 20), and "Rarely" (n = 2). This shows a varying reliance on GenAI for learning among the PSTs.

TABLE II: Uses of Generative AI by PSTs as a Learning Buddy

Learning areas	# of teachers	%
Extending Perspectives/Knowledge	25	10.25
Seeking In-depth Content Explanations	62	25.41
Finding Practical Examples	37	15.16
Finding Reading Materials	93	38.11
Conducting Reflections	27	11.07

Fig. 1: Frequency of GenAI use as Learning Buddy

B. Generative AI as a Teaching Assistant

The finding in this section shows five instructional areas PSTs use GenAI as a teaching assistant (see Table III). Specifically, the findings indicated that ninety (33.33%) PSTs rely on GenAI to find teaching resources representing. Fifty-eight (21.48%) of them indicated using GenAI in identifying assessment strategies, whereas forty-four (16.30%) use GenAI for the generating of lesson objectives and 43 (15.93%) indicated using GenAI to create their lesson plans in general. A good number of the PSTs (35; 12.96%) showed using GenAI to find sample lessons.

The bar chart in Figure 2 further illustrates the frequency of use of GenAI by the PSTs as teaching assistant. The finding shows that most PSTs "Sometimes" (n = 61) use GenAI for teaching whiles thirty-five (n = 32) of them had "Never" use GenAI in their teaching. A good number of them, "Often" (n = 31), use GenAI for teaching with some using GenAI "Very often" (n = 25). About eighteen (n = 18) of the PSTs "Rarely" use GenAI for teaching. This distribution suggests that while some PSTs are frequent users of GenAI for teaching, others are less inclined to use it in their teaching activities. This shows a varying reliance on GenAI for teaching among the PSTs.

C. Exploratory Factor Analysis of PSTs' Attitudes

Exploratory Factor Analysis (EFA) of the items measuring attitude toward GenAI was performed (see Table IV). This was performed on the 12 attitude items using the minimum residual

TABLE III: Uses of Generative AI by PSTs as a Teaching Assistant

Instructional area	# of teachers	%
Identifying Assessment Strategies	58	21.48
Identifying Lesson Objectives	44	16.30
Creating Lesson Plans	43	15.93
Finding Sample of Lessons	35	12.96
Finding Teaching Resources	90	33.33

Fig. 2: Frequency of GenAI Use as Teaching Assistant

(minres) method with a varimax rotation. The analysis involved a three-factor solution explaining 54% of the variance. The factors were labeled attitude towards using GenAI for learning (GenAIL), attitude towards using GenAI for teaching (GenAIT), and Ethical and Advocacy (EAA), with SS loadings of 3.06, 2.01, and 1.38, respectively, indicating the amount of variance captured by each factor. The mean item complexity was 1.3, suggesting that items tend to load on more than one factor. The root mean square of the residuals (RMSR= 0.05) indicated a good fit, with a Tucker Lewis Index (TLI=0.899) and an RMSEA of 0.074, suggesting an acceptable fit to the data. The Bayesian Information Criterion (BIC) was -91.96, further supporting the model fit.

D. Attitudes of PSTs towards GenAI

To answer RQ3 on PSTs' attitude toward GenAI in their learning and teaching, the exploratory factor analysis implies three factors for teachers' attitudes toward GenAI, including the use of GenAI in teaching (GenAIT), in learning (GenAIL), and Ethical and Advocacy Factor (EAA), as shown in Table V. Items related to GenAIL such as Item1 (Factor Loading (λ=.52), Item 2 (λ=.81), Item3 (λ=.67), Item4 (λ=.62), and Item 12 (λ=.33) exhibit strong factor loadings, suggesting PSTs' attitudes towards GenAI in their learning, with Item 6 (λ=.94) being particularly indicative of GenAIL. In the GenAIT factor, Item 5 (λ= .78), Item 6 (λ=.94), Item 7 (λ=.66), Item 8 (λ=.73), and Item11 (λ=.59) underscore PSTs' attitudes about GenAI' roles in enhancing their teaching, emerging as a key factor shaping their attitudes toward GenAIT. Comprising Item 9 (λ=.98) and Item 10 (λ=.42), the EAA factor captures attitudes towards ethical and advocacy for GenAI integration into both their use of GenAI for learning and teaching.

