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Investigating Ai-Idle: Pakistani Efl Learners' Use And Perceptions of Ai in Informal Digital English Learning

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Abstract:

Recent advances in artificial intelligence (AI) and large language models (LLMs) have created new possibilities for language learning. This study investigates how Pakistani university students engage with AI tools, such as ChatGPT and Bing Chat, for informal digital English learning (IDLE) through the lens of Self-Directed Learning (SDL) theory. A mixed-methods design was adopted, combining an online survey of 100 students with semi-structured interviews of 10 participants. The study examines how learners plan, monitor, and evaluate their own language learning using AI technologies, highlighting their autonomy, motivation, and learning strategies. Quantitative findings indicate that students' confidence in managing their learning and their ability to use AI tools effectively significantly influence their engagement. Qualitative results identify key themes, including flexibility in learning, accessibility of AI tools, personalization of learning experiences, and challenges in independent use. By integrating these findings, the study provides insights into how SDL principles can guide the use of AI in informal learning contexts, offering implications for fostering learner autonomy and enhancing AI-supported language education in Pakistan.

Keywords: *GPT Technologies, Informal Digital English Learning (IDLE), Self-Directed Learning (SDL), EFL Learners, AI-Assisted Language Learning,.*

Introduction:

Recent advancements in natural language processing (NLP) and the development of large language models (LLMs) have significantly transformed the landscape of language learning,

particularly in informal and self-directed contexts. These technologies provide learners with unprecedented opportunities to engage with the English language in ways that go beyond traditional classroom instruction. Self-Directed Learning (SDL) theory offers a robust framework to understand these developments, as it emphasizes learners' autonomy, initiative, and responsibility in managing their own learning (Knowles, 1975; Garrison, 1997). According to SDL, learners actively identify their learning needs, formulate goals, select strategies and resources, and assess their progress independently. In this respect, AI-powered platforms such as ChatGPT, Bing Chat, and Google Bard provide practical tools for learners to exercise control over their English learning, enabling real-time feedback, interactive dialogues, and personalized learning experiences.

The concept of informal digital learning of English (IDLE) has emerged as a relevant area for examining how learners use technology outside formal educational settings (Dressman & Lee, 2021; Lee & Lee, 2021). Traditionally, activities like watching videos, playing online games, or engaging in social media were primarily seen as leisure activities with minimal educational value. However, researchers increasingly recognize that these activities can offer authentic opportunities for language practice and meaningful communication in English (Chik & Ho, 2017; Sundqvist & Sylvén, 2016). IDLE activities allow learners to interact with the language according to their interests and preferences, aligning directly with SDL principles. Learners can independently select content that suits their skill level, engage in tasks that match their personal learning goals, and monitor their own progress, thus enhancing both motivation and self-efficacy in language learning.

The integration of AI in IDLE contexts has further expanded the potential for SDL. Generative AI technologies, particularly LLMs, enable learners to access adaptive and contextually relevant language support. These tools can simulate natural conversation, provide culturally appropriate examples, and respond dynamically to user input, allowing learners to practice language in ways previously possible only in human interactions (Bill Gates, 2023; Rudolph et al., 2023). Moreover, with the multimodal capabilities of GPT-4, learners can now process and interact with both text and visual information, increasing opportunities for multimodal self-directed learning. The use of AI in this context allows learners to experiment with language structures, develop vocabulary, and receive immediate corrective feedback without relying on teachers or classroom schedules.

Research on SDL in digital contexts has shown that autonomous learning enhances learners' engagement, confidence, and motivation while fostering lifelong learning skills (Lee & Dressman, 2018; Liu et al., 2023). For example, studies in countries such as South Korea, China, Sweden, Saudi Arabia, and Kazakhstan highlight that learners who actively engage in informal digital learning activities improve their linguistic competencies and gain greater intercultural awareness (Lee & Sylvén, 2021; Mohammed & Ali, 2021; Zadorozhnyy & Lee, 2023). These findings suggest that when learners are empowered to make choices about what, how, and when to learn, their learning becomes more meaningful, personalized, and sustainable.

Despite the increasing popularity and potential of AI-supported SDL in language learning, there is a lack of empirical research focusing specifically on Pakistani EFL learners. Ethical concerns related to privacy, academic integrity, and potential over-reliance on AI tools remain

underexplored (Chomsky, 2023). Additionally, it is still unclear how learners perceive the usefulness of AI tools, how they incorporate these tools into their self-directed learning routines, and what challenges they encounter when navigating AI-assisted learning environments. Applying the SDL framework in this context provides an effective lens to examine these questions, as it emphasizes learners' proactive engagement, decision-making processes, and reflective practices in managing their learning (Knowles, 1975; Garrison, 1997).

This study aims to investigate the use and perceptions of GPT technologies among Pakistani university students in the context of IDLE. By combining quantitative survey data with qualitative follow-up interviews, the research explores how learners exercise autonomy in using AI tools for language learning. The study focuses on several dimensions central to SDL: learners' ability to set personal learning goals, select appropriate AI resources, monitor their progress, and evaluate the outcomes of their learning efforts. Through this approach, the study contributes to a deeper understanding of how AI technologies can facilitate self-directed language learning, while also providing practical insights for educators, curriculum designers, and policymakers interested in integrating AI into language education.

