# From Curiosity to Competence: Developing AI Literacy through ESP Instruction at a Technical University

JANA LUPRICHOVÁ

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# FROM CURIOSITY TO COMPETENCE: DEVELOPING AI LITERACY THROUGH ESP INSTRUCTION AT A TECHNICAL UNIVERSITY

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**FROM CURIOSITY TO COMPETENCE: DEVELOPING AI LITERACY THROUGH ESP INSTRUCTION AT A TECHNICAL UNIVERSITY**

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*In loving memory of my father.*

*Always in my heart, forever in my thoughts.*

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# INTRODUCTION

"*Our job is not to censure but to understand*".
Margaret Atwood, *The Handmaid's Tale*

When Margaret Atwood put these words into the mouth of a futuristic academic in her seminal novel, she was warning us against a cold, detached approach to history that forgets human empathy. Yet, in the landscape of 21st-century higher education, this phrase acquires a completely new, urgent dimension. As generative AI and advanced algorithms rapidly enter academia, the initial instinct of many institutions has been to *censure* – to view the technology through a lens of suspicion, focusing primarily on its risks, potential misuse, and threats to academic integrity. However, this monograph argues that the path forward lies in the second part of Atwood's imperative: to *understand*. Rather than reducing the AI phenomenon to a policing problem or an administrative dilemma, this work aims to map how artificial intelligence is fundamentally transforming the university environment, pedagogical practices, and our relationship with text, ultimately seeking a way toward a meaningful and ethical coexistence between human intellect and machine learning.

This need for genuine understanding becomes especially clear when considering how deeply artificial intelligence has already permeated higher education. Indeed, generative AI and algorithmic tools have become among the most significant technological developments influencing contemporary universities. Their rapid expansion affects not only technical fields such as computer science, engineering, or business, but also everyday academic practices across disciplines, including information searching, writing support, translation, language revision, presentation preparation, and independent learning. The public availability of generative AI tools has made these practices even more visible, as students and teachers now interact with AI systems directly through natural language prompts for a wide range of academic and communicative purposes (UNESCO IESALC, 2023; Farrokhnia et al., 2024; OECD, 2026).

The integration of artificial intelligence into university education brings both opportunities and challenges. On the one hand, AI tools can support learning, increase access to information, provide language assistance, help students revise texts, explain difficult concepts and support academic communication (Kasneci et al., 2023; Holmes et al., 2019). On the other hand, their use raises important concerns related to inaccurate outputs, fabricated sources, over-reliance, academic dishonesty, authorship, transparency, data privacy and the possible weakening of students' own critical thinking (Cotton et al., 2024; Bender et al., 2021; European Commission, 2022). For this reason, the question facing universities is no longer whether students will use AI tools, but how they can be guided to use them purposefully, critically and ethically.

This issue is particularly relevant in relation to Generation Z university students. These students have grown up in digitally saturated environments and are usually familiar with online platforms, mobile applications and digital communication (Twenge, 2017; Seemiller and Grace, 2016). However, digital familiarity should not be confused with developed AI literacy. Research on digital natives has repeatedly shown that frequent use of technology does not automatically

mean advanced academic digital competence, critical information literacy or responsible use of digital tools (Bennett et al., 2008; Margaryan et al., 2011; Kirschner and De Bruyckere, 2017). Students may therefore be confident users of digital tools and still need guidance in evaluating AI-generated outputs, verifying sources, recognising ethical boundaries and understanding the difference between AI-supported assistance and inappropriate academic dependence on AI-generated content.

The present monograph focuses on the development of AI literacy in English for Specific Purposes courses at a technical university. English for Specific Purposes is a suitable context for such research because it connects language learning with students' academic, disciplinary and professional needs (Hutchinson and Waters, 1987; Dudley-Evans and St John, 1998; Basturkmen, 2010). Technical university students need English not only for general communication, but also for understanding technical texts, working with specialised terminology, preparing presentations, reading academic sources, producing written assignments and communicating in international academic and professional environments. At the same time, these are precisely the areas in which students increasingly use AI-supported tools.

In this monograph, AI literacy is understood as a multidimensional competence. It includes basic understanding of AI tools and their limitations, practical ability to use AI for academic and ESP-related tasks, critical evaluation of AI-generated outputs, ethical awareness and the transfer of AI-supported skills into academic and professional contexts (Long and Magerko, 2020; Ng et al., 2021; UNESCO, 2024). Such an understanding moves beyond simple tool use. It emphasises that students should not only know how to operate AI applications, but also how to judge their outputs, verify information, acknowledge assistance and remain responsible for their own academic work.

The main aim of the monograph is to examine whether structured AI-enhanced ESP instruction can support the development of AI literacy among technical university students. More specifically, the research investigates students' initial experience with AI tools, their frequency and purposes of AI use, their self-perceived AI-related competence, their attitudes towards AI and their ethical awareness before and after completing AI-focused instructional activities integrated into ESP lessons.

To achieve this aim, several research objectives were formulated. The first objective was to identify students' initial AI literacy, including their previous experience with AI tools, frequency of use, purposes of use and ethical awareness before the instructional intervention. The second objective was to examine whether students' self-perceived AI-related skills developed after completing AI-enhanced ESP instruction. The third objective was to analyse possible changes in the frequency and purposes of AI tool use after the intervention. The fourth objective was to investigate students' ethical awareness and responsible attitudes towards the academic use of AI. The fifth objective was to explore students' attitudes towards AI after the course and to describe the relationship between AI usage frequency and self-perceived AI competence.

The empirical research was conducted at the Faculty of Materials Science and Technology of the Slovak University of Technology in Trnava. The research sample consisted of 75 second-year full-time undergraduate students enrolled in English for Specific Purposes courses during

the winter semester of the academic year 2025/2026. The students were organised into five ESP groups and participated in comparable AI-enhanced ESP instruction. The selection of this research setting was intentional because ESP courses at a technical university combine language development, technical terminology, academic communication, presentation skills, source work, digital competence and professional preparation.

