



The critical role of structured training in GenAI adoption: a longitudinal case study on student perceptions and skills development

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Abstract

This study underscores the indispensable role of structured training programs in equipping students with the necessary skills and awareness to effectively and ethically utilize Generative AI (GenAI) technologies. Unlike most studies that primarily examine short-term effects, this research adopts a longitudinal perspective, exploring both the immediate and sustained impacts of GenAI training. With the rapid proliferation of GenAI tools, students increasingly engage with these technologies without sufficient understanding, raising concerns about their uninformed and sometimes problematic use. Addressing this gap, our study investigates how formal GenAI education can foster responsible, informed, and skillful engagement with AI technologies. This research evaluates students' perceptions and technical competencies before, immediately after, and six months following a structured, two-week training program conducted with a group of undergraduate students. Utilizing semi-structured interviews and structured observations, the findings reveal a marked increase in students' competence, confidence, and motivation towards GenAI technologies post-training. Moreover, six months later, while proficiency remained high, students demonstrated a more refined and realistic understanding of GenAI's role and ethical implications. These findings highlight the necessity of integrating formal GenAI training into academic curricula to ensure students not only adopt these technologies effectively but also develop critical digital literacy and ethical awareness for long-term engagement in academic and professional settings.

Keywords Generative artificial intelligence · Structured training · Digital literacy · Undergraduate students · Longitudinal study · Ethical awareness

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Introduction

Artificial intelligence (AI) is one of the greatest innovations in computer science and technology, enabling machines to perform human-like tasks (Chen et al., 2022). In recent years, the boundaries of AI have rapidly expanded, leading to remarkable innovations, particularly in the field of Generative Artificial Intelligence (GenAI). GenAI systems can analyze data sets and create new and original content. This technology can be applied in a wide range of areas, from text to visuals, music to coding, and is notable for its ability to mimic human creativity (Bozkurt, 2023; Orak & Turan, 2024). The emergence of GenAI has had significant implications for various industries, especially education, and is increasingly being integrated into learning environments (Luan et al., 2020).

The potential of GenAI in education is immense, offering the ability to personalize learning experiences, enhance creativity and critical thinking, and provide instant feedback to students (Firat & Kuleli, 2024; Kasneci et al., 2023). However, the rapid advancement of these technologies also presents significant challenges and considerations that educators and policymakers must address. In particular, there is a lack of practical guidance on how teachers can effectively integrate GenAI tools into their teaching and how they can train students to use these technologies responsibly (Baidoo-Anu & Owusu Ansah, 2023). Recent findings by Reina Marín et al. (2025) highlight that both students and educators often lack confidence in AI's pedagogical value and stress the urgent need for structured training programs and ethical frameworks to guide its educational use. In line with this, Tzirides et al. (2024) argue that enhancing AI literacy in higher education requires not only technical instruction but also human-centered, ethically grounded curricula that support critical thinking and collaborative engagement.

In the current literature, studies on the potential and challenges of GenAI in education are increasing. For example, Kasneci et al. (2023) emphasize the potential of GenAI to personalize learning experiences and provide instant feedback to students. Holmes and Miao (2023) states the necessity of structured training for educators and students to use GenAI tools effectively.

However, comprehensive studies investigating how students interact with GenAI technologies and how structured training programs can improve their effective use are still limited. While researchers such as Erdoğan (2023) and Zawacki-Richter et al. (2019) emphasize the importance of using GenAI in education, they note that empirical studies on how students perceive and use these technologies are insufficient. This situation creates a significant gap in equipping students with the necessary skills to use GenAI responsibly and effectively in their academic and professional lives.

The development and implementation of GenAI-based educational applications can lead to more efficient learning processes and successful outcomes (Alasadi & Baiz, 2023). However, with the rise of tools such as ChatGPT, Google Bard, and DALL-E, concerns about students using GenAI ignorantly or incorrectly are increasing (Zouhaier, 2023). Chan and Tsi (2024) found that students' adoption of GenAI tools such as ChatGPT is strongly shaped by their perceived usefulness, risk awareness, and motivation, indicating that students' decisions to use these tools are not solely driven by technological availability, but also by psychological and contextual factors. Many students may use these tools to create content or conduct research, but they often do not have a comprehensive understanding of the ethical implications or technical functioning of these technologies (Bennett & Abusalem, 2024).

These applications, which span various fields such as text, image, and presentation creation, are central to students' academic practices (Luckin et al., 2016). For example, ChatGPT has 400 million weekly active users worldwide (Reuters, 2024), demonstrating its widespread adoption in educational settings. This rapid adoption highlights the importance of proper training and understanding of GenAI tools (Çayak, 2024; Durak et al., 2024). In particular, more research is needed on the challenges students face when using GenAI tools and the support needed to overcome these challenges (Dwivedi et al., 2023).

Despite its potential benefits, the widespread adoption of GenAI in educational settings poses various challenges. A significant issue is ensuring that students know how to use these tools as well as understand their ethical implications (Kılınc, 2024; traLuckin et al., 2016). Without structured training, students risk misusing GenAI tools or relying on them without developing critical thinking and problem-solving skills (Apolzan & Cimpineanu, 2024). As the World Economic Forum's 2024 report highlights, the adoption of GenAI tools in education must be guided by ethical and responsible considerations; otherwise, the potential benefits of these tools may be overshadowed by risks (Elhussein et al., 2024). This raises the question of how GenAI can be effectively integrated into educational programs while mitigating these risks. In addition, more research is needed on appropriate frameworks and methods for evaluating the use of GenAI in education (Zawacki-Richter et al., 2019).

However, most current research focuses on the short-term effects of GenAI training and provides limited research on the long-term retention and sustained impact of these skills on students' academic and personal development (Purnama et al., 2023). There is not enough information about how structured training affects students' skills in the long term and the permanence of these skills. Therefore, examining the short, medium, and long-term effects of structured training is critical not only to understand the immediate benefits of GenAI in education but also to understand its lasting impact on students' engagement, ethical evaluations, and skill applications (Apolzan & Cimpineanu, 2024). In particular, more research is needed on the long-term effects of GenAI training on different student groups (e.g., students from different disciplines, students with different learning styles) (Holmes & Tuomi, 2022).

This study, therefore, aims to fill this gap by comparatively analyzing the short, medium, and long-term effects of structured GenAI training on university students' perceptions and technical skills before training, after training, and six months later. The main research question guiding this study is: How does structured GenAI training affect university students' perceptions and technical skills related to GenAI technologies both immediately after training and six months later? This study, which includes a six-month follow-up, provides information about the immediate and lasting benefits and challenges perceived by students, as well as valuable data on how GenAI applications can be integrated into educational settings more effectively and sustainably.