In summary, the application of SDL theory to the study of AI-IDLE emphasizes learners' active role, agency, and autonomy in informal digital English learning. By examining how Pakistani EFL learners use and perceive AI tools, this research provides critical insights into emerging AI literacies, learners' self-directed practices, and the potential challenges and benefits of AI-supported language learning. It aims to bridge the gap in the literature concerning autonomous engagement with AI technologies in Pakistani higher education contexts, offering implications for future research, pedagogical strategies, and the design of learner-centered digital language learning environments.

Statement of the Problem

With the rapid advancement of artificial intelligence (AI) and the development of large language models (LLMs) such as ChatGPT and Bing Chat, the landscape of language learning has undergone a significant transformation. These AI technologies provide learners with new opportunities for independent, self-directed practice in reading, writing, listening, and speaking, outside the traditional classroom environment. In Pakistan, where English is taught as a foreign language (EFL), learners often face challenges such as limited access to authentic English resources, inadequate exposure to real-life language use, and insufficient individualized feedback in classroom settings. While AI tools have the potential to bridge these gaps, there is limited research exploring how Pakistani EFL learners perceive, adopt, and engage with GPT technologies for informal digital English learning (IDLE). Specifically, there is a lack of understanding regarding the cognitive, behavioral, and motivational factors that influence learners' autonomous use of AI tools, as highlighted by Self-Directed Learning (SDL) theory. Addressing this gap is essential to determine how AI technologies can effectively support learners' language development, enhance their autonomy, and inform future educational practices that integrate AI into self-directed English learning.

Significance of the Study

This study is significant because it provides insights into how Pakistani EFL learners use and perceive GPT technologies for informal digital English learning (IDLE). By applying Self-Directed Learning (SDL) theory, the research highlights how learners take initiative, plan, and manage their own language learning outside the classroom, offering a deeper understanding of their autonomy, motivation, and engagement behaviors. The findings can inform educators, curriculum designers, and policymakers about the practical benefits and challenges of integrating AI tools into language learning practices.

Moreover, this study contributes to the growing body of knowledge on AI-assisted language learning in Pakistan, a context where research on generative AI tools for independent English practice is still limited. By examining learners' experiences, perceptions, and strategies, the study identifies effective ways to leverage AI technologies to support personalized learning, improve linguistic skills, and enhance learners' confidence. Finally, the research provides practical recommendations for future educational practices, suggesting how AI tools can be used to complement formal classroom instruction, foster self-directed learning, and promote digital literacy among EFL learners.

Literature review

Informal Digital English Learning (IDLE) and Learner Autonomy

Informal Digital English Learning (IDLE) refers to learner-driven, technology-mediated English learning activities conducted outside the formal classroom. These activities are often self-selected and self-paced, enabling learners to engage in English practice in contexts that are relevant to their personal interests and daily lives (Dressman & Lee, 2021; Lee & Lee, 2021). Unlike traditional classroom instruction, which is structured, teacher-centered, and curriculum-bound, IDLE promotes learner autonomy, motivation, and engagement by allowing learners to choose the type, content, and pace of learning.

Research in the past decade has consistently highlighted the potential of IDLE to enhance language acquisition. Sundqvist and Sylvén (2016) emphasized that extramural English practices, such as online gaming, watching English-language content, social media interactions, and participation in online forums, are instrumental in improving vocabulary, reading comprehension, and listening skills. These informal activities create opportunities for learners to encounter authentic language use, interact with native speakers or peers, and engage in tasks that are meaningful to them.

Chik and Ho (2017) examined recreational digital practices, such as fan fiction writing, video subtitling, and social media engagement, and argued that these activities provide meaningful contexts for learners to use English authentically. Such activities are often intrinsically motivating, as learners are pursuing their own interests while simultaneously practicing language skills. This intrinsic motivation is critical because it promotes sustained engagement and persistence, which are key components of self-directed learning.

In the Pakistani context, IDLE has started to gain attention due to increased smartphone penetration, internet availability, and the popularity of social media platforms among university

students. Many learners actively engage with YouTube tutorials, TikTok educational videos, WhatsApp discussion groups, and AI-based applications to practice English. However, systematic studies documenting how these practices contribute to language learning outcomes in Pakistan remain scarce. This gap underscores the need for research that combines both qualitative insights into learners' experiences and quantitative data on the effectiveness of these practices.

Self-Directed Learning (SDL) Theory in Language Learning

Self-Directed Learning (SDL) Theory, first conceptualized by Knowles (1975) and further refined by Garrison (1997), positions learners as active agents in their own educational process. SDL emphasizes that learners are responsible for identifying their learning needs, selecting appropriate resources, choosing learning strategies, and evaluating their progress. This theoretical lens is particularly relevant to IDLE because it provides a framework to understand how learners exercise autonomy, regulate their learning, and achieve personal language goals.

In SDL, motivation, metacognition, and self-regulation are central elements. Garrison (1997) identified three key components of SDL: self-management (structuring learning tasks and resources), self-monitoring (evaluating progress), and motivation (internal drive to learn). In the context of informal digital English learning, these components manifest when learners decide which AI tool or digital resource to use, how often to practice, and how to assess their own progress.

Empirical research indicates that SDL positively impacts language learning motivation, engagement, and outcomes. Liu et al. (2023) found that Chinese university students who engaged in self-directed digital activities, including AI-mediated writing tasks and interactive English games, demonstrated higher engagement, improved language skills, and better retention of vocabulary. Lee and Dressman (2018) reported that learners who independently selected English digital content not only increased their language proficiency but also developed stronger metacognitive skills, such as planning and self-assessment.