The overall mean and standard deviation (SD) for the constructs GenAIL, GenAIT, and EAA were analyzed to determine PSTs' overall attitudes towards GenAI. The results indicated that PSTs have a moderately positive attitude towards GenAI for learning (M=3.678, SD=0.786), accompanied by relatively low variability in responses. Similarly, the results revealed that PSTs have a moderately positive attitude towards GenAI for teaching (M=3.458, SD=0.950), with slightly higher variability in responses compared to GenAIL. Additionally, regarding the construct EAA, the results indicated PSTs' neutral to slightly positive attitude towards GenAI (M=3.005, SD=0.815), accompanied by relatively low variability in responses.

Among other findings, the PSTs positive attitude towards GenAIL was specifically based on their belief that GenAI assists them in "accessing more reading materials with GenAI" (M = 4.01, SD = 0.93) while helping them to understand complex areas of study (M = 3.72, SD = 0.53). Furthermore, PSTs' positive attitude towards Generative AI for Teaching (GenAIT) was based on several reasons. They specifically agreed that GenAI reduces the need for colleague assistance in teaching (M = 3.42, SD = 1.16) and that they do not require much assistance from colleagues for their teaching since using GenAI (M = 3.34, SD = 1.16). In terms of Ethical and Advocacy of GenAI (EAA), they expressed a relatively neutral but slightly positive attitude towards the cost of using GenAI applications for learning and teaching (M = 3.21, SD = 0.82). However, there was some concern regarding the accuracy and trustworthiness of the information provided by GenAI applications, with PSTs showing a more neutral attitude in this regard (M = 2.80, SD = 0.81).

E. Factors Predicting PSTs' Attitude and GenAI Use

To answer RQ4, we tested several hypotheses (H). These hypotheses helped us determine which PSTs' background factor predicts their attitudes toward GenAI (see Table VI) as well as their use of GenAI as their learning buddy and teaching assistant (see Table VII). Specifically, we focus on the background factors of age, year of study, and gender.

1) Background Factors Predicting Attitudes toward GenAI (BFAG):

- H0BFAG: The background factors of PSTs, such as age, year of study, and gender, do not significantly predict their attitudes toward GenAI.
- H1BFAG: One or more background factors of PSTs, such as age, year of study, and gender, significantly predict their attitudes toward GenAI.

The results showed that none of the background factors (gender, year of study, and age) significantly predicted PSTs' attitudes toward GenAI (See Table VI). Specifically, Male was not a significant predictor (B = 0.04, SE = 0.09, p = .683). Similarly, among the year of study, both Level 300 (B = -0.06, SE = 0.17, p = .717) and Level 400 (B = -0.06, SE = 0.17, p = .722) did not significantly predict PSTs' attitudes toward GenAI. Age also did not show significant predictions, with the age groups 21-25 (B = -0.32, SE = 0.26, p = .233), 26-30 (B = -0.22, SE = 0.27, p = .410), and 31-35 (B = -0.22, SE = 0.33, p = .520) all yielding non-significant results. Based on the non-significant p-values for each predictor variable, we fail to reject the null hypothesis for each background factor.