Literature review

The potential and challenges of using artificial intelligence (AI) in education have been explored in various studies, emphasizing the importance of innovative practices and pedagogical integration (Álvarez-Álvarez & Falcon, 2023; Barrett & Pack, 2023). AI's ability to enhance personalized learning and streamline educational processes is a recurring theme in the literature (Duong et al., 2023). Hsu and Ching (2023) highlight AI's role in developing

innovative learning applications, while Hwang and Chen (2023) emphasize the need for further research on the ethical and practical challenges that AI poses in educational environments. Recent studies have also demonstrated the potential of AI language models like GPT for automated essay scoring (AES), with findings suggesting that GPT can serve as a viable tool for evaluating and providing feedback on L2 writing, especially when enhanced with linguistic features (Mizumoto & Masaki, 2023). In addition to scoring and feedback, Kim et al. (2025) provide qualitative evidence that students perceive GenAI as a multi-role assistant—acting as a tutor, peer, and ideation partner during academic writing tasks.

In particular, Kelly et al. (2023) and Yu and Guo (2023) investigate university students' attitudes towards AI, finding that perceptions of AI's usefulness vary across disciplines, while Maxwell et al. (2025) show that these perceptions also differ by demographic factors such as academic level and institution type. Similarly, Cowling et al. (2023) analyze the use of large language models (LLMs) like ChatGPT, revealing that while these tools can support learning, they also present challenges related to accuracy and ethical use. Adding to this discourse, Henderson et al. (2025) found that students appreciated GenAI feedback for its clarity and speed, but considered teacher feedback more trustworthy and context-aware. The study concluded that students view the two as serving complementary roles in learning. These studies predominantly focus on short-term evaluations of AI's impact, often overlooking the longer-term effects on students' attitudes and skill retention. Specifically, more research is needed on the challenges students face when using AI tools and the support required to overcome these challenges (Dwivedi et al., 2023).

Ethical considerations are further explored by Lim et al. (2023), who discuss the implications of AI in education, particularly in terms of privacy and fairness. Tlili et al. (2023) delve into ChatGPT's role in education, noting its potential to improve student engagement, but also pointing out risks like generating inaccurate information and reinforcing biases. While these concerns are significant, they primarily address immediate ethical implications without examining how prolonged exposure to GenAI affects students' ethical understanding over time. Bikanga Ada (2024) similarly found that students widely use ChatGPT but often lack clarity on ethical boundaries, highlighting the need for institutional guidance. Additionally, more research is needed on appropriate frameworks and methods for evaluating the use of GenAI in education (Zawacki-Richter et al., 2019).

Specific fields, such as data science and STEAM education, have seen significant AI integration. For instance, Ellis and Slade (2023) examine AI's impact on data science education, while Lee et al. (2023) show that AI enhances creativity in STEAM education. Pretorius (2023) addresses the need for improving AI literacy among students, focusing on preparing them for a future where AI plays a central role in education. Similarly, Pellas (2023) investigates how GenAI platforms enhance students' narrative intelligence and writing self-efficacy, illustrating the positive effects of AI on skill development. However, more research is needed on the long-term effects of GenAI training on different student groups (e.g., students from different disciplines or with different learning styles) (Holmes & Tuomi, 2022).

Despite these benefits, several studies caution against over-reliance on AI tools. Fergus et al. (2023) assess the limitations of ChatGPT in answering subject-specific questions, such as in chemistry, and Ratten and Jones (2023) explore the ethical and practical challenges AI presents in management education. These studies underline the risks associated with GenAI, including dependency on AI tools and potential erosion of critical thinking skills, yet fail to address whether these concerns persist or evolve with sustained GenAI usage.

Collectively, the literature underscores AI's transformative potential in education but stresses the importance of addressing ethical concerns, ensuring accurate usage, and continuing research to maximize its benefits for both students and educators (Eager & Brunton, 2023; Tiwari et al., 2023). In particular, there is a lack of practical guidance on how teachers can effectively integrate GenAI tools into their teaching and how they can train students to use these technologies responsibly (Baidoo-Anu & Owusu Ansah, 2023; Yusuf et al., 2024).

Although numerous studies have been conducted on the applications of artificial intelligence (AI) in education and the challenges encountered (Álvarez-Álvarez & Falcon, 2023; Kelly et al., 2023; Hsu & Ching, 2023), detailed research focusing on the impact of structured training programs specific to Generative AI (GenAI) technologies remains limited (O'Dea et al., 2024). Most studies tend to focus on the general usage of AI tools like ChatGPT or on ethical issues (Tlili et al., 2023; Lim et al., 2023). However, there is a lack of research examining how structured training interventions influence students' perceptions and technical skills regarding these technologies. Meinschmidt et al. (2025) designed a trial using GenAI in communication training for psychology students, assessing its impact on skills, motivation, and attitudes, as well as ethical and practical concerns. As emphasized by Michel-Villarreal et al. (2023), there is an urgent need for empirical research to understand user experiences and perceptions of AI systems in educational contexts. Additionally, studies on how to more effectively integrate GenAI into educational settings and how to maximize the benefits of such integration are also scarce (Cowling et al., 2023; Yu & Guo, 2023). Moreover, the long-term effects of GenAI training on students' ethical awareness, critical thinking, and skill retention remain unexplored in the current body of literature.

Addressing these gaps will help ensure that GenAI is used responsibly and effectively in education to promote equity, access, and success for all students. This study, therefore, aims to fill this gap by comparatively analyzing the short-, medium-, and long-term effects of structured GenAI training on university students' perceptions and technical skills before, immediately after, and six months following the training. Building on the reviewed literature, this study explores how structured GenAI training influences students' perceptions and skills over time, addressing both short- and long-term impacts. Including a six-month follow-up, this study provides insights into the immediate and lasting benefits and challenges perceived by students, as well as valuable data on how GenAI applications can be integrated into educational settings more effectively and sustainably.

Theoretical framework

In this study, four theoretical frameworks are employed to explain undergraduate students' perceptions of GenAI technologies and their processes of adopting these tools. Each framework provides a unique perspective on how students interact with emerging technologies like GenAI and how these interactions shape educational environments. These theories collectively address key aspects of technology adoption, motivation, and long-term engagement, aligning with the study's focus on both immediate and sustained impacts of GenAI training.

To explain students' motivation towards GenAI technologies, Self-Determination Theory (SDT) is utilized. Developed by Deci and Ryan (1985), SDT addresses the fundamental psychological needs of autonomy, competence, and relatedness that drive individuals to

engage with technology. In the context of GenAI training, supporting these needs is critical for increasing students' motivation and engagement. SDT also provides a lens to examine whether students' intrinsic motivation towards GenAI is sustained over time, particularly in the six months following the training. This aligns with the study's goal of exploring the long-term effects of structured GenAI training on students' attitudes and behaviors.