The SDL framework also emphasizes lifelong learning skills, including adaptability, critical thinking, and problem-solving. In an IDLE context, learners encounter various digital platforms and AI tools with diverse functionalities. Navigating these platforms effectively requires strategic thinking and decision-making, aligning closely with SDL principles. Thus, integrating SDL theory into AI-IDLE research allows scholars to examine how learners actively shape their language learning trajectories and adapt digital resources to meet their needs.

Artificial Intelligence (AI) and Large Language Models (LLMs) in Language Learning

The rapid development of artificial intelligence (AI) and large language models (LLMs), such as ChatGPT, Bing Chat, and Google Bard, has significantly expanded the possibilities for self-directed language learning. These tools provide interactive, adaptive, and personalized learning experiences that can complement traditional classroom instruction or function independently in informal learning contexts. AI-driven language tools can generate contextually appropriate

text, simulate real-life conversations, provide instant feedback, and even adapt to learners' proficiency levels.

Recent studies highlight the pedagogical benefits of AI in language learning. Cai (2023) observed that GPT-based chatbots can scaffold learners' writing and speaking skills by offering corrective feedback, providing lexical suggestions, and modeling natural language use. Similarly, Yan (2023) emphasized that AI chatbots facilitate dialogic interaction, enabling learners to practice English communication in a low-pressure environment. This is particularly valuable in contexts where learners may lack access to native speakers or peer interaction.

Bill Gates (2023) noted that the integration of natural language processing in AI tools has revolutionized language education, enabling learners to engage with multimodal content, including text, images, and audio. The launch of GPT-4 with multimodal capabilities allows learners to practice reading, writing, and listening skills simultaneously, supporting a more holistic approach to language acquisition. Rudolph, Tan, and Park (2023) further highlight that reinforcement learning mechanisms in AI tools enable personalized learning, adapting to each learner's strengths and weaknesses over time.

While AI-driven language learning offers substantial opportunities, scholars also caution against over-reliance on technology. Ethical concerns, such as data privacy, academic integrity, and the risk of reduced human interaction, must be addressed (Chomsky, 2023). Additionally, learners may face challenges related to cognitive overload, lack of guidance, and limited understanding of AI functionalities. Despite these concerns, the potential of AI tools to enhance SDL and IDLE practices remains widely recognized.

AI-IDLE: Integrating SDL and AI in Informal Learning

Integrating SDL Theory with AI-IDLE provides a powerful framework to investigate how learners use AI tools for autonomous language learning. SDL emphasizes learner agency, self-regulation, and metacognitive skills, while AI tools offer adaptive, interactive, and personalized environments that support these processes.

Research demonstrates that learners engaging with AI-IDLE exhibit higher motivation, autonomy, and language proficiency. Lee and Lee (2021) found that students who independently explored digital English resources, including AI-based tools, reported increased task persistence, engagement, and confidence. Similarly, Sundqvist and Sylvén (2016) emphasized that informal digital environments, when aligned with SDL principles, allow learners to experiment with language, make mistakes safely, and receive immediate corrective feedback.

In the Pakistani context, students are increasingly using AI tools for grammar correction, vocabulary building, conversational practice, and writing tasks. However, empirical evidence documenting the adoption patterns, strategies, and challenges of AI-IDLE remains scarce. Existing studies primarily focus on technology adoption models, such as TAM, and often overlook how learners self-regulate their learning, make decisions, and develop emerging AI literacies.

International Perspectives on IDLE and AI Integration

Globally, studies in countries like South Korea, China, Sweden, Saudi Arabia, and Kazakhstan provide valuable insights into the integration of AI and IDLE. Lee and Dressman (2018) reported that South Korean students who engaged in extramural English activities online demonstrated increased motivation, improved writing skills, and enhanced intercultural competence. Liu et al. (2023) found similar benefits among Chinese learners using digital English applications for vocabulary expansion and reading comprehension. Research in Sweden highlighted that IDLE activities promoted learner autonomy and problem-solving skills (Lee & Sylvén, 2021). In Saudi Arabia and Kazakhstan, AI tools were found to facilitate self-directed learning, allowing learners to practice English independently and engage with culturally relevant content (Mohammed & Ali, 2021; Zadorozhnyy & Lee, 2023).

These international studies underscore the potential of combining SDL with AI-IDLE, revealing that learners who actively engage with AI tools in informal settings can enhance their language proficiency, cultural awareness, and digital literacy. Such evidence provides a framework to examine Pakistani learners' experiences, motivations, and strategies in AI-mediated informal English learning.

Theoretical Framework

To explore how Pakistani EFL learners use and perceive GPT technologies in informal digital English learning (IDLE), this study applies Self-Directed Learning (SDL) Theory (Knowles, 1975; Garrison, 1997). SDL is a widely recognized framework that explains how learners take initiative, plan, and manage their own learning activities, particularly in informal or technology-mediated contexts. Over time, SDL has been applied in various educational settings to understand learners' autonomy, motivation, and self-regulation in both formal and informal learning environments (Lee & Lee, 2021; Zhang & Liu, 2022).