The instructional intervention consisted of five AI-focused training sessions integrated into a 13-week ESP course. The intervention was not designed to teach artificial intelligence as an isolated technological topic. Instead, AI-related activities were connected with academic and technical English. Students worked with chatbots, prompt formulation, AI-supported source retrieval, responsible academic use of AI, presentation preparation, Canva, Gamma and AI-supported video content creation. The purpose of the intervention was to help students move from intuitive or spontaneous use of AI tools towards more purposeful, critical and ethically aware academic application.

The research design combined quantitative and qualitative elements. The quantitative part was based on closed questionnaire items in the pre-intervention and post-intervention questionnaires. These items made it possible to identify general tendencies in students' AI use, attitudes, self-perceived competence and ethical awareness. The qualitative part was based on open-ended written responses and supplementary classroom reflections, which provided additional insight into students' perceptions of AI, their expectations, concerns and reflections on AI-supported learning. The study is therefore understood as a small-scale educational intervention that offers context-bound but pedagogically relevant findings for ESP instruction at technical universities.

The monograph is structured into theoretical and empirical parts. The theoretical part consists of three chapters. The first chapter discusses artificial intelligence and AI literacy in higher education. It introduces artificial intelligence and generative AI in university learning, defines AI literacy as a multidimensional competence and examines the main opportunities and risks of AI use in academic contexts. The second chapter focuses on Generation Z university students and AI use. It discusses Generation Z as digitally immersed learners and explains why digital familiarity does not automatically lead to responsible AI use. The third theoretical chapter situates AI literacy within English for Specific Purposes at technical universities. It examines ESP in technical higher education, the role of AI tools in ESP learning and academic communication, and the integration of AI literacy into ESP instruction.

The empirical part presents the research methodology, the intervention and the analysis of findings. It first explains the research design, aim, objectives, research questions, hypotheses, research setting, sample, instruments, data collection and ethical considerations. It then analyses the pre-intervention questionnaire findings in order to describe students' initial AI literacy before the ESP intervention. The following chapter presents the post-intervention questionnaire findings and examines students' AI use, self-perceived development, ethical awareness, attitudes and transfer of AI skills into academic and ESP-related practice after the AI-enhanced activities. The final empirical chapter evaluates and interprets the research findings in relation

to the research objectives, research questions and hypotheses, and presents pedagogical implications, limitations and suggestions for further research.

The contribution of the monograph lies in its focused exploration of AI literacy in a concrete ESP context. While many discussions of AI in education remain broad or policy-oriented, the present study examines how AI literacy can be integrated into regular ESP instruction for technical university students. It shows that AI literacy can be developed not only through separate digital-skills courses, but also through language-learning tasks connected with source work, terminology, presentation preparation, academic writing, translation, multimodal communication and ethical reflection.

The monograph does not present AI as an automatically beneficial solution, nor does it approach AI only as a threat to academic integrity. Instead, it adopts a balanced position. AI tools can support students' learning and communication, but only when their use is guided, reflected upon and connected with clear academic standards. The central educational task is therefore to help students use AI in ways that support rather than replace their own thinking, language development and academic responsibility.

In this sense, the monograph responds to one of the current challenges of higher education: how to prepare students for academic and professional environments in which artificial intelligence is increasingly present. For technical university students, this preparation includes not only technical or digital competence, but also English-language communication, source evaluation, ethical awareness and the ability to work responsibly with AI-supported tools. The development of AI literacy in ESP courses can therefore contribute to more meaningful, critical and future-oriented university education.

# 1 Artificial Intelligence and AI Literacy in Higher Education

Artificial intelligence has become one of the most influential technological and educational phenomena of the early twenty-first century. In higher education, AI is no longer associated only with computer science, engineering or advanced data processing. It increasingly affects everyday academic practices, including information searching, academic writing, language learning, translation, feedback, presentation preparation, text revision and independent study. The public availability of generative AI tools has intensified this development because students and teachers can now interact with AI systems directly through natural language prompts and use them for a wide range of academic and communicative tasks (UNESCO IESALC, 2023; OECD, 2026).

The growing use of AI in education has also changed the way digital competence is understood. Digital literacy traditionally referred to the ability to access, evaluate and use digital information effectively, but the integration of AI into writing assistants, chatbots, search tools and educational platforms requires a broader competence. Students now need to understand how AI tools generate outputs, how reliable or unreliable these outputs may be, how to evaluate them critically and how to use them ethically in academic contexts (Long and Magerko, 2020; Ng et al., 2021; Bagalová and Kováčiková, 2026).

For this reason, the present monograph understands AI literacy as a multidimensional university competence. It includes knowledge of AI tools and their limitations, practical ability to use AI for academic tasks, critical evaluation of AI-generated outputs, awareness of ethical boundaries and responsible decision-making. Such an understanding corresponds with current international approaches to AI literacy, which emphasise not only technical skills but also human-centred, ethical and critical engagement with AI systems (Long and Magerko, 2020; Ng et al., 2021; UNESCO, 2024; European Commission, 2022).

At the same time, the integration of AI into higher education should not be interpreted only in positive terms. AI tools can support learning, efficiency, access to information, language development and personalised assistance, but they may also create risks connected with over-reliance, academic dishonesty, inaccurate information, hallucinated sources, data privacy, reduced critical thinking and weakening of student authorship. A balanced theoretical discussion therefore needs to include both the opportunities and the risks of AI-supported learning (Farrokhnia et al., 2024; European Commission, 2022; OECD, 2026).

This balanced perspective is particularly important in relation to Generation Z students. They have grown up in digitally saturated environments and often use online tools naturally and frequently. However, frequent digital use does not automatically mean advanced digital or AI literacy. Students may be confident users of digital technologies while still lacking critical, ethical and academic strategies for working with emerging tools such as generative AI (Twenge, 2017; Seemiller and Grace, 2016; Chan and Lee, 2023; Bagalová and Kováčiková, 2026).