While SDT focuses on internal motivation and psychological needs, Uses and Gratifications Theory (UGT) (Katz et al., 1973) extends the perspective by examining how individuals actively seek out technologies to fulfill specific needs. UGT is applied to understand how students use GenAI tools and what satisfaction they derive from them. This theory provides insights into students' motivations to continue using these tools in their educational journeys after training. UGT is also used to explore whether students' perceived gratification from GenAI remains consistent six months post-training, reflecting the sustained relevance of these tools in their educational practices.

Building on this, Diffusion of Innovations Theory (DIT) (Rogers, 2003) adds a temporal and social dimension by analyzing how quickly and widely GenAI technologies are adopted in educational environments. While UGT addresses individual motivation for use, DIT explains the process through which students accept or reject GenAI tools and how these innovations can be better integrated into educational settings. DIT also provides a framework for understanding how students' adoption of GenAI tools evolves over an extended period, highlighting factors that contribute to sustained or diminishing interest six months after training.

In parallel, Eccles' Expectancy-Value Theory (EVT) (Eccles, 2009) provides a comprehensive framework for understanding students' motivations and behaviors through the dual lens of expected success and perceived value. EVT suggests that students' engagement in tasks is shaped by two primary factors: the value they place on the task and their expectations of success in completing it (Wigfield & Eccles, 2000). In this study, EVT is utilized to examine how students' perceptions of the value of GenAI technologies for their professional development and their confidence in using these tools influence their participation in the training. By assessing changes in students' task value and expectancy over six months, EVT allows the study to explore whether students continue to view GenAI as beneficial for their long-term professional growth. If students believe that GenAI will significantly contribute to their professional growth and feel capable of mastering its use, they are more likely to engage actively in the training. Conversely, lower levels of value and expectancy may result in decreased motivation and participation.

The development of interview questions was directly guided by the theoretical frameworks discussed above. Each construct—such as autonomy (SDT), gratification (UGT), trialability (DIT), and task value (EVT)—was explicitly addressed in the design of the interview protocols to ensure alignment between the theoretical lens and the empirical focus. These frameworks informed both the structure and the content of the data collection tools from the outset, rather than being applied retrospectively.

The six-month follow-up interviews were specifically designed to examine how these theoretical constructs evolved over time. This longitudinal approach enabled us to explore sustained changes in students' motivation, behavior, and attitudes toward GenAI technologies. Through this design, the theoretical frameworks are fully integrated into the research process—extending across data collection, coding, and interpretation—and reinforcing the study's analytical depth and conceptual rigor.

Method

The study employs a case study approach to investigate the impact of structured GenAI training on students' perceptions and skills. According to Yin's classification, this research falls under the "explanatory" case study category, as it aims to explore the reasons and mechanisms behind changes in students' perceptions and skills, grounded in theoretical frameworks and pre- and post-training comparisons (Yin, 2009). This approach provides insight into the evolving perceptions and skills of students, consistent with longitudinal case study design.

Participants

Within the framework of the study, participants were selected on a voluntary basis from among first-year pre-service teachers enrolled in the Information Technologies and Software course at a Faculty of Education in Türkiye. A total of 12 undergraduate students participated in the study, including 6 female and 6 male students. These participants represented six different departments within the faculty: Mathematics Education, Science Education, Primary Education, English Language Teaching, Social Studies Education, and Early Childhood Education. The rationale behind selecting participants from diverse departments was to explore potential disciplinary differences and provide broader insights into GenAI technology adoption across various educational contexts.

During participant selection, priority was given to students who had no prior experience with Generative AI tools, to enable a clearer assessment of how structured training influences initial perceptions, skill acquisition, and sustained engagement over time.

While all 12 students participated in initial and post-training interviews, two students were unavailable for the six-month follow-up interview due to scheduling conflicts. There were no other unexpected events or dropouts during the participant recruitment and data collection process. To maintain confidentiality, participants were anonymized using codes such as S1, S2, etc., throughout the analysis.

Application stage

To ensure a comprehensive understanding of GenAI technologies, the study followed a meticulously designed training program structured in three stages: pre-training assessment, immersive hands-on training, and a six-month follow-up evaluation. This multi-stage approach allows for a thorough examination of both the immediate and long-term effects of GenAI training, addressing the study's research questions.

Initially, individual interviews were conducted with participants to assess their baseline perceptions, skills, and motivations related to GenAI technologies. These interviews laid the foundation for identifying knowledge gaps and tailoring the subsequent training content to participants' needs. The pre-training assessment aligns with the theoretical frameworks employed in the study, such as SDT and EVT, by providing insights into students' initial motivations and expectations.

The two-week training was held in a modern computer lab with high-speed internet and necessary software, combining theory and practice for interactive learning over two weeks. The training content was developed using articles on the subject and YouTube videos pre-

pared by experts. The first week focused on ChatGPT, a widely recognized text-based chatbot, selected for its advanced conversational capabilities, speed, and extensive knowledge base. Participants engaged in diverse activities, such as summarizing, paraphrasing, generating content, coding, answering questions, and initiating discussions, to explore the tool's multifaceted applications. This hands-on approach ensures that students not only understand the theoretical aspects of GenAI but also gain practical skills that can be applied in real-world educational settings.

The second week emphasized visual content creation and presentation design using cutting-edge GenAI tools. Gamma, chosen for its intuitive interface and robust content options, allowed participants to create professional presentations effortlessly. Midjourney, selected for its free access and Turkish language support, facilitated visual content creation, while Scribble Diffusion offered participants a no-login-required platform to experiment with generating visuals through English prompts. This phase of the training highlights the versatility of GenAI tools and their potential to enhance creativity and productivity in education.

To ensure robust data collection and insights, participants were observed throughout the training using structured observation forms. This process allowed researchers to objectively evaluate task performance and skill acquisition. Immediately following the training, a second round of individual interviews was conducted to assess the short-term impact of the training. These interviews focused on changes in students' perceptions, skills, and motivations, providing valuable data on the immediate efficacy of the training program.

Six months later, a follow-up interview was conducted with each participant to evaluate long-term retention of skills, changes in GenAI usage frequency, ethical perspectives, and the perceived influence of GenAI tools on their academic and professional development. This comprehensive approach not only ensures the immediate efficacy of the training but also provides valuable insights into the sustainability and real-world application of GenAI tools in education. The follow-up evaluation is particularly critical for addressing the study's focus on the long-term effects of GenAI training, as highlighted in the theoretical framework and literature review. Throughout the training, no unexpected incidents or technical difficulties occurred, allowing smooth completion of all planned activities. The training environment fostered a collaborative and supportive social atmosphere, enhancing participants' comfort and engagement levels.