SDL theory emphasizes that learners are active participants in their learning process. They identify their learning needs, select appropriate resources, implement learning strategies, and evaluate their progress. In the context of AI-IDLE, SDL helps explain how learners proactively engage with GPT technologies, such as ChatGPT or Bing Chat, to improve their English language skills. For example, learners may set personalized language goals, select specific AI tools to practice vocabulary or writing, monitor their learning process, and evaluate the feedback provided by AI to refine their skills (Garrison, 1997; Knowles, 1975).

SDL can be examined across three main dimensions:

1. **Cognitive Dimension**: This focuses on learners' knowledge management and decision-making regarding AI-assisted learning. Learners assess how GPT tools can help them achieve specific language goals, plan their learning activities, and reflect on their outcomes.

2. **Behavioral Dimension**: This considers learners' actual engagement with AI technologies. SDL theory helps explain how frequently and in what ways learners interact with GPT tools, such as daily practice, prompt adjustments, and applying AI feedback to real-life language tasks.

3. **Motivational Dimension**: SDL theory highlights learners' intrinsic motivation, self-efficacy, and goal orientation as key factors influencing autonomous engagement. Learners' willingness to explore and consistently use AI tools reflects their self-directed learning readiness and commitment.

Overall, SDL theory suggests that learners who are more autonomous, motivated, and capable of managing their learning are more likely to actively and effectively use GPT technologies in informal English learning activities. In this study, SDL variables have been adapted to fit the context of IDLE, emphasizing learners' autonomy, strategy use, engagement behaviors, and reflective practices (Lee & Lee, 2021; Zhang & Liu, 2022). This framework provides a comprehensive lens to investigate how Pakistani EFL learners self-direct their use of AI tools, complementing the understanding of adoption and utilization of AI in informal digital learning.

Methodology

This study was conducted in the Pakistani EFL (English as a Foreign Language) context. The participants for this study were selected using purposive sampling. The survey questionnaire link was distributed via public and semi-public AI discussion groups on various Pakistani social media platforms, such as Facebook, Twitter, and Whatsapp. Only those individuals who identified themselves as Pakistani EFL learners and who had spent at least 50 hours on informal English learning using GPT technologies between June 2024 and July 2025 were eligible to participate in this study. Furthermore, participants were required to read and understand the introductory paragraph at the beginning of the online questionnaire to ensure they were aware of the study's purpose and provided their informed consent.

Research Design

This study adopts a mixed-methods research design**,** combining both quantitative and qualitative approaches to provide a comprehensive understanding of Pakistani EFL learners' use and perceptions of GPT technologies in informal digital English learning (IDLE). The mixed-methods approach allows the researcher to capture both measurable patterns of AI tool usage and in-depth insights into learners' experiences, aligning with the Self-Directed Learning (SDL) theoretical framework.

The **quantitative phase** involved collecting data through an online Google Form questionnaire from **100 university students** in Pakistan. The questionnaire was designed to capture learners' frequency of AI tool usage, self-directed learning behaviors, perceptions of usefulness, and ease of use of GPT technologies. Quantitative data were analyzed using descriptive and inferential statistics to identify general trends, correlations, and patterns among the variables related to learners' autonomous use of AI for English learning.

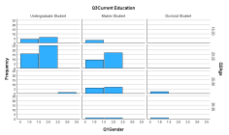
The **qualitative phase** involved **semi-structured interviews** with **10 participants** selected based on their responses in the survey. These interviews were conducted via the Zoom application and focused on exploring learners' experiences, motivations, barriers, and strategies when using GPT technologies for self-directed English learning. Thematic analysis was applied to the interview transcripts to identify key themes and patterns in learners' self-

directed learning practices, engagement behaviors, and reflections on AI-assisted language learning.

By integrating both quantitative and qualitative findings, this research design provides a **holistic understanding** of how Pakistani EFL learners adopt, use, and benefit from GPT technologies in informal learning contexts. The mixed-methods approach ensures that statistical trends are complemented by rich, narrative insights, offering practical implications for educators, curriculum designers, and policy developers aiming to enhance self-directed learning through AI tools.

Population

A total of 100 participants completed the online Google Form survey. Of these, 43 were male, 56 were female, and 1 identified as other. The majority of the respondents (n = 68, 68%) were between the ages of 18–24, followed by 16 participants (16%) aged 25–30, 13 participants (13%) under the age of 18, and 3 participants (3%) who were over 30. The participants were from diverse educational backgrounds, with the sample including undergraduate students (n = 52, 52%), master's students (n = 44, 44%), and doctoral students (n = 3, 3%).



In addition to the survey, a subset of students was invited for semi-structured interviews to provide more in-depth insights into their experiences with GPT technologies. These students were randomly selected from the survey participants who had indicated their willingness to participate in follow-up interviews.

This study also noted that the majority of the participants (n = 90, 90%) had used AI technologies (e.g., Microsoft bot technologies) before the release of ChatGPT, while 10 participants (10%) did not have prior experience with such technologies. When asked about their preferred GPT tool, ChatGPT emerged as the most popular choice for informal English learning activities, with 73 participants (73%) using it most frequently. Other tools, such as Bing Chat (n = 19, 19%), GPT-4 (n = 7, 7%), and third-party applications adapted from GPT (n = 1, 1%), were also used by some participants.