A critical view of digital technology and AI is also present in the work and public commentary of Martin Jan Stránský, who draws attention to the possible effects of excessive digital technology use on attention, memory and critical thinking. His perspective is relevant because it reminds educators that AI should not be understood only as a productivity tool, but also as a

technology that may influence how students think, learn and process information. In the context of higher education, this critical view supports the need for pedagogically guided, reflective and ethically grounded AI use rather than uncritical adoption of AI tools (Stránský, 2025; Stránský, 2024).

In English for Specific Purposes courses at technical universities, these issues become especially relevant. Students need English for academic and professional communication, but they also increasingly use AI tools when working with specialised terminology, technical texts, presentations, academic sources and written assignments. ESP instruction can therefore become a meaningful space for developing AI literacy because it connects language learning with academic communication, digital competence, professional preparation and ethical reflection (Hurajová, Luprichová and Chmelíková, 2024; Hurajová and Chmelíková, 2025).

The following chapter introduces the key theoretical concepts on which the empirical research is based. It first discusses artificial intelligence and generative AI in university learning. It then defines AI literacy as a multidimensional competence and finally examines the opportunities and risks of AI in academic contexts. These theoretical foundations provide the basis for the empirical part of the monograph, which investigates how AI-enhanced ESP instruction may support the development of AI literacy among technical university students.

## 1.1 Artificial Intelligence and Generative AI in University Learning

Before discussing the role of AI in higher education, it is necessary to clarify briefly what is meant by artificial intelligence. The idea of machine intelligence existed before the term itself became established. One of the most important early contributions was Turing's discussion of the question whether machines can think and his proposal of the imitation game as a way of considering machine intelligence (Turing, 1950). Although Turing did not use the term artificial intelligence in the contemporary institutional sense, his work became one of the conceptual foundations for later debates about intelligent machines.

The term artificial intelligence became established in connection with the Dartmouth Summer Research Project on Artificial Intelligence, proposed by John McCarthy, Marvin Minsky, Nathaniel Rochester and Claude Shannon in 1955 and held in 1956. The proposal was based on the assumption that learning and other aspects of intelligence could, in principle, be described precisely enough for a machine to simulate them. The Dartmouth project is therefore commonly understood as one of the founding moments of AI as a research field (McCarthy et al., 1955; Delipetrev et al., 2020).

Since the mid-twentieth century, AI has developed through several stages, including symbolic approaches, expert systems, machine learning, neural networks, deep learning and, more recently, generative AI. These developments show that AI should not be understood as a single tool or one specific technology. It is rather a broad field that includes different methods and systems designed to perform tasks associated with human intelligence, such as learning, reasoning, problem-solving, language processing, perception and decision-making (Russell and Norvig, 2021; Delipetrev et al., 2020).

A widely used contemporary approach describes AI through the concept of intelligent agents. In this view, an intelligent system perceives information from its environment and acts upon that environment in order to achieve particular goals. This definition is useful because it does not reduce AI only to human-like thinking. Instead, it emphasises the ability of systems to process information, make decisions and produce outputs in relation to specific tasks (Russell and Norvig, 2021). For the purposes of the present monograph, however, AI is understood primarily from an educational perspective: as a group of technologies that can support, automate or transform tasks connected with learning, communication, language production, information processing and academic work.

In university contexts, artificial intelligence is now encountered mainly through accessible digital tools rather than through abstract technological systems. Students use AI-powered search tools, grammar checkers, translation systems, recommendation systems, writing assistants, chatbots, presentation tools and image or video generators. These tools have gradually become part of academic work because they can help students search for information, reformulate texts, explain concepts, summarise materials, generate ideas, prepare visual outputs and receive language support (UNESCO IESALC, 2023; Farrokhnia et al., 2024; Absolon, 2024). In relation to translation technologies, Welnitzová (2024) points out that machine translation has become an important communication tool for both general users and professional translators, although its output still depends on several factors and often requires human revision.

Generative artificial intelligence represents a particularly significant development because it can produce new text, images, slides, code, audio or video in response to user prompts. Tools such as ChatGPT, Copilot, Gemini, Claude, Canva, Gamma and other AI-supported applications allow users to interact with AI systems in natural language and obtain outputs that may appear coherent, fluent and academically useful. In higher education, this has changed students' access to writing support, language assistance, idea generation and presentation preparation (UNESCO IESALC, 2023; OECD, 2026).

The educational potential of generative AI lies partly in its accessibility. Unlike specialised software that requires advanced technical training, generative AI tools can be used by students from various disciplines, including non-computer-science fields. This makes them relevant not only for technical subjects, but also for language learning, academic writing, communication, presentation skills and professional preparation. UNESCO IESALC (2023) notes that ChatGPT and similar tools can be used in higher education for activities such as generating ideas, explaining concepts, supporting writing and assisting with teaching and learning processes.

At the same time, the fact that generative AI tools produce fluent and confident outputs creates a specific educational challenge. Their answers may appear authoritative even when they are incomplete, inaccurate, biased or unsupported by reliable sources. For this reason, AI-supported academic work requires more than technical ability to operate a tool. Students need to evaluate the quality, accuracy, relevance and appropriateness of AI-generated content before using it in academic tasks (European Commission, 2022; Farrokhnia et al., 2024).

The OECD similarly emphasises that generative AI can support learning when it is used with clear pedagogical guidance, but it may fail to produce real learning gains if students simply

outsource tasks to AI. This distinction is essential for higher education because improved task completion does not automatically mean improved understanding. If students rely on AI-generated answers without active cognitive engagement, the visible quality of their work may increase while their actual learning remains superficial (OECD, 2026).