Data collection tools

In this study, individual interviews with the students were conducted three times: before the GenAI training, immediately after the training, and six months after the training, following the collection of voluntary consent forms. The semi-structured interview forms were developed based on the four theoretical frameworks guiding the study: SDT, EVT, UGT, and DIT. For example, questions exploring intrinsic motivation and autonomy were drawn from SDT, while expectancy and perceived task value were guided by EVT. UGT informed the exploration of gratification and continued use, and DIT shaped questions about perceived innovation, trialability, and adoption patterns.

The interview questions were initially piloted with five undergraduate students to assess clarity and theoretical alignment. Based on their feedback, adjustments were made before seeking expert review. After making the necessary adjustments, the semi-structured inter-

view form was reviewed by three experienced educational technology experts. These experts evaluated the form not only in terms of content but also in terms of its alignment with the study's theoretical framework. Based on their feedback, the final version of the interview form was completed, ensuring that the questions were both relevant and theoretically grounded. The finalized versions of all three interview protocols (pre-training, post-training, and six-month follow-up) are provided in Appendices 1.

Additionally, a structured observation form was used as another data collection tool. During the training process, researchers observed the students as they completed various tasks related to GenAI. The observation process assessed the students' ability to complete the assigned tasks and the time taken to finish them. These evaluations focused on tasks involving the use of text-based chatbots, presentation preparation, and visual content creation using GenAI tools. The observation form included dimensions such as task completion accuracy, tool selection, creative use of features, and time management. The researchers systematically analyzed the participants' performance using objective evaluation criteria detailed in the observation form, ensuring consistency and reliability in data collection.

Six months later, follow-up interviews were conducted to explore long-term usage patterns, perceived benefits, challenges, and the ethical perspectives of students regarding GenAI tools. This multi-stage data collection approach—combining interviews, observations, and expert input—ensures a comprehensive understanding of both the immediate and long-term impacts of GenAI training, addressing the study's research questions and theoretical foundations while adhering to the transparency principles outlined by Buckley et al. (2021) for methodological rigor and reproducibility.

Data analysis

First, the interviews conducted with the students were systematically transcribed. Following this, Two researchers independently coded the transcripts using an open coding process to identify meaningful units related to perceptions, skills, and experiences with GenAI technologies. The researchers then met to compare their coding schemes. The consistency between the coding schemes was measured, resulting in a Cohen's Kappa coefficient of 0.89, indicating a high level of agreement.

After establishing consistency, the researchers reached a consensus and worked together to identify themes. During the theme development process, the theoretical framework of the study guided the analysis to ensure that the findings were coherent and meaningful. Methods such as content analysis and thematic analysis were employed to explore students' perceptions and experiences with GenAI technologies.

The data from the six-month follow-up interviews was coded separately to identify changes in attitudes, skill levels, and perceptions about GenAI tools over time. This additional dataset provided insights into the retention of skills, evolving attitudes towards ethical considerations, and any new challenges faced during the extended usage of GenAI tools. By comparing the data from all three interview stages, the study was able to capture a holistic view of how students' perceptions and skills evolved over time, addressing the study's focus on both short- and long-term impacts.

Trustworthiness

To ensure the trustworthiness of the study, several strategies were employed across all stages of data collection and analysis. These strategies addressed four key components of qualitative rigor: credibility, dependability, confirmability, and transferability.

Credibility was enhanced through data triangulation, including three rounds of interviews (pre-training, post-training, and six-month follow-up), as well as structured classroom observations. This multi-phase design allowed us to verify changes in participants' perceptions and behaviors over time and to explore how students' engagement with GenAI tools evolved longitudinally. The use of direct quotations in the results further grounds interpretations in the participants' own words.

Dependability was addressed by maintaining consistency in data collection procedures and by applying a clear coding process. Coding schemes were developed independently by two researchers and then compared, resulting in a Cohen's Kappa coefficient of 0.89, indicating a high level of agreement. The audit trail maintained during theme development helped ensure systematic analysis.

Confirmability was supported through the use of external expert review at multiple points in the research process. The interview protocols were reviewed by three experts to ensure alignment with the theoretical framework and research objectives. In addition, peer debriefing and methodological transparency were maintained throughout the analysis to minimize researcher bias.

Transferability was addressed by providing detailed descriptions of the participants' educational backgrounds, academic departments, and prior experience with GenAI technologies. This contextual information allows readers to determine how applicable the findings may be to other educational settings. While gender data were collected, no meaningful differences were observed between male and female participants.

In terms of reflexivity, the researchers acknowledged their dual roles as trainers and data collectors. To minimize potential bias during data collection and interpretation, reflexive notes were kept throughout the process, and structured protocols were followed consistently across participants. No unexpected events or disruptions occurred during the research process. All interviews and observations proceeded as planned, and no participants reported discomfort or withdrawal.

Ethical considerations were also prioritized. Participants were fully informed about the nature and purpose of the study, and confidentiality was ensured through anonymized coding (e.g., S1, S2). These measures fostered open and honest participation.

Findings

The results obtained were interpreted within the theoretical framework of the study, leading to the identification of the following themes: (a) GenAI proficiency levels, (b) intention to use GenAI and dissemination, and (c) benefits and threats of GenAI. These themes provide a comprehensive understanding of how students' perceptions and skills evolved over time, addressing both the immediate and long-term impacts of the GenAI training.

GenAI proficiency levels

Participants were asked what first came to mind when they thought of artificial intelligence before and after the training. According to Fig. 1, under the theme of “Evolving Perceptions of GenAI,” participants primarily associated GenAI with convenience and robots before the training. These keywords are followed by the concept of fast access to information. After the training, it was observed that the participants focused on more specific and technical issues related to GenAI. At this stage, the concept of humanoid robots was the most emphasized



Fig. 1 Concept map of learners’ evolving perspectives over time

among the participants' responses. This concept was followed by GenAI tools such as Chat-GPT and Gamma. Six months later, participants retained their knowledge of these tools but shifted to a more applied understanding, mentioning "virtual assistant," "practical tools", "presentation aid" and "information accuracy" as primary keywords. This indicates a move towards a more practical appreciation of GenAI in educational contexts over time.

Before, after, and six months following the training, participants rated their GenAI proficiency levels. The changes in their self-assessed proficiency are shown in Fig. 2.

According to Fig. 2, as a result of the participants' self-assessments, their GenAI proficiency levels are presented in 3 categories: "low", "medium", and "high". In the pre-training assessment, 9 of the 12 participants rated their proficiency levels as "low" and 3 as "medium", while in the post-training assessment, 1 of the participants rated themselves as "low", 2 as "medium", and 9 as "high". In the context of the practical examples carried out during the training processes, the performance of the participants was observed by a research team of six people. The forms filled in as a result of these observations were analyzed, and the performance of the participants in the relevant tasks was evaluated. According to these evaluations, it was found that the majority of the participants were able to perform the relevant practical examples effectively. Therefore, a high degree of agreement was found between the research team's observations and the participants' own evaluations. These results show that the GenAI training significantly increased the participants' knowledge and skills. In particular, the increase in the number of participants at the "proficient" level underscores the effectiveness of the training. Additionally, six months later, two participants rated their proficiency as "low" again, citing infrequent use as the primary reason. Three of the participants rated themselves as "medium" and 7 as "high".