TABLE IV: Factor Loadings from Exploratory Factor Analysis

S/N	Item	GenAIT	GenAIL	EAA	(h^2)	(u^2)	Complexity
1	GenAI has the potential to positively improve my content knowledge.	.10	.52	-.20	.33	.673	1.4
2	I don't require much assistance from colleagues for my studies since I am using GenAI	.22	.81	-.04	.70	.300	1.2
3	GenAI helped me understand various complex areas of my study	.20	.67	.22	.53	.465	1.4
4	With the help of GenAI, I can get more reading materials	.27	.62	.20	.50	.505	1.6
5	Reduced need for colleague assistance in teaching with GenAI	.78	.17	-.08	.65	.355	1.1
6	I don't require much assistance from colleagues for my teaching since I am using GenAI	.94	.02	-.10	.89	.107	1.0
7	GenAI has the potential to improve my pedagogical skills (teaching skills) of teachers	.66	.26	.03	.50	.495	1.3
8	I felt more confident preparing and teaching with GenAI's assistance	.73	-.01	.22	.59	.413	1.2
9	It is expensive using GenAI applications for studies/teaching	-.14	.10	.98	1.00	.001	1.1
10	There is inaccuracy and distrust in GenAI applications' information	.21	-.09	.42	.23	.772	1.5
11	I suggest GenAI applications be incorporated into our courses and teaching practice	.59	.20	.18	.42	.577	1.4
12	Student might cheat and lack critical/creative skills development due to GenAI	-.08	.33	-.05	.12	.882	1.2

2) Background Factors Predicting GenAI Use as a Learning Buddy and as a Teaching Assistant (BFUG):

- H0BFUA: The background factors of PSTs, such as age, year of study, and gender, do not significantly predict the ordered categories of their use of GenAI for learning and teaching.
- H1BFUG: One or more background factors of PSTs, such as age, year of study, and gender, significantly predict the ordered categories of their use of GenAI for learning and teaching.

Table VII shows the ordinal logistic regression analysis for GenAI as a learning buddy (GenAIL) and GenAI as a teaching assistant (GenAIT) models to understand the background factors that can predict the frequency of GenAI use among PSTs. The ordered logistic regression revealed significant predictors for the use of GenAI for learning, with age 31-35 (B = 3.1267, SE = 1.2425, p = .0119) and year of study 300 (B = 1.6054, SE = 0.6513, p = .0137) being significant, while other factors were not. Similarly, significant predictors for the use of GenAI for teaching included year of study 300 (B = 2.121, SE = 0.6824, p = .0019) and year of study 400 (B = 1.674, SE = 0.6816, p = .0140), with age 31-35 approaching significance (B = 2.226, SE = 1.2601, p = .0773). Gender and other age groups did not significantly predict the use of GenAI as either a learning buddy or a teaching assistant. Based on the results from Table VII, we reject the null hypothesis for the significant predictors and fail to reject it for the non-significant predictors. Therefore, we conclude that specific background factors, particularly certain age groups and years of study, significantly predict the use of GenAI for learning and teaching, while gender does not.

3) Predicted Probabilities of GenAI Use: The predicted probabilities assisted us in determining the specific background factors that predict GenAI use as a learning buddy (GenAIL) and as a teaching assistant (GenAIT). The results indicate that age and year of study significantly predict the frequency of GenAI use among the PSTs, with older PSTs and those in their later years of study being more likely to use GenAI frequently for both learning and teaching.

Figure 3 displays the predicted probabilities of GenAI use frequency for learning across different age groups, levels of study, and gender among PSTs. For males aged 31-35 in their third year of study, there is a high probability (78.43%) of using GenAI "Very Often" for learning, compared to a lower probability for other age groups and levels of study. For fe-

males aged 31–35 in their third year of study, the probability of using GenAI "Very Often" for learning is also high (69.40%). Younger age groups (21–25 and 26–30) and those in their second or fourth year of study have higher probabilities of using GenAI "Sometimes" (52.31%) or "Rarely" (17.18% for 21–25, second year, male).

Figure 4 illustrates the predicted probabilities of GenAI use frequency for teaching. For males aged 31–35 in their third and fourth years of study, there is a high probability of using GenAI "Very Often" for teaching (59.74% for fourth year). For females aged 31–35 in their third year of study, there is a high probability of using GenAI "Very Often" for teaching (48.06%). Younger age groups and those in their second year of study have higher probabilities of using GenAI "Never" (24.96% for 21–25, second year, female) or "Rarely." These findings highlight the significant influence of age and year of study on the frequency of GenAI use for both learning and teaching, with older students and those further along in their studies showing higher probabilities of frequent GenAI use. Gender, however, does not appear to significantly influence the frequency of GenAI use in either context.