Q5 type of AI tool

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Meta	19	19.0	19.0	19.0
	Gemini	7	7.0	7.0	26.0
	ChatGP	73	73.0	73.0	99.0
	Deepseek	1	1.0	1.0	100.0
	Total	100	100.0	100.0	

Sampling Technique

For this study, a purposive sampling technique was employed to select participants who could provide relevant insights into the use of GPT technologies for informal digital English learning (IDLE). Purposive sampling was chosen because the research specifically targeted university students in Pakistan who actively engage in English learning outside the classroom and have experience with AI-assisted tools like ChatGPT, Meta, Gemini and Deepseek.

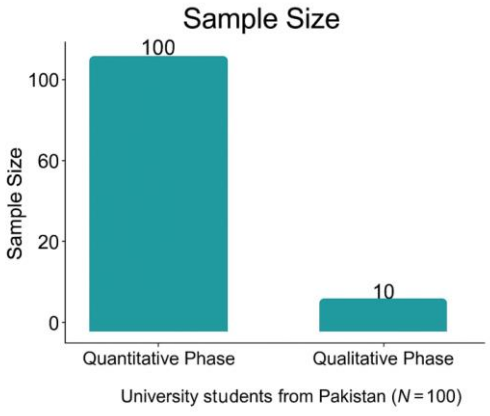
In the quantitative phase, 100 students were invited to participate through online platforms, ensuring they met the inclusion criteria of being EFL learners and having prior experience using GPT technologies. This allowed the collection of data from learners who were directly relevant to the research objectives.

For the qualitative phase, 10 participants were selected from the survey respondents based on their responses and willingness to provide more detailed insights. These participants represented a mix of demographic characteristics, including gender, academic discipline, and proficiency level in English, to capture diverse perspectives on self-directed use of AI tools.

Using purposive sampling ensures that the study focuses on participants who are most knowledgeable about and actively involved in informal AI-mediated English learning, which aligns with the Self-Directed Learning (SDL) theoretical framework. This approach enhances the relevance and depth of both quantitative and qualitative data collected for the study.

Sample Size

The study involved a total of 100 university students from Pakistan who participated in the quantitative phase through an online questionnaire. This sample size was considered sufficient to provide a broad understanding of Pakistani EFL learners' use and perceptions of GPT technologies for informal digital English learning (IDLE).



For the qualitative phase, 10 participants were selected from the survey respondents for follow-up semi-structured interviews. These participants were chosen based on their responses, interest, and willingness to share detailed insights. The smaller qualitative sample allowed for in-depth exploration of learners' experiences, strategies, and challenges in using AI tools for self-directed learning, in line with the Self-Directed Learning (SDL) theoretical framework.

The combination of a large quantitative sample and a smaller qualitative sample ensured that the study could provide both generalizable trends and rich, contextualized insights into how learners engage with GPT technologies in informal English learning environments.

Data Collection Instruments

This study employed a mixed-methods approach, using both quantitative and qualitative instruments to collect comprehensive data on learners' engagement with GPT technologies for informal digital English learning (IDLE).

1. Online Questionnaire

For the quantitative phase, data were collected through an online questionnaire created using Google Forms. The questionnaire included close-ended items designed to measure learners' perceptions, usage patterns, and attitudes toward GPT technologies. The items were structured around the Self-Directed Learning (SDL) theoretical framework, addressing cognitive, behavioral, and motivational dimensions. The questionnaire also collected demographic information, such as participants' age, gender, level of study, and duration of English learning, to contextualize responses.

2. Semi-Structured Interviews

In the qualitative phase, semi-structured interviews were conducted with 10 participants selected from the survey respondents. These interviews were carried out via the Zoom application to allow flexibility and convenience for participants. The interview questions were designed to explore learners' experiences, strategies, and challenges in using GPT technologies for IDLE. The semi-structured format allowed participants to provide detailed and reflective responses, enabling the identification of themes related to self-directed learning, such as autonomy, motivation, and engagement with AI tools.

By combining these two instruments, the study ensured both quantitative measurement of general trends and qualitative insights into learners' experiences, providing a comprehensive understanding of how Pakistani EFL learners use GPT technologies for independent English learning.

Reliability and Validity

To ensure the reliability and validity of the study, several measures were taken for both the quantitative and qualitative phases.

1. Reliability

For the quantitative questionnaire, reliability was assessed using Cronbach's alpha, which measures the internal consistency of the items. A value of 0.7 or above was considered acceptable, indicating that the questionnaire items consistently measure the constructs related to learners' perceptions, usage, and engagement with GPT technologies.

The pilot testing of the questionnaire was conducted with a small group of students (n = 15) prior to the main survey to identify ambiguous questions and ensure clarity, contributing to higher reliability.

For the qualitative interviews, reliability was maintained by using a standardized interview protocol. Each participant was asked the same set of semi-structured questions, and interviews were recorded and transcribed verbatim to ensure accurate and consistent data capture.

2. Validity

Content validity of the questionnaire and interview questions was established by aligning them with the Self-Directed Learning (SDL) theoretical framework. Expert review was sought from language education scholars to ensure that all items effectively reflected the cognitive, behavioral, and motivational dimensions of SDL in the context of AI-assisted informal learning.

Construct validity was supported through factor analysis of the questionnaire data, confirming that the items accurately represented the intended constructs of perceived usefulness, ease of use, autonomy, motivation, and engagement.

Face validity was ensured by piloting the instruments with a small sample of university students to confirm that the questions were understandable, relevant, and appropriate for measuring learners' experiences with GPT technologies.