In this section, direct quotations are given to the participants' views to show this change. For example, while S1 stated that her "knowledge level was at an intermediate level," her post-training statement that she "used my increased knowledge in a useful way at school"

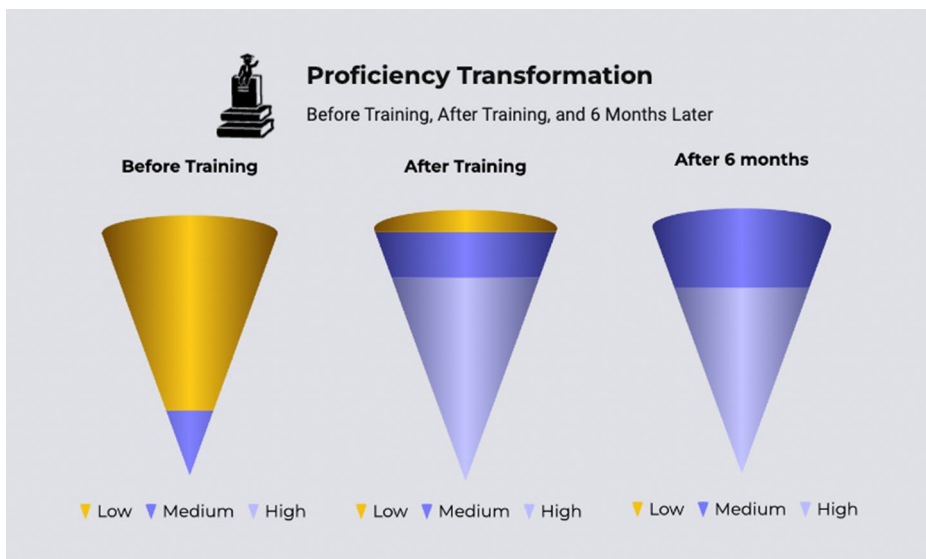


Fig. 2 GenAI proficiency levels

shows that the training increased her ability to put theoretical knowledge into practice. Six months later, S1 shared, “*I still use GenAI, but only for certain tasks where I feel comfortable*”. S6 stated that she “*did not feel competent*” at the beginning, but after the training, she “*reached the level of being able to use the four GenAI applications*”, indicating the development of practical skills. But six months later, S6 stated, “*I haven’t used Gamma since the training, so I’ve lost some familiarity*”. S9, on the other hand, stated that she had “*insufficient knowledge about the subject*” before the training, but after the training she stated that “*the programs were useful but her skill level was still insufficient*”, indicating that the training may have different effects on each participant. After six months, S9 admitted, “*I’ve forgotten some functions, but the basics are still helpful*”.

Intention to Use GenAI and dissemination

Participants’ motivation to participate in the GenAI training and changes in their intention to use GenAI technologies after the training were analyzed. Concepts under the theme of “Motivations for GenAI Adoption” are listed in Fig. 1. The concept of preparing for the future was the most important source of motivation before training. This concept is followed by career development, need, and curiosity. After the training, the concepts of academic success and sense of competence are equally prominent in the participants’ expectations of the GenAI training. Six months later, the participants’ motivations evolved further, with “task efficiency” becoming the most frequently mentioned source of motivation. This shows that over time, participants began to appreciate GenAI as a practical tool that streamlined their daily tasks, transitioning from a broad career-focused perspective to a more immediate, task-oriented approach. Additionally, “learning aid” and “daily life” emerged as significant motivations, reflecting a deeper integration of GenAI into their ongoing learning activities and everyday routines.

Most of the participants stated that participating in the GenAI training would prepare them for the future, meet their specific needs, and be useful for their career development. While S4 was motivated by the thought of “*being one step ahead in the future*” before the training, she stated that GenAI would make her life easier and that she would use it frequently after the training. Six months after the training, S4 expressed that “*GenAI has become a core part of my daily study routine, helping me manage tasks more efficiently.*” This evolution suggests that her motivation had shifted from a futuristic outlook to a focus on practical, everyday utility. P8, on the other hand, stated that she attended the training “*to keep up with the widespread use of AI*”, and after the training she emphasized that “*AI will be valuable in her teaching and personal development*”. Six months later, she added, “*AI has become an essential tool in my learning preparation, especially for creating contents.*” This progression reflects how participants’ motivations transitioned from broad career aspirations to incorporating GenAI as an integral learning aid and career advancement tool. In general, it can be seen that participants are satisfied with the practical applications of GenAI after the training and its possible contributions to their careers. This indicates that the GenAI training has a significant impact on both personal and professional development of the participants. The sustained emphasis on practical benefits and task efficiency six months later suggests that participants not only retained what they learned but also adapted GenAI as a long-term tool to support their academic and daily needs.

Participants were asked about the needs they hope to fulfill by using GenAI technologies and how they plan to apply what they have learned in this training to their daily life or education, with their responses summarized under the theme of “Evolving Intentions for GenAI Use” in Fig. 1. Prior to the GenAI training, participants specifically mentioned the concepts of task facilitation and academic success in relation to their intention to use GenAI technologies. These concepts were followed by the concept of shortening time-consuming tasks. After the training, the concept of content production and enrichment was the most prominent. Six months later, the participants’ intentions had further evolved, with “task facilitation” once again becoming the most significant concept, indicating that the practical, routine use of GenAI had been firmly integrated into their daily and academic lives. Additionally, “content customization” became a prominent theme, suggesting that participants were not only using GenAI for general tasks but also adapting it to meet specific needs in their personal and professional work.

While S1 stated before the training that GenAI “*will be used for routine tasks in daily life*”, he stated after the training that “*it can create fun and useful content for students in the future*”. After six months, S1 noted that GenAI was now instrumental in “*creating tailored study materials for different subjects*,” showcasing a more personalized use of the technology. While S4 initially stated that she could “*use GenAI for research*”, she emphasized that she could “*access information faster and easier while doing homework and research*”. After six months, she shared that, “*GenAI has become a key tool for finding and organizing information quickly, which helps with ongoing projects and studies.*” While S6 stated before the training that she could use it “*for language learning, research and reading articles*”, after the training she stated that she would “*use it to prepare for exams, summarize topics from ChatGPT, prepare presentations with Gamma and lecture*”. Six months later, S6 shared, “*I still use GenAI to summarize complex topics, especially for exam preparation, as it helps me organize information effectively,*” demonstrating the tool’s lasting value for her academic work. S12, on the other hand, initially thought that he would “*access the information quickly and clearly*”, but afterwards said that he would “*use GenAI to prepare content for his future students*”. Six months later, he mentioned, “*GenAI has become essential for gathering information quickly, especially when I need to complete research tasks efficiently,*” showing that GenAI remained a valuable resource in his studies.