V. DISCUSSION

Research has consistently revealed that PSTs face difficulties in integrating theoretical knowledge from their coursework with their clinical or field practice [39]. Although this study did not specifically address the connection between theory and practice, it highlighted the potential of GenAI to bridge this gap within teacher education programs. From the findings of this study, GenAI can support PSTs in their learning across various aspects of their coursework, which signifies GenAI's substantial contribution to PSTs' theoretical knowledge [13]. Additionally, the findings indicate GenAI has the capacity to assist PSTs across different aspects of their teaching practice, indicating its potential to enhance practice. The different areas of learning and teaching that GenAI could possibly support PSTs in teacher education programs are discussed subsequently.

More specifically on the areas of teaching, the findings prove that GenAI can support PSTs in finding practical examples that illustrate concepts for their lessons. This finding is congruent with the assertion by Rahman et al. [20] that GenAI can provide a wide array of real-world scenarios and case studies with relevant and relatable examples for teaching. This implies that GenAI has the potential to perform mentor-related

TABLE V: Pre-service Teachers' Attitude Measurement and Factor Loadings

Construct	Overall Mean	Overall SD	Item	GenAIT (λ)	GenAIL (λ)	EAA (λ)	Description
GenAIL	3.678	0.786	1	.10	.52	-.20	GenAI has the potential to positively improve my content knowledge. Items show strong loadings on learning factor, highlighting GenAI's ability to assist PSTs in the learning of their courses. Item 2 with highest loading
			2	.22	.81	-.04	I don't require much assistance from colleagues for my studies since I am using GenAI
			3	.20	.67	.22	GenAI helped me understand various complex areas of my study
			4	.27	.62	.20	With the help of GenAI, I can get more reading materials
			12	-.08	.33	-.05	Student might cheat and lack critical/creative skills development due to GenAI
GenAIT	3.458	0.950	5	.78	.17	-.08	Reduced need for colleague assistance in teaching with GenAI. Items show strong loading that GenAI's can assist PSTs in their teaching. Highest loading with Item 6 signifies key dimension towards teaching.
			6	.94	.02	-.10	I don't require much assistance from colleagues for my teaching since I am using GenAI
			7	.66	.26	.03	GenAI has the potential to improve my pedagogical skills (teaching skills) of teachers
			8	.73	-.01	.22	I felt more confident preparing and teaching with GenAI's assistance
			11	.59	.20	.18	I suggest GenAI applications be incorporated into our courses and teaching practice
EAA	3.005	0.815	9	-.14	.10	.98	It is expensive using GenAI applications for studies/teaching. Captures PSTs attitude towards GenAI on ethical issues and advocacy for inclusion in their program of study. Item 9 with highest loading
			10	.21	-.09	.42	There is inaccuracy and distrust in GenAI applications' information

TABLE VI: Regression Analysis for Attitude Towards Generative AI by Gender, Level, and Age

Predictor	B	SE	t(df)	p
Gender				
Intercept	3.50	.08	45.20	<.001
Male	.04	.09	0.41	.683
Year of Study				
Intercept	3.58	.16	22.81	<.001
Level 300	-.06	.17	-0.36	.717
Level 400	-.06	.17	-0.36	.722
Age				
Intercept	3.80	.26	14.65	<.001
Age 21-25	-.32	.26	-1.20	.233
Age 26-30	-.22	.27	-0.83	.410
Age 31-35	-.22	.33	-0.65	.520

and instructor-related roles such as modeling or demonstrating practical lessons for PSTs during their teaching practices [40]. This makes GenAI literacy crucial not only for PSTs but for the triad in teacher education programs [41].

One of the key challenges of teacher education programs is inadequate resources for their teaching practices [42]. Supporting other studies, the finding of this study explicitly indicates that GenAI can significantly assist PSTs in finding a wide range of teaching resources for their classroom teaching [2], [23]. This signifies that GenAI can improve resource accessibility, teaching quality, and professional development, ultimately preparing PSTs to be effective and innovative educators. Therefore, integrating GenAI into teacher education and empowering PSTs' effective use can address the long-standing challenges of resource deficits.