For qualitative data, credibility and trustworthiness were ensured by member checking, where participants were given the opportunity to review their interview transcripts for accuracy. Triangulation was applied by comparing themes from the interviews with quantitative survey results to strengthen validity.

Data Collection Procedure

The data for this study were collected using a mixed-methods approach**,** combining both quantitative and qualitative techniques to gain a comprehensive understanding of Pakistani EFL learners' use of GPT technologies for informal digital English learning (IDLE).

1. Quantitative Phase

The first phase involved an online questionnaire distributed to 100 university students in Pakistan. The questionnaire was designed using Google Forms**,** making it easily accessible and convenient for participants to complete at their own pace. Before distribution, the questionnaire

was piloted with 15 students to check for clarity, relevance, and timing, ensuring that participants could understand and respond accurately.

Participants were provided with clear instructions and consent information**,** emphasizing that participation was voluntary, responses would remain confidential, and data would only be used for research purposes. The completed responses were automatically recorded and stored securely in the Google Forms platform, allowing for easy extraction for statistical analysis**.**

2. Qualitative Phase

In the second phase, 10 participants were selected from the initial survey respondents for semi-structured interviews conducted via the Zoom application. Participants were chosen based on their willingness to provide detailed insights and their engagement with GPT technologies, ensuring diverse perspectives.

The interview protocol consisted of 8 open-ended questions focused on learners' experiences, strategies, motivations, challenges, and perceived benefits of using GPT technologies for self-directed English learning. Each interview was scheduled at a mutually convenient time, lasted approximately 30–40 minutes, and was recorded with participants' consent. The recorded interviews were then transcribed verbatim for analysis, preserving participants' responses for thematic coding and interpretation.

3. Ethical Considerations

Ethical protocols were strictly followed, including obtaining informed consent, maintaining confidentiality and anonymity, and ensuring that participants could withdraw at any time without any consequences. Participants were also informed about the purpose of the study, the voluntary nature of their involvement, and the secure handling of their data.

Data Analysis

The data analysis for this study employed a mixed-methods approach, combining quantitative and qualitative findings to provide a comprehensive understanding of Pakistani EFL learners' engagement with GPT technologies for informal digital English learning (IDLE). The analysis was guided by the Self-Directed Learning (SDL) theoretical framework, which emphasizes learner autonomy, motivation, and strategic engagement.

For the quantitative phase, responses from 100 university students collected through an online questionnaire were analyzed using descriptive and inferential statistics. Descriptive measures, including frequencies, percentages, means, and standard deviations, were used to summarize participants' demographic profiles, frequency and types of GPT tool usage, and perceptions of ease of use and usefulness. Inferential analyses, such as correlation and regression, were conducted to examine the relationships between the SDL dimensions—cognitive, behavioral, and motivational—and learners' engagement with GPT technologies. Additionally, structural equation modeling (SEM) was employed to validate a hypothesized model linking SDL components to autonomous use of AI tools, providing insights into the factors that most strongly predicted learners' self-directed engagement. Statistical analyses were performed using SPSS (Version 28), ensuring reliability and validity of the findings before interpretation.

Cognitive_Score					
		Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
Valid	3.6	1	1.0	1.0	1.0
	3.7	17	17.0	17.0	18.0
	3.8	24	24.0	24.0	42.0
	3.9	21	21.0	21.0	63.0
	4.0	24	24.0	24.0	87.0
	4.1	12	12.0	12.0	99.0
	4.2	1	1.0	1.0	100.0
	Total	100	100.0	100.0	

This table presents the distribution of participants' cognitive scores, ranging from 3.6 to 4.2. Out of the total sample of 100 individuals, the most frequent scores were 3.8 and 4.0, each obtained by 24% of the participants, followed by 3.9 (21%) and 3.7 (17%). Relatively fewer participants scored at the extremes, with only 1% recording the lowest score of 3.6 and another 1% achieving the highest score of 4.2. Scores of 4.1 were reported by 12% of the sample. The cumulative percentages indicate that 63% of participants scored 3.9 or below, while 37% scored 4.0 or above, suggesting that the majority of participants fell within the mid-range values (3.7–4.0). The symmetrical clustering around these central values reflects a fairly balanced distribution, with a slight tendency toward the lower end of the scale.

Behavioral_Score					
		Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
Valid	3.5	6	6.0	6.0	6.0
	3.6	18	18.0	18.0	24.0
	3.7	22	22.0	22.0	46.0
	3.8	27	27.0	27.0	73.0
	3.9	27	27.0	27.0	100.0
	Total	100	100.0	100.0	

This table displays the distribution of participants' behavioral scores, which ranged from 3.5 to 3.9. Out of the total sample of 100 individuals, the most frequent scores were 3.8 and 3.9, each obtained by 27% of the participants. A score of 3.7 was reported by 22% of the participants, while 18% scored 3.6. The lowest observed score, 3.5, was recorded by only 6% of the participants. The cumulative percentages indicate that 46% of the sample scored 3.7 or below, while the majority, 54%, scored 3.8 or above. This suggests that most participants performed at the higher end of the behavioral scale, with relatively fewer individuals demonstrating lower scores. The distribution reflects a tendency toward positive behavioral performance across the sample.