Participants were asked which topics they easily understood during the GenAI training and which topics they struggled with. Their responses to these questions are shown in Fig. 3.

Participants’ individual comments provided further insights into their experiences with GenAI tools. While S3 stated that “*I easily understood how to write prompts when using ChatGPT*”, he stated that some aspects of using Gamma were challenging, as “*I had difficulty with how to add links from other sites to the page during the editing phase of the slide created while using Gamma*”. S12, on the other hand, drew attention to how questions should be formulated in order to get efficient results from chatbots, stating: “*I learned that if we want to get detailed feedback from a chatbot on a topic, we need to ask short and clear questions*”. She also noted that there can be some difficulties in using the drawing applications with the statement “*I had some difficulties in drawing a picture*”. These comments highlight the areas where participants experienced both ease and difficulty in using the GenAI tools. Acquiring the ability to write effective prompts for chatbots such as ChatGPT was relatively easy for participants while using GenAI presentation preparation tools and visual content creation tools was challenging for some participants.

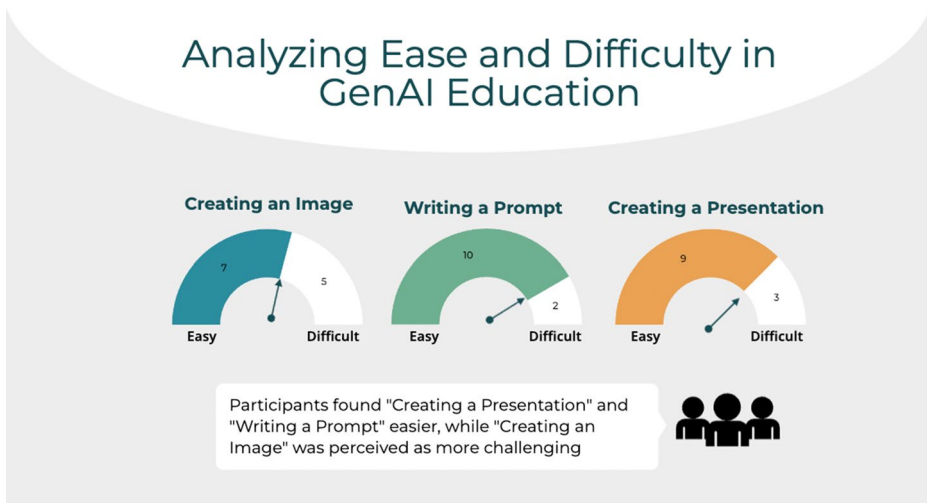


Fig. 3 Participants' perceptions of ease and difficulty in GenAI training tasks

Benefits and threats of GenAI

Participants were asked to share their opinions on the benefits and threats of GenAI technologies. Their responses regarding the benefits of GenAI, both before and after the training, are summarized under the theme of "Perceived Benefits of GenAI" in Fig. 1. Before the training, the most frequently mentioned benefit of GenAI was its "usability," followed by its role as a "facilitator" and usefulness for "routine tasks." These responses indicate that participants initially saw GenAI as a practical tool for making everyday activities easier and more efficient. After the training, participants' views shifted, with "facilitator" and the "importance of GenAI training" emerging as the most prominent benefits. This change reflects an increased appreciation for the training itself, as it helped them understand and apply GenAI tools more effectively in their academic lives. Six months later, "facilitator" remained the most cited benefit, with an even greater frequency, showing that GenAI continued to be valuable in supporting their academic and routine tasks. Additionally, "content creation" and "continuous learning" became significant benefits, highlighting the long-term impact of training as participants incorporated GenAI into ongoing study and learning activities.

For example, S5 initially valued GenAI for time savings, stating, "I think it saves time and is very useful to get information in the fastest and most reliable way." After the training, S5 expressed a deeper understanding of its potential, noting, "Now I feel more confident using AI effectively, especially for generating content quickly." Six months later, S5 continued to rely on GenAI, sharing, "GenAI has become my go-to tool for creating presentations and managing my study materials."

Participants were asked whether they perceived GenAI as a threat to the future and the reasons behind their views. The theme of "Perceived Threats of GenAI," presented in Fig. 1, compares key concepts from their responses before the training, immediately after, and six months later, highlighting participants' evolving perspectives and concerns on this issue. Before the training, most participants viewed GenAI as a threat, with "professions being

taken away” as the primary concern. After the training, this concern decreased, while worries about “making people lazy” and “information security problems” grew, along with a new awareness of “ethical issues.” Six months later, concerns about laziness and information security remained prominent, and ethical concerns also gained importance, showing a shift toward broader societal and ethical impacts over time. The worry about job loss slightly resurfaced.

For instance, S6 initially worried about AI “possibly advancing beyond human control.” After the training, he remarked, “I don’t see it as a threat anymore, as long as humans remain in control.” Six months later, however, S6 noted, “While I’m less worried about control, I am increasingly concerned about ethical and data privacy issues,” showing a shift from general fears to more specific ethical concerns.

Participants were asked to share their views on how GenAI training could provide them with a competitive edge over their peers. The theme of “GenAI as a Competitive Advantage,” illustrated in Fig. 1, compares key concepts from their responses before the training, immediately afterward, and six months later, highlighting shifts in their perceptions over time. Before the training, participants primarily saw GenAI as a tool for “preparing for the future” and “adapting to technological developments”, viewing it as a way to stay relevant in a changing world. After the training, they shifted focus to immediate benefits like “time saving”, “making tasks easier”, and “access to information”, showing an appreciation for GenAI’s practical, day-to-day applications. Six months later, the most cited advantages were “making tasks easier” and “creative problem solving”, indicating that participants had begun using GenAI not just for efficiency but also for complex problem-solving and adaptability.

For example, S2 initially viewed GenAI as a tool to “do the job of the future.” After the training, he noted, “I can get information in a much more practical way and maybe even stay a step ahead because I’m faster.” Six months later, S2 found that GenAI was “helping me approach assignments more creatively.” Similarly, S11 highlighted the time-saving advantage of GenAI by saying, “Two people working on the same topic—one with GenAI and one without—won’t finish at the same speed.” Six months later, she remarked, “I’m now able to use GenAI to approach complex problems creatively and adapt quickly to new subjects,” highlighting its role in fostering adaptability and innovation.