This concern is also present in critical discussions of AI and cognition. Stránský draws attention to the risk that excessive digital dependence may affect attention, memory and critical thinking. His perspective should be used as a critical medical and public-intellectual view rather than as the main empirical foundation for educational policy. Nevertheless, it contributes an important cautionary argument: educational AI use should preserve intellectual effort, independent judgement and the development of thinking skills (Stránský, 2025; Stránský, 2024).

A similar concern appears in broader critical literature on technology and cognition. Carr (2010) argues that digital environments may encourage fragmented attention and shallow processing of information if users constantly move between short, rapidly changing inputs. Turkle (2015) also warns that digital technologies may reshape communication, reflection and human interaction when they are used as substitutes for deeper engagement. These perspectives do not mean that AI should be excluded from education, but they support the argument that AI use must be guided, reflective and connected with real learning.

In language education and academic communication, generative AI tools offer several practical benefits. They can support vocabulary development, reformulation, grammar correction, translation comparison, text simplification, explanation of terminology and preparation of presentation content. For students who study English for Specific Purposes, such support may be particularly valuable because they often need to work with technical vocabulary, discipline-specific texts and academic communication tasks in a foreign language (Hurajová and Chmelíková, 2025; Bagalová and Kováčiková, 2026).

However, AI-supported language work also raises important questions about authorship, accuracy and academic integrity. If students use AI only to improve grammar or clarify terminology, the tool may function as learning support. If they use it to generate complete assignments without personal engagement, the tool may undermine authorship and learning. This distinction is central to responsible AI use in higher education and requires explicit institutional and pedagogical guidance (European Commission, 2022; UNESCO IESALC, 2023; Bagalová and Kováčiková, 2026).

The Slovak educational context also confirms the relevance of this issue. Bagalová and Kováčiková (2026) argue that AI literacy should be understood as an extension of digital literacy in bilingual and content-integrated educational contexts. Their findings suggest that teachers may have strong functional digital skills but still lack conceptual and ethical frameworks for responsible AI integration. This distinction is also relevant for university students: the ability to use digital or AI tools frequently does not automatically mean that students can use them critically, ethically and academically.

In the context of ESP and technical higher education, AI tools should therefore be approached as educational instruments that require pedagogical framing. Their value does not lie only in

accelerating academic tasks, but in helping students learn how to ask better questions, formulate clearer prompts, evaluate outputs, work with sources, improve language and reflect on responsible academic use. When integrated meaningfully, generative AI can support the development of both language competence and AI literacy (Long and Magerko, 2020; Ng et al., 2021; Hurajová, Luprichová and Chmelíková, 2024).

This subchapter has shown that artificial intelligence, and especially generative AI, has become an important part of university learning. Its use offers clear opportunities for academic support, language development and more flexible access to information. However, these opportunities are inseparable from risks related to reliability, over-reliance, reduced critical engagement and academic integrity. For this reason, the central educational question is not whether students will use AI, but whether they will learn to use it purposefully, critically and responsibly.

## 1.2 AI Literacy as a Multidimensional Competence

The growing presence of artificial intelligence in higher education has made AI literacy an increasingly important academic competence. Since students now use AI tools for searching information, preparing written assignments, improving language, generating ideas, creating presentations and solving study-related problems, it is no longer sufficient to understand AI only as a technological phenomenon. In educational contexts, AI literacy refers to the ability to understand, use, evaluate and ethically apply AI technologies in ways that support learning, communication and responsible academic work (Long and Magerko, 2020; Ng et al., 2021; UNESCO, 2024).

One of the most influential definitions of AI literacy was proposed by Long and Magerko (2020), who define it as a set of competences that enable individuals to critically evaluate AI technologies, communicate and collaborate effectively with AI, and use AI as a tool in everyday, academic and professional contexts. This definition is particularly useful for higher education because it does not reduce AI literacy to programming knowledge or technical expertise. Instead, it emphasises critical evaluation, interaction with AI systems and purposeful use. From this perspective, university students do not need to become AI developers, but they need to understand what AI tools can and cannot do, how to interact with them effectively and how to evaluate their outputs critically.

Ng et al. (2021) also understand AI literacy as a complex and multidimensional construct. Their framework includes several interconnected areas: knowing and understanding AI, using and applying AI, evaluating and creating with AI, and understanding ethical issues related to AI. This model is relevant to the present monograph because the empirical research also examines students' knowledge of AI, their use of AI tools, their self-perceived competence, their attitudes and their ethical awareness. AI literacy is therefore not treated as one isolated skill, but as a combination of knowledge, practical ability, critical judgement and responsible behaviour.

AI literacy is also closely connected with broader discussions of artificial intelligence in education. Holmes, Bialik and Fadel (2019) argue that AI in education should not be understood only in terms of technological innovation, but also in terms of its implications for teaching, learning, assessment and the roles of teachers and learners. Their perspective supports the view that AI literacy is not merely operational knowledge of tools, but part of a broader educational

competence that includes understanding how AI may affect learning processes, decision-making and educational responsibility.

The ethical dimension of AI literacy is emphasised strongly by Dignum (2019), who argues that responsible AI requires attention not only to the technical system itself, but also to the social and institutional context in which AI is designed, implemented and used. This perspective is important for higher education because students' use of AI is not an isolated technical activity. It takes place within academic rules, assessment practices, authorship expectations and institutional understandings of academic integrity. Therefore, AI literacy must include responsibility, transparency and human accountability (Dignum, 2019; European Commission, 2022).

The ability to evaluate AI-generated outputs has also become a central concern in recent educational research. Bearman et al. (2024) connect generative AI with the concept of evaluative judgement and argue that students need to learn how to judge the quality of AI outputs and AI-supported processes. This is particularly relevant in academic contexts because students may receive fluent and convincing AI-generated responses that still require careful verification. AI literacy therefore includes not only the ability to produce outputs with AI, but also the ability to judge whether those outputs are accurate, relevant, reliable and appropriate for the academic task.