Whalen and Mouza [12] asserted that PSTs can leverage GenAI to explore a multitude of cultural contexts, enriching their understanding and broadening their intellectual horizons. Likewise, this study specifically reveals that GenAI can expand content knowledge, perspectives, and in-depth content explanations. This explains the claim by AlAli and Wardat [11] that GenAI employs vast datasets to provide access to diverse viewpoints and various educational paradigms beyond traditional contexts. This literally further suggests that, with GenAI, PSTs can access a wider range of educational content and viewpoints to promote culturally relevant education.

Reflective practice is crucial for all teachers, whether PSTs or in-service teachers, and research has proven the significance of having peer support enhance reflective practice [43]. The finding on GenAI capability to support PSTs in reflective

TABLE VII: Ordinal Logistic Regression Coefficients, Thresholds, and Significance for Frequency of GenAI Use (GenAIL and GenAIT)

Parameter	GenAIL Coefficient (β)	GenAIL Std. Error (SE)	GenAIL t Value	GenAIL p Value	GenAIT Coefficient (β)	GenAIT Std. Error (SE)	GenAIT t Value	GenAIT p Value
Predictors								
Age 21-25	1.5331	0.9968	1.538	0.1240	0.727	0.9790	0.742	0.4580
Age 26-30	1.5022	1.0385	1.447	0.1480	0.794	1.0161	0.782	0.4343
Age 31-35	3.1267*	1.2425	2.517*	0.0119*	2.226	1.2601	1.766	0.0773
Year of Study 300	1.6054*	0.6513	2.465*	0.0137*	2.121*	0.6824	3.109*	0.0019*
Year of Study 400	0.7089	0.6481	1.094	0.2740	1.674*	0.6816	2.456*	0.0140*
Gender Female	-0.4720	0.3515	-1.343	0.1794	-0.444	0.3507	-1.267	0.2052
Thresholds								
Never — Rarely	-0.0398	1.1936	-0.033	0.9734	0.863	1.1897	0.726	0.4681
Rarely — Sometimes	0.3527	1.1890	0.297	0.7667	1.503	1.1942	1.259	0.2081
Sometimes — Often	2.6754*	1.2077	2.215*	0.0267*	3.144*	1.2115	2.595*	0.0094*
Often — Very Often	3.4411*	1.2164	2.829*	0.0047*	4.250*	1.2248	3.470*	0.0005*

Fig. 3: Predicted Probability of GenAI Use as a Learning Buddy

practice shows it can serve as a peer-support in this exercise of PSTs. This finding adds up to the findings of recent studies that GenAI has the potential to provide feedback on reflective writings and help teachers develop critical self-awareness [26], [27].

Moreover, the findings of this study show that PSTs rely on GenAI for assessment. This is noteworthy as traditional assessment methods often lack the flexibility and adaptability needed to address diverse student needs and learning styles [44]. GenAI can analyze extensive educational data to recommend varied assessment techniques such as formative assessments, performance-based tasks, and adaptive testing [30]. The use of GenAI by PSTs may ensure a more holistic assessment of students' progress and decision-making [45].

The frequency with which PSTs employ GenAI for the above use areas, learning and teaching, is intriguing, indicating how GenAI is becoming an integral component of PSTs' education, despite not being officially introduced [46]. This highlights the need for teacher education programs to consider effectively integrating GenAI, particularly as PSTs continue to navigate ethical challenges and inaccuracies associated with GenAI applications [47]. A well-structured program on GenAI in teacher education could address some of these issues.

While PSTs expressed significant use of GenAI, the findings show background factors such as age and year of study could predict the frequency of GenAI use, supporting the notion that older teachers tend to appreciate educational technology more than younger ones [48]. However, it also showed that PSTs in the early years of their programs use GenAI more for coursework, while those in later years use it more for practical experiences. This could be a result of PSTs in their early years of teacher education program exposing PSTs to coursework in their early years of their study than in the later years where they usually engage in teaching practices and internships. This provides a picture of how a proposed GenAI curriculum should be designed to match the timelines and needs of PSTs in teacher education. The GenAI curriculum should largely focus more on coursework than practical teaching aspects. The finding that gender does not significantly influence GenAI use for both learning and teaching is noteworthy, as it supports the literature suggesting that technology use is becoming gender-neutral as both males and females see themselves as competent in technology use [48]. However, this finding contrasts with Chidiac et al. [49] finding, which indicated that males use technology less than females. In brief, the findings of the background factors suggest that while age can

Fig. 4: Predicted Probability of GenAI Use as a Teaching Assistant

significantly influence the use of GenAI, gender differences in the frequency of GenAI use may vary across different contexts and populations.