Conclusion, discussion, and recommendations

This study examined how students’ perceptions and competencies related to GenAI evolved across three time points: before, after, and six months following structured training. While most studies in the literature predominantly focus on short-term effects (Alvarez-Alvarez & Falcon, 2023; Hsu & Ching, 2023), this research adopted a longitudinal comparative perspective, assessing both immediate and long-term changes in students’ perceptions, motivations, and perceived skills. By extending the follow-up period, this study provides a holistic understanding of how structured GenAI training may contribute to the sustained integration of these technologies into students’ academic and daily lives. Similar insights were reported by Kim et al. (2025), who found that students’ use of a ChatGPT-embedded academic writing system led to evolving perceptions of GenAI—from novelty to routine, and from generalized expectations to specific, tool-based applications. Participants often

attributed such changes to the training, yet it is acknowledged that other factors—such as exposure to additional courses or tools—may have also played a role. This longitudinal approach can be considered a significant contribution to the literature, as most existing studies lack a long-term perspective on GenAI adoption and skill retention.

The structured GenAI training program led to notable shifts in participants' perceptions and usage skills. Initially, participants associated GenAI with broader concepts such as “convenience” and “robots.” However, post-training, their focus shifted towards specific tools and functionalities, such as ChatGPT and Gamma, reflecting an increase in domain-specific technical knowledge and applied competence. Within the framework of SDT, this enhancement of autonomy and competence contributed to heightened motivation and engagement with GenAI tools. This finding aligns with the work of Hwang and Chen (2023), who emphasize the role of structured training in enhancing students' technical knowledge and practical skills and confirms Kelly et al.'s (2023) conclusion that well-structured GenAI training enhances participants' knowledge depth and practical application skills. Moreover, this finding is particularly novel as it highlights the importance of structured training in transitioning students from abstract, generalized perceptions of GenAI to concrete, tool-specific competencies—a gap not adequately addressed in previous research.

Through self-assessment, participants who initially perceived themselves as “inadequate” in using GenAI began to feel more confident and competent after the structured training, with some displaying more selective and conscious usage behaviors by the six-month mark. Participants perceived that the training supported durable skill acquisition, leading to continued engagement with GenAI tools. This finding is significant as it reveals a critical process of long-term skill retention and the adaptive use of GenAI tools over time, a dimension not yet sufficiently investigated in the literature. The connection between this outcome and SDT suggests that meeting autonomy and competence needs fosters long-term self-efficacy, reinforcing Chiu's (2024) findings on the enduring impact of structured GenAI training on students' technical proficiency and confidence. This study expands on Chiu's work by demonstrating how these skills evolve and adapt over a six-month period, providing new insights into the sustainability of GenAI training outcomes.

A notable change was also observed in participants' motivations towards GenAI. Initially linked to “future preparation” and “academic success,” motivations shifted post-training towards more practical goals, such as “content production” and “task efficiency.” By six months, motivations had further evolved to focus on daily needs like “task facilitation” and “content customization.” This evolution of motivations from abstract, future-oriented goals to concrete, task-specific applications is a novel contribution to the literature, as it reveals how students' engagement with GenAI becomes more integrated into their daily academic routines over time. Unlike previous studies that emphasize the immediate post-training increase in motivation (Duong et al., 2023), this study demonstrates that motivations evolve over time from career-oriented intentions to practical, task-focused goals. Participants' own reflections suggest that GenAI is increasingly used to enhance productivity in everyday academic tasks. From an EVT perspective, this change indicates an increased perceived value of GenAI, along with a positive shift in expectations for its future use. This evolution underscores the importance of long-term evaluations and aligns with research highlighting the value of extended exposure to educational technologies (Eager & Brunton, 2023; Tiwari et al., 2023). Furthermore, participants' views on GenAI's competitive advantage transformed, with the tool initially viewed for efficiency, later seen as fostering creativity and

adaptive learning—an important insight for educators seeking to cultivate enduring skills through GenAI integration, as supported by Tiwari (2023) and Chan and Hu (2023). This finding highlights the critical role of long-term evaluations in education by demonstrating how students' motivations change over time and how GenAI tools are integrated into their daily academic routines.

The ease and challenges experienced when using GenAI tools also provide significant data on long-term effects. During training, participants appreciated GenAI's benefits in "content production" and "task facilitation," but also noted some challenges with tasks like "visual creation." Six months later, these challenges diminished as participants adapted GenAI for practical purposes, demonstrating sustained personal satisfaction and integration of GenAI as a lasting educational resource. Similar to Henderson et al. (2025), who found that students view GenAI as accessible yet limited in contextual depth, our findings suggest that students gradually learn to use GenAI more critically and selectively over time. This finding is particularly important as it shows how students overcome initial challenges and adapt GenAI tools to meet their ongoing needs, a process not well-documented in existing research. According to UGT, the enduring satisfaction participants derived from GenAI indicates that these tools met their educational needs, with purposes like "task facilitation" and "increased efficiency," reinforcing GenAI's value in supporting daily academic activities. This study contributes to the literature by showing how GenAI tools transition from being perceived as novel innovations to becoming fundamental, daily resources for students.

From the DIT perspective, the sustained adoption of GenAI in educational contexts among participants indicates widespread acceptance over the six-month period. The continued perception of GenAI as both a short-term innovation and a permanent educational solution underscores the sustainability of its integration. Skills acquired during training and their applicability to daily academic tasks facilitated rapid adoption and encouraged prolonged use. Participants frequently associated their continued use of GenAI with the structured training, but it should be noted that external factors such as peer influence, new assignments, or exposure to other tools may have also contributed to this adoption. The role of structured training in accelerating the adoption and sustained use of GenAI tools is a factor not extensively explored in previous studies with a detailed and longitudinal perspective. Simultaneously, it aligns with Mao et al. (2023)'s work on factors influencing technology acceptance and supports DIT's role in accelerating GenAI's adoption among participants. This study expands on Mao et al.'s work by providing empirical evidence of how structured training can facilitate the long-term adoption and integration of GenAI tools in educational settings.

Participants' perceptions of GenAI's benefits and threats evolved over time. Initially, concerns focused on job displacement, but post-training, new issues such as "promoting laziness" and "information security" emerged. Six months later, ethical concerns became more pronounced, indicating a more nuanced and realistic risk assessment. Participants believed that the training contributed to their ethical awareness, but other influences during the follow-up period cannot be ruled out. The increased focus on ethics demonstrates that participants were using GenAI more responsibly. This situation is novel in that it demonstrates how students' awareness of ethical issues develops over time, illuminating a dimension not sufficiently addressed in the literature. Findings consistent with studies by Ahmad et al. (2023), Bikanga Ada (2024), Sabharwal et al. (2023), and Yilmaz and Yilmaz (2023), which highlight concerns about laziness and information security, demonstrate that ethical awareness develops and deepens over time, expanding on these studies and providing new

insights into the long-term ethical implications of GenAI use in education. In line with this, Mah et al. (2024) highlighted that students' and teachers' interpretations of cheating and learning with GenAI tools like ChatGPT are deeply context-dependent. Their qualitative findings point to tensions between using AI as a shortcut versus a scaffold, or for language versus ideas—emphasizing the need for co-constructed, ethically grounded norms.