Although several AI literacy frameworks have been proposed, there is no single universally accepted model of AI literacy in higher education. Some frameworks emphasise technical understanding and interaction with AI systems, while others focus more strongly on ethics, critical evaluation, social consequences, academic integrity or discipline-specific transfer. Gu and Ericson (2025), in their integrative review of AI literacy in K-12 and higher education, point out that the concept of AI literacy remains diverse and that it can be approached from functional, critical and sociocultural perspectives. This confirms that AI literacy is not a fixed or narrow construct, but an evolving educational concept.

More recent higher-education models also show that AI literacy can be structured in different ways. Hackl, Mueller and Sailer (2025), for example, propose the AI Literacy Heptagon, which includes technical, applicational, critical thinking, ethical, social, integrational and legal dimensions. Their model is useful because it demonstrates the complexity of AI literacy in higher education and shows that AI literacy can include more dimensions than simple tool use. At the same time, such detailed frameworks may be too broad for a small-scale ESP-based educational intervention. The present monograph therefore uses a more compact synthesis adapted to its empirical focus.

The present monograph does not attempt to replace existing AI literacy frameworks. Instead, it uses a simplified five-dimensional synthesis adapted to the aim of the empirical research and to the context of ESP instruction at a technical university. The five dimensions – understanding AI, using and applying AI, evaluating AI outputs, ethical and responsible use, and academic and professional transfer – were selected because they correspond directly with the research instruments and the AI-enhanced ESP intervention. They also reflect the practical needs of

university students who use AI tools for information searching, language support, source work, presentation preparation and academic communication.

These dimensions are summarised in Figure 1.

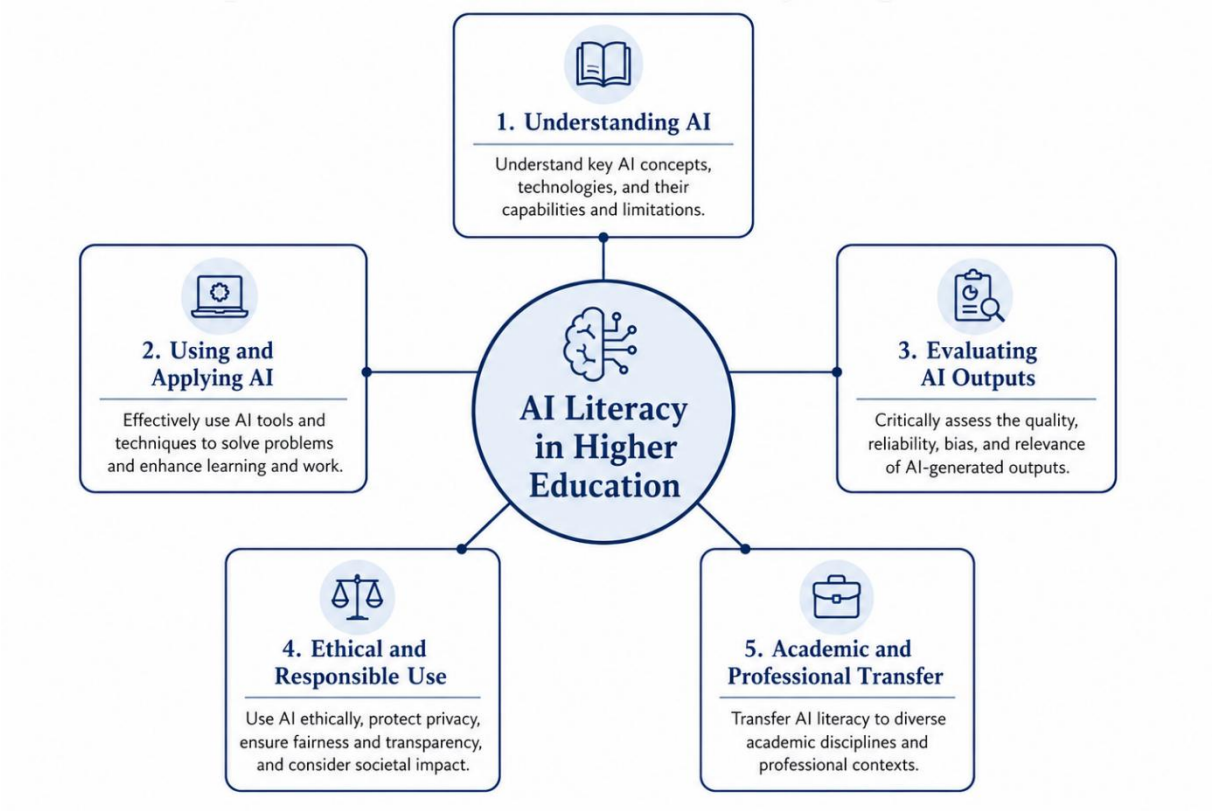



Figure 4: Core Dimensions of AI Literacy in Higher Education
*Source: Author's own elaboration based on Long and Magerko (2020), Ng et al. (2021), UNESCO (2024), Bagalová and Kováčiková (2026), Gu and Ericson (2025), and Hackl, Mueller and Sailer (2025). Visual design prepared with AI assistance; content checked and edited by the author.*

The first dimension, understanding AI, refers to students' basic conceptual knowledge of artificial intelligence. This includes understanding what AI is, what generative AI is, how AI tools produce outputs and what limitations such tools may have. Students do not need detailed technical expertise, but they should understand that AI-generated answers are produced through computational processes and data-based models, not through human understanding. This distinction is important because students may otherwise interpret fluent AI-generated text as automatically reliable or authoritative (Long and Magerko, 2020; UNESCO IESALC, 2023).

The second dimension, using and applying AI, concerns the practical ability to work with AI tools for learning and academic tasks. In higher education, students may use AI to search for information, generate ideas, explain difficult concepts, reformulate texts, support grammar and vocabulary development, prepare presentations or organise study materials. However, practical use should not mean passive dependence on AI-generated content. It should involve purposeful tool use, effective prompting and active student engagement with the output (Ng et al., 2021; Holmes et al., 2019; UNESCO, 2024).