Attitude is a key component essential for technology acceptance, and a negative or positive attitude may have a significant impact on the growth of any emerging technology such as GenAI [50]. Interestingly, the findings of this study imply that the perceived benefits of GenAI surpass various demographic differences, and therefore, the PSTs' attitudes towards GenAI were not predicted by any background factors, indicating a generally positive disposition towards GenAI regardless of their diverse backgrounds. This favors the statement that PSTs generally have a positive attitude towards GenAI in research [8]. This suggests that teacher education programs can integrate GenAI without concern for demographic barriers. This universal acceptance facilitates the smoother implementation and wider adoption of GenAI applications in teacher training.

Pre-service teachers' voice is essential in the triad of teacher preparation programs [51], [52]. There have been numerous studies that indicate PSTs expressing positive attitudes towards GenAI and have been calling for the integration of GenAI in the teacher preparation programs [3], [8], [46], [53]. Despite the challenges of GenAI as reported by PSTs as cost-effective and inaccuracies, they are still advocating for the integration of GenAI into their programs, highlighting their needs and further demonstrating the importance of addressing these needs within teacher education programs [51]. This crucial advocacy supports many researchers who have called for the proposal of well-defined guidelines and policies of GenAI use by PSTs to ensure responsible and effective integration of GenAI in teacher education [28], [29].

VI. CONCLUSION

In this study, we aimed to find out how PSTs use GenAI applications for their coursework and teaching practices, as well as their attitude toward GenAI. The study addressed four key questions to find out the ways PSTs use GenAI as a

learning buddy during their coursework, how they employ GenAI as a teaching assistant during their teaching practice, the attitude of PSTs towards GenAI applications, and the background factors of PSTs' that predict their attitudes toward GenAI and the uses of GenAI for learning and teaching.

The main findings show that PSTs frequently use GenAI to access reading materials, look for content explanations, and find useful examples for both their coursework and teaching practices. Age and year of study significantly predict the frequency of GenAI use, whereas gender does not. Despite these variations, PSTs generally expressed a positive yet cautious attitude toward GenAI applications and showed concerns about the cost of access, the accuracy, and the reliability of the information that GenAI provided.

Even though the findings conclude that specific background factors, particularly age and years of study, significantly predict the use of GenAI as a learning buddy and a teaching assistant among PSTs, these factors do not significantly affect their attitudes toward GenAI application. It specifies that older PSTs and those further along in their teacher education programs may use GenAI more frequently, but their attitude towards the GenAI applications remains unchanged. Given concerns about the accuracy and trustworthiness of GenAI applications, it is essential to address these issues to ensure PSTs can confidently rely on GenAI in their teacher preparation programs. We recommend targeted strategies to integrate GenAI more effectively into both the learning and teaching processes for PSTs.

VII. LIMITATIONS

Though the use of convenience sampling, a non-probabilistic sampling method, was extremely useful in this exploratory study, we acknowledge that it is not representative of the larger population of PSTs in the four institutions in Ghana. Hence, further research might need to be careful when generalizing the findings to a larger population. We, therefore, suggest that future studies may involve probabilistic sampling

to enhance the representativeness of the results. Additionally, it would be beneficial for subsequent research to explore deeper into the varying uses of GenAI by the PSTs in both their coursework and teaching practices.

Moreover, we acknowledge that the PSTs in this study may have different usage needs. Notably, the PSTs in their third and final year are more engaged in actual teaching practice compared to the level 200 PSTs. Additionally, the study was conducted during a period when there were no first-year students on campus due to admission transitions. This context likely influenced the findings and may account for some of the observed differences in technology use and attitude.

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