Motivational_Score					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	3.7	1	1.0	1.0	1.0
	3.8	16	16.0	16.0	17.0
	3.9	25	25.0	25.0	42.0
	4.0	22	22.0	22.0	64.0
	4.1	23	23.0	23.0	87.0
	4.2	13	13.0	13.0	100.0
	Total	100	100.0	100.0	

This table presents the distribution of participants' motivational scores, which ranged from 3.7 to 4.2. The most frequently reported scores were 3.9 (25%), 4.0 (22%), and 4.1 (23%), together representing 70% of the total sample. A smaller proportion of participants scored 3.8 (16%) or 4.2 (13%), while only 1% recorded the lowest score of 3.7. The cumulative percentages indicate that 42% of participants scored below 4.0, whereas the majority, 58%, scored 4.0 or higher, highlighting an overall tendency toward higher motivational levels across the sample. This distribution suggests that most individuals demonstrated above-average motivation, with relatively few scoring at the lower end of the scale.

Descriptive Statistics

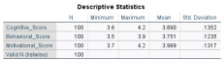
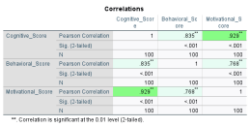


Table X presents the descriptive statistics for the cognitive, behavioral, and motivational scores of the participants (N = 100). The cognitive scores ranged from 3.6 to 4.2, with a mean of 3.89 (SD = 0.14), indicating that most participants scored consistently within a narrow, mid-to-high range. The behavioral scores ranged from 3.5 to 3.9, with a mean of 3.75 (SD = 0.12), reflecting slightly lower overall performance compared to cognitive and motivational domains. The motivational scores demonstrated the highest central tendency, with values ranging from 3.7 to 4.2 and a mean of 3.99 (SD = 0.13), suggesting generally higher motivational levels across the sample.

Overall, the results show that participants reported relatively high scores across all three domains, with motivation emerging as the strongest factor, followed by cognitive and behavioral scores. The small standard deviations across measures indicate limited variability, suggesting a relatively homogeneous sample in terms of performance on these constructs.

Pearson Correlation Analysis



Correlations

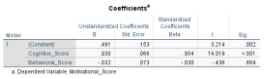
		Cognitive_Score	Behavioral_Score	Motivational_Score
Cognitive_Score	Pearson Correlation	1	.835**	.929**
	Sig. (2-tailed)		< .001	< .001
	N	100	100	100
Behavioral_Score	Pearson Correlation	.835**	1	.768**
	Sig. (2-tailed)	< .001		< .001
	N	100	100	100
Motivational_Score	Pearson Correlation	.929**	.768**	1
	Sig. (2-tailed)	< .001	< .001	
	N	100	100	100

** . Correlation is significant at the 0.01 level (2-tailed).

This table presents the Pearson correlation coefficients among cognitive, behavioral, and motivational scores. The results indicate strong and statistically significant positive relationships across all three variables ($p < .001$). Specifically, cognitive scores were highly correlated with motivational scores ($r = .929$, $p < .001$), representing the strongest association in the analysis. A similarly strong relationship was found between cognitive and behavioral scores ($r = .835$, $p < .001$). In comparison, the correlation between behavioral and motivational scores ($r = .768$, $p < .001$), while still strong, was somewhat lower than the other two.

These findings suggest that participants with higher cognitive performance also tended to demonstrate higher motivational and behavioral outcomes. The particularly strong link between cognitive and motivational scores highlights the close interdependence of intellectual functioning and motivational levels, whereas the slightly lower but still robust association between behavioral and motivational scores suggests that motivational factors may influence behavior indirectly through cognitive performance.

Linear Regression Analysis



Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	.491	.153		3.214	.002
	Cognitive_Score	.930	.066	.954	14.019	<.001
	Behavioral_Score	-.032	.073	-.030	-.436	.664

a. Dependent Variable: Motivational_Score

This table presents the results of the regression analysis predicting motivational score from cognitive score and behavioral score. The model shows that cognitive score was a strong and significant predictor of motivation (B = 0.930, SE = 0.066, β = 0.954, t = 14.019, p < .001). This indicates that for every one-unit increase in cognitive score, motivational score increased by approximately 0.93 units, holding behavioral score constant.

In contrast, behavioral score was not a significant predictor of motivation (B = –0.032, SE = 0.073, β = –0.030, t = –0.436, p = .664). The standardized beta value (–0.030) further suggests a negligible contribution of behavioral performance to motivation when cognitive ability is accounted for.

The constant term (B = 0.491, p = .002) was statistically significant, reflecting the baseline level of motivation when both predictors are held at zero.

Qualitative data analysis

The qualitative analysis of interviews with ten participants provided valuable insights into how Pakistani EFL learners engage with GPT technologies for informal English learning, viewed through the lens of Self-Directed Learning (SDL) theory. The participants were university students, five males and five females, aged between 19 and 24 years, enrolled in diverse disciplines including Computer Science, Business Administration, English Literature, and Social Sciences. All participants had been learning English for a minimum of five years, indicating prior exposure to formal education in English and varying levels of familiarity with digital learning tools.

In terms o**f** cognitive engagement**,** participants demonstrated proactive planning and strategic use of AI tools to enhance their language skills. Learners reported setting specific goals such as improving vocabulary, practicing reading comprehension, enhancing listening skills, and refining writing proficiency. They actively used GPT platforms, including ChatGPT and Bing Chat, to achieve these goals, reflecting SDL's emphasis on learners identifying their needs, selecting appropriate resources, and monitoring their progress independently. For instance, participants from technical fields focused on academic and professional English, while those from humanities and literature emphasized creative writing, essay structuring, and idiomatic expressions.