Structured GenAI interventions are gaining attention in education. For example, Meinschmidt et al. (2025) propose a trial integrating GenAI into psychology students' communication training, assessing skills, motivation, and ethics. Such efforts, echoed by Maxwell et al. (2025), highlight the growing recognition of GenAI's role in fostering engagement and long-term competence. On the other hand, this study provides a comprehensive perspective on the sustainable integration of GenAI in education by examining the long-term effects of structured GenAI training on university students' skills, perceptions, and motivations. This research, which addresses changes in students' perceptions and usage over a six-month period, demonstrates that GenAI training not only provides immediate benefits but is also critical for continuous skill development and practical integration. Thus, it fills a significant gap in the literature by evaluating short and long-term effects together and offers a theoretically grounded understanding of how students internalize GenAI technologies. In light of these findings, several recommendations are presented for future research and educational practices:

For policymakers Considering the effectiveness of structured GenAI training in enhancing students' skills and ethical awareness, policies should be developed to support the widespread implementation of such training in educational institutions. These policies should encourage the integration of GenAI training into curricula and support programs to enhance educators' competence in this area. Additionally, frameworks should be established for the determination and implementation of ethical standards in GenAI use. As highlighted by Michel-Villarreal et al. (2023), there is an urgent need for clear policies and frameworks to responsibly integrate AI systems like ChatGPT in higher education.

For institutions Given that our study demonstrates the contribution of structured GenAI training to students' long-term skill development and practical integration, institutions should offer comprehensive training programs that equip students with the ability to use GenAI tools effectively and ethically. These programs should include theoretical knowledge as well as practical experiences, enabling students to learn how to use GenAI in real-world scenarios.

For educators Based on the finding that structured GenAI training enhances students' motivations and practical application skills, educators should enrich students' learning experiences by effectively using GenAI tools in their lessons. Educators should raise students' awareness of the ethical dimensions of GenAI and encourage them to use it responsibly. Furthermore, they should equip students with the ability to evaluate GenAI tools from a critical perspective. Additionally, educators should be mindful of the potential identity-related impacts of AI, such as changes in work dynamics and status perceptions, as highlighted by Mirbabaie et al. (2022). By addressing these issues proactively, educators can foster a positive identification with AI and reduce potential resistance among students.

For researchers This study has demonstrated the importance and long-term effects of structured GenAI training. Future research is recommended to deepen our knowledge in this area by examining the experiences of students from different disciplines and educational levels with GenAI training. Additionally, research is recommended to explore how GenAI training can be implemented with different teaching methods (e.g., online, blended) and which methods are more effective. Researchers are also recommended to contribute to discussions in this area by examining the ethical dimensions and social impacts of GenAI.

Limitations

While the six-month follow-up adds depth to the study, several limitations must be acknowledged. The small sample size restricts the generalizability of findings. Furthermore, although many participants attributed changes in their skills, motivations, and ethical awareness to the training, other academic experiences and external resources encountered during the follow-up period may have influenced these developments. Therefore, conclusions about long-term impact should be interpreted with caution. In addition, the potential for the Hawthorne effect should be considered, as students were aware they were part of a research study, which may have influenced their behavior during and after the training. Future research should attempt to mitigate this by including control groups or less obtrusive observation strategies.

Appendix

Appendix A: Pre-training interview questions

1. After completing the training, what keywords or concepts first come to mind when you hear “Artificial Intelligence (AI)”?
2. How do you evaluate your knowledge and skills regarding AI after the training? Please explain.
3. Do you perceive AI as a threat to your future? How has the training influenced this perception?
4. How do you plan to use what you learned about AI in your daily life or academic activities? Can you provide examples?
5. After the training, to what extent do you think using AI technologies will be beneficial or easy for you?
6. Which topics during AI training did you find easy to understand, and which were more challenging? Please explain.
7. Has your intention to use AI technologies changed after the training? If so, how?
8. Do you plan to use AI software in your future academic or professional life? Why?
9. Have your expectations or purposes for using AI technologies changed after the training? Please explain.
10. How has your attitude toward AI changed since the training? What role did your social environment or training play in this change?

11. Did the AI training meet your expectations? To what extent? How do you define the value of this training?
12. Do you think that having AI training gives you an advantage over your peers? Has your perspective changed after the training? Please explain.

Appendix B: Post-training interview questions

1. When you hear “Artificial Intelligence (AI),” what keywords or concepts first come to mind?
2. How would you evaluate your current knowledge and competence regarding AI?
3. Do you perceive AI as a threat to your future? Why or why not?
4. What are your main motivations for participating in AI training?
5. To what extent do you think using AI technologies will be beneficial or easy for you?
6. What needs do you expect to fulfill by using AI technologies?
7. Do you expect to be satisfied by the outcomes of this AI training? Why?
8. Do you think AI training is valuable for you? Why?
9. Do you think participating in AI training will give you an advantage over your peers? Why?

Appendix C: Six-month Follow-up interview questions

1. What concepts or keywords now come to mind when you hear “Artificial Intelligence (AI)”? Have these concepts changed in the six months following your training?
2. How have your AI-related knowledge and skills evolved over the past six months? Has the impact of your training continued during this period?
3. Has your perception of AI as a threat to your career or personal future changed over the past six months? Why or why not?
4. Have you been using AI tools in your daily life or academic activities over the past six months? Please give specific examples of the tools and purposes.
5. Has your perception regarding the ease and usefulness of using AI technologies changed in the last six months? Please explain.
6. During the last six months, which AI-related skills have you improved in, and in which areas do you still face challenges?
7. How has your motivation to use AI technologies changed in the past six months? What factors influenced this change?
8. Have your future plans for using AI in education or your career changed over the past six months? What factors influenced these decisions?
9. Have your needs or purposes for using AI technologies evolved over the past six months? Please explain these changes.
10. Have your ethical concerns or your sense of responsibility regarding AI use changed over the past six months? Please explain.
11. To what extent do you feel the impact and value of your AI training have persisted after six months? Please explain.
12. How do you currently view the benefits of AI training compared to six months ago? What factors influenced your perspective?

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Declarations

Declaration of generative AI and AI-assisted technologies in the writing process During the preparation of this work the author(s) used AI technologies in order to ensure linguistic accuracy and control. After using this tool/service, the author(s) reviewed and edited the content as needed and take(s) full responsibility for the content of the publication.

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
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