The third dimension, evaluating AI outputs, is central to academic AI literacy. AI-generated content may be incomplete, inaccurate, biased, outdated or unsupported by reliable sources. Students therefore need to assess the quality, relevance, accuracy and reliability of AI outputs before using them in academic work. This dimension is especially important in relation to academic source work, because generative AI tools may produce plausible but false references or misleading summaries. Critical evaluation of AI output is therefore closely connected with academic reading, source verification, information literacy and evaluative judgement (European Commission, 2022; Farrokhnia et al., 2024; Bearman et al., 2024).

The fourth dimension, ethical and responsible use, refers to students' ability to recognise the boundaries between acceptable AI-supported assistance and inappropriate academic dependence on AI. AI can support students in learning, planning, revising and improving their work, but it can also be misused to produce complete assignments without sufficient student authorship. Ethical AI literacy therefore includes transparency, acknowledgement of AI use, respect for academic integrity, awareness of data privacy, and the ability to preserve one's own thinking and responsibility in academic tasks (Dignum, 2019; European Commission, 2022; UNESCO, 2024).

The fifth dimension, academic and professional transfer, concerns the ability to apply AI literacy beyond one isolated classroom activity. University students need AI-related competences not only for individual assignments, but also for future academic, professional and lifelong learning contexts. For technical university students, this is particularly relevant because their future work may involve AI-supported systems, digital communication, technical documentation, professional presentations, data processing and international cooperation. AI literacy should therefore be understood as part of broader academic and professional competence (UNESCO, 2024; Hurajová and Chmelíková, 2025).

The relationship between digital literacy and AI literacy is especially important. Digital literacy traditionally refers to the ability to access, evaluate, use and communicate information through digital technologies. However, AI literacy goes further because AI tools do not only provide access to information; they generate, transform and mediate content. Students must therefore understand not only how to use digital tools, but also how AI systems influence the production, interpretation and credibility of information (Ng et al., 2021; Bagalová and Kováčiková, 2026).

Bagalová and Kováčiková (2026) argue that AI literacy should be seen as part of an expanded understanding of digital literacy, particularly in bilingual and content-integrated educational contexts. Their findings suggest that teachers may demonstrate strong functional digital skills and regular technology use, but still lack conceptual and ethical frameworks for responsible AI integration. This distinction is relevant also for university students. The fact that students frequently use AI tools does not automatically mean that they possess developed AI literacy. They may know how to access and operate tools, but they may still need support in understanding AI, evaluating outputs, acknowledging AI use and applying AI responsibly in academic contexts.

The European and international policy context also supports the importance of AI literacy. UNESCO's AI Competency Framework for Students emphasises that students should develop

a human-centred understanding of AI, ethical awareness, knowledge of AI techniques and applications, and the ability to use AI responsibly (UNESCO, 2024). Similarly, the European Commission's ethical guidelines on AI and data in teaching and learning stress the importance of human agency, transparency, fairness, accountability and responsible educational use of AI (European Commission, 2022). These frameworks show that AI literacy is not only a technical issue, but also an ethical and educational priority.

The EU Artificial Intelligence Act further strengthens the relevance of AI literacy by explicitly requiring attention to AI literacy among people who work with or are affected by AI systems. Although this regulation is primarily legal and institutional in nature, it has clear implications for higher education. Universities are expected to prepare students for environments in which AI-supported tools and systems will increasingly shape professional, social and academic practices (European Union, 2024).

For the purposes of the present monograph, AI literacy is therefore understood as a multidimensional competence consisting of knowledge, practical use, critical evaluation, ethical awareness and transfer into academic and professional practice. This understanding directly informs the empirical part of the research. The pre- and post-intervention questionnaires examine students' experience with AI, frequency and purposes of use, knowledge and understanding, attitudes, ethical perception, self-assessed competence and transfer of AI skills into academic practice. The instructional intervention similarly focused not only on tool use, but also on prompting, source searching, presentation preparation, video creation and responsible academic application.

The analysis therefore indicates that AI literacy should be developed intentionally rather than left to students' spontaneous experimentation with AI tools. Students may already use AI frequently, but structured educational guidance is necessary if this use is to become purposeful, critical, academically relevant and ethically responsible. In this sense, AI literacy represents an important competence for higher education, especially in ESP contexts where students use English, digital tools and academic communication skills together.

## 1.3 Opportunities and Risks of AI in Academic Contexts

The integration of artificial intelligence into higher education brings both significant opportunities and serious challenges. AI tools can support learning, communication, academic writing, information searching, feedback, language development and productivity. At the same time, they raise concerns related to accuracy, academic integrity, authorship, over-reliance, bias, privacy and the possible weakening of critical thinking. For this reason, AI in academic contexts should not be discussed only as a technological innovation, but as a complex educational phenomenon that requires pedagogical, ethical and institutional reflection (Zawacki-Richter et al., 2019; Holmes et al., 2019; Kasneci et al., 2023).

One of the main opportunities of AI in higher education is its potential to provide students with more flexible learning support. AI tools can explain difficult concepts, generate examples, simplify complex texts, offer language corrections, support vocabulary development and help students organise ideas. For students who need additional support outside classroom contact hours, such tools may function as accessible learning assistants. Kasneci et al. (2023) argue that

large language models can support education by generating explanations, examples, exercises and feedback, although their use must be accompanied by appropriate teacher guidance and student literacy. In the context of STEM education, Miština (2026) argues that generative AI may support personalised learning, increase the visibility of female role models and encourage reflection on gender stereotypes, which shows that AI can also be used to promote inclusive educational practices.

AI can also support individualised learning. Since students differ in language proficiency, prior knowledge, confidence and learning pace, AI tools may help them access explanations and examples adapted to their immediate needs. This is especially relevant in language learning and ESP contexts, where students often need support with terminology, sentence formulation, text comprehension and professional communication. However, such individualisation should not be understood as a replacement for the teacher. Rather, AI may function as an additional support mechanism within a pedagogically designed learning environment (Holmes et al., 2019; Zawacki-Richter et al., 2019).

Another important opportunity concerns academic writing and language support. Students may use AI tools to improve grammar, reformulate sentences, check clarity, generate outlines, compare translations or receive suggestions for improving coherence. In this sense, AI can support the writing process, especially for students writing in a foreign language. Nevertheless, AI-supported writing should be understood as assistance within the student's own writing process, not as a substitute for student authorship. The distinction between support and substitution is central to responsible academic AI use (Cotton et al., 2024; European Commission, 2022).

In relation to translation and multilingual communication, AI tools have already become part of academic and professional language practice. Machine translation and AI-supported translation systems can help users understand texts in foreign languages, compare formulations and access information across linguistic boundaries. Welnitzová (2024) points out that machine translation has become an important communication tool for both general users and professional translators, although its output is influenced by several factors and often requires human revision. This is relevant for ESP students because they increasingly work with technical texts, terminology and academic sources in English.

AI tools also offer opportunities for academic source orientation and information processing. Students may use AI to identify possible directions for research, summarise complex texts, generate search terms or clarify unfamiliar terminology. However, this use requires particular caution. AI-generated summaries or references may appear plausible even when they are incomplete or incorrect. Therefore, AI-supported source work should always be combined with independent verification, reading of original sources and critical judgement (Farrokhnia et al., 2024; Bearman et al., 2024).

Presentation preparation and multimodal communication represent another area where AI tools may support academic work. Applications that generate slides, visual materials, images or video content can help students prepare academic or professional presentations more efficiently. Such tools may be particularly useful in ESP courses, where students practise presentation skills,

poster preparation and technical explanation. However, the quality of AI-generated visual or multimodal outputs still needs to be evaluated in terms of accuracy, clarity, relevance, copyright, visual appropriateness and academic purpose (Holmes et al., 2019; Hurajová and Chmelíková, 2025).

Despite these opportunities, the use of AI in academic contexts involves several risks. One of the most frequently discussed problems is the reliability of AI-generated outputs. Large language models can produce fluent and coherent text, but this does not guarantee factual accuracy. Bender et al. (2021) warn that large language models generate language on the basis of statistical patterns rather than genuine understanding. This is important for education because students may mistake linguistic fluency for reliability. A well-written AI-generated answer may still contain factual errors, unsupported claims or misleading interpretations. At the same time, Miština (2026) warns that the educational use of generative AI requires careful attention to algorithmic bias, digital inequality and human oversight, since AI tools may otherwise reproduce rather than reduce existing disparities.

The other risk concerns hallucinated or fabricated sources. Generative AI tools may produce references that look academically credible but do not actually exist or do not support the claim for which they are cited. This problem is particularly serious in higher education because academic work depends on verifiable sources, transparent citation and responsible engagement with literature. If students use AI-generated references without checking them, they may unintentionally include false or misleading information in their assignments (Farrokhnia et al., 2024; Cotton et al., 2024).

Academic integrity is one of the central challenges associated with AI use in universities. AI tools can be used ethically to support brainstorming, planning, language improvement or feedback. However, they can also be misused to generate complete assignments, essays or reports without sufficient student input. Cotton et al. (2024) discuss the challenges that ChatGPT creates for academic honesty and argue that universities need to rethink assessment, plagiarism policies and guidance for students. In this context, the key issue is not only whether students use AI, but how transparently and responsibly they use it.

The question of authorship is closely connected with academic integrity. If students use AI to generate substantial parts of a written assignment, it may become unclear which ideas, formulations or arguments are genuinely theirs. This does not mean that every use of AI in writing is inappropriate. However, students need to understand the difference between using AI as a support tool and submitting AI-generated work as their own. This distinction requires explicit institutional guidance and classroom discussion (European Commission, 2022; UNESCO, 2024).

Over-reliance on AI represents another important risk. If students repeatedly use AI to solve academic tasks without engaging in their own thinking, reading, writing and problem-solving, AI may reduce rather than support learning. The OECD warns that generative AI can improve the visible quality of student outputs without necessarily producing deeper learning gains if students simply outsource cognitive work to AI systems (OECD, 2026). This issue is highly

relevant in higher education, where the purpose of assignments is not only task completion, but the development of knowledge, reasoning and independent judgement.

Critical voices from technology and education research also draw attention to the broader cognitive and social consequences of digital dependence. Selwyn (2019) argues that educational technology should be approached critically and that claims about technological improvement in education should not be accepted automatically. Similarly, Stránský (2024) warns against the weakening of attention, memory and independent thinking in digitally saturated environments. These perspectives do not reject technology as such, but they support the need for reflective and pedagogically guided use of AI in education.

Bias is another significant concern. AI systems are trained on large datasets that may contain social, cultural, linguistic or ideological biases. As a result, AI-generated outputs may reproduce stereotypes, marginalise certain perspectives or present culturally limited interpretations as neutral. Bender et al. (2021) emphasise that large language models may amplify harmful biases present in their training data. For students, this means that AI outputs should not be accepted as objective or universally valid. They require critical reading, comparison with reliable sources and awareness of the social conditions under which AI systems are developed.

Privacy and data protection also need to be considered. When students use AI tools, they may enter personal data, unpublished academic work, institutional information or sensitive content into external systems. This raises questions about data storage, reuse, ownership and confidentiality. Borenstein and Howard (2021) argue that AI ethics education should address not only technical issues, but also responsibility, transparency, privacy and the broader social consequences of AI use. In higher education, students and teachers therefore need clear guidance on what kinds of data should not be submitted to AI tools.

Another challenge concerns unequal access to AI tools and unequal levels of AI literacy. Some students may have regular access to advanced AI systems, paid versions of tools or stronger prior digital competence, while others may use only limited free tools or lack confidence in working with AI. This may create new inequalities in academic performance and participation. Zawacki-Richter et al. (2019) point out that although AI applications in higher education are expanding, their pedagogical integration remains uneven. Universities should therefore avoid assuming that all students have the same AI-related resources, competences or confidence.

The opportunities and risks of AI in academic contexts can therefore be understood as interconnected rather than separate. The same tool that helps students improve language may also be misused to replace student writing. The same chatbot that supports explanation may also produce inaccurate information. The same AI-supported presentation tool that saves time may also produce superficial or visually attractive but academically weak content. For this reason, the educational value of AI depends less on the tool itself and more on how it is used, guided, evaluated and reflected upon (Kasneci et al., 2023; Bearman et al., 2024).

The main opportunities and risks discussed in this subchapter are summarised in Figure 2.

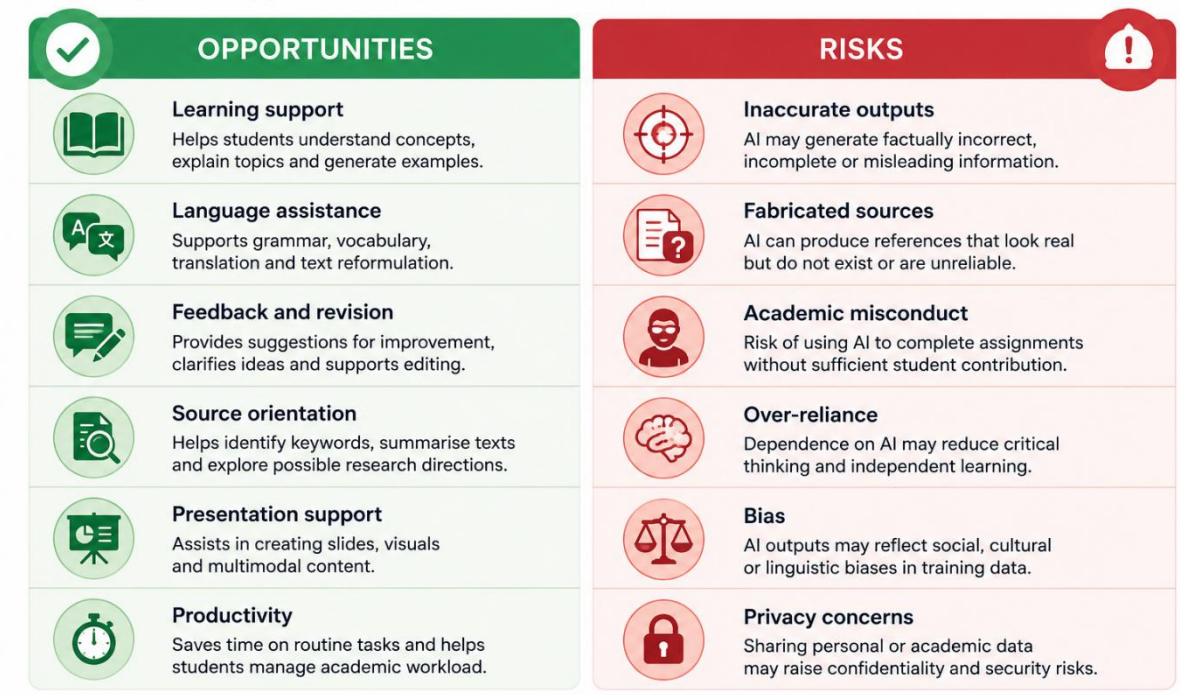



Figure 5: Opportunities and Risks of Generative AI in Academic Contexts
*Source: Author's own elaboration based on Zawacki-Richter et al. (2019), Kasneci et al. (2023), Farrokhnia et al. (2024), Cotton et al. (2024), Bender et al. (2021), and Bearman et al. (2024). Visual design prepared with AI assistance; content checked and edited by the author.*

As Figure 2 shows, the academic use of generative AI cannot be evaluated only in terms of its benefits or only in terms of its risks. The same technological affordances that support learning, language development, feedback, source orientation, presentation preparation and productivity may also create problems related to inaccurate outputs, fabricated sources, academic misconduct, over-reliance, bias and privacy. This dual character of AI use is particularly important for the present monograph, because the empirical intervention did not aim to encourage uncritical use of AI tools. Rather, it aimed to help ESP students develop more informed, selective and responsible ways of using AI in academic and professionally oriented communication.

For the purposes of the present monograph, the most important implication is that AI should be integrated into higher education through explicit pedagogical guidance. Students should not be left to develop AI practices only through trial and error. They need opportunities to test AI tools, compare outputs, identify weaknesses, verify sources, discuss ethical boundaries and reflect on the role of AI in their own learning. This is especially important in ESP contexts, where students use AI not only for general study support, but also for academic communication, technical vocabulary, source work, presentation preparation and future professional communication.

The analysis in this subchapter shows that AI in academic contexts cannot be evaluated in a one-sided way. It offers clear educational opportunities, especially in relation to accessibility, language support, feedback, academic communication and productivity. At the same time, it

creates risks connected with reliability, authorship, academic integrity, over-reliance, bias, privacy and unequal access. The central pedagogical task is therefore not to prohibit or uncritically promote AI, but to teach students how to use it purposefully, critically, transparently and responsibly.

# 2 Generation Z University Students and AI Use

The integration of artificial intelligence into higher education is closely connected with the characteristics of contemporary university students. The present monograph focuses on students who belong to Generation Z, a cohort whose everyday lives have been shaped by digital technologies, permanent internet access, social media, mobile communication and rapid information exchange. These students often enter university with extensive experience of digital environments; however, this experience should not be automatically interpreted as advanced academic digital competence or AI literacy.

The aim of this chapter is to examine Generation