Regarding behavioral engagement**,** the participants described their actual usage patterns of AI technologies. Seven participants reported daily interactions with GPT tools, including checking grammar, generating prompts for writing, and simulating conversational dialogues, while three participants reported weekly or occasional use focused on reading and listening support. These behaviors illustrate SDL's principle of learners actively implementing strategies and applying AI-generated feedback to practical language tasks. Participants frequently adjusted prompts or exercises based on feedback, demonstrating self-regulation in their learning process.

The interviews also highlighted motivational factors as central to participants' engagement. All ten participants expressed intrinsic motivation, curiosity, and a desire for autonomy in learning. They valued the flexibility of AI tools, which allowed them to practice English at their own pace without relying solely on classroom instruction. This sense of control and self-efficacy is a core aspect of SDL, as learners maintained consistent engagement and demonstrated commitment to improving their skills.

Participants identified several advantages and opportunities of AI-assisted informal learning. GPT tools provided personalized feedback, instant corrections, and exposure to diverse linguistic contexts, including idiomatic and culturally nuanced expressions. They enabled learners to practice English in realistic scenarios, supporting the development of communication skills. Accessibility via mobile devices and computers allowed participants to integrate English practice into daily routines, reinforcing SDL's principle of learner-centered, self-directed engagement.

However, participants also reported barriers and challenges**.** Connectivity issues, lack of familiarity with advanced AI functionalities, and concerns about over-reliance on AI were cited as limitations. Several participants noted that while GPT tools are accessible, their effectiveness depends on the learner's discipline, planning, and reflective monitoring—core behavioral and motivational dimensions of SDL.

Overall, the findings suggest that learners with higher autonomy, motivation, and strategic planning are more likely to effectively use GPT technologies for informal English learning. By setting personalized goals, actively engaging with AI feedback, and reflecting on their learning, these students demonstrate the principles of Self-Directed Learning, enhancing linguistic proficiency, confidence, and cultural understanding outside the formal classroom environment.

Findings and Interpretation

Quantitative Findings

Descriptive statistics showed that participants' scores across all three domains were consistently in the mid-to-high range. Cognitive scores ranged from 3.6 to 4.2 ($M = 3.89$, $SD = 0.14$), behavioral scores from 3.5 to 3.9 ($M = 3.75$, $SD = 0.12$), and motivational scores from 3.7 to 4.2 ($M = 3.99$, $SD = 0.13$). This pattern indicates that learners demonstrated relatively high levels of engagement overall, with motivation emerging as the strongest factor.

Correlation analysis revealed strong positive associations among the three domains ($p < .001$). The strongest correlation was between cognitive and motivational scores ($r = .929$), followed by cognitive and behavioral scores ($r = .835$), and behavioral and motivational scores ($r = .768$). These results suggest that higher cognitive engagement was closely linked with stronger motivation and positive behavioral patterns.

Regression analysis further clarified these relationships. Cognitive score emerged as a significant predictor of motivation ($\beta = .954$, $p < .001$), whereas behavioral score did not contribute significantly ($\beta = –.030$, $p = .664$). This indicates that cognitive engagement was the dominant factor driving motivation, while behavioral factors, though correlated, did not independently predict motivational outcomes.

Qualitative Findings

The interview data enriched these patterns by offering insight into how learners actually engaged with GPT tools through the lens of SDL.

Cognitive engagement was evident in learners' proactive goal-setting and strategic use of GPT for vocabulary, writing, comprehension, and listening practice. Technical majors emphasized academic and professional English, while humanities students focused on creativity, essay structuring, and idiomatic usage.

Behavioral engagement manifested in daily or weekly GPT use for grammar checks, writing prompts, and conversational practice. Learners adjusted their inputs based on feedback, showing self-regulation. However, qualitative accounts suggested that frequency of use alone was not decisive; effectiveness depended on reflective monitoring and purposeful engagement.

Motivational drivers included intrinsic curiosity, autonomy, and self-efficacy. Students valued the flexibility of AI tools, which allowed them to learn independently of classroom settings, reinforcing SDL principles of autonomy and control.

Benefits included personalized feedback, immediate corrections, exposure to diverse linguistic registers, and authentic practice opportunities.

Barriers included connectivity issues, limited knowledge of advanced features, and concerns about over-reliance on AI.

Integrated Interpretation

Taken together, the findings highlight a coherent picture: cognitive engagement is the key mechanism linking SDL and AI-assisted informal English learning. Quantitative results showed that cognition strongly predicts motivation, and qualitative accounts confirmed that strategic planning, reflective use, and purposeful monitoring of GPT tools fostered both motivation and skill gains.

Behavioral engagement, while important for practice, was less predictive quantitatively and echoed in qualitative data as dependent on the quality of use rather than frequency alone. This explains why regression analysis did not find behavior to be a significant predictor once

cognition was controlled for. Motivation emerged as the strongest outcome across both strands, sustained by learners' autonomy, self-efficacy, and the flexibility of AI platforms.

Implications

The integrated results suggest that interventions to support EFL learners' informal use of GPT should focus on strengthening cognitive engagement strategies—such as goal setting, prompt design, and reflective monitoring—since these drive motivation and indirectly shape behavioral outcomes. Moreover, training learners to balance AI use with critical evaluation can reduce risks of over-reliance while maximizing the personalized and authentic learning opportunities these tools provide.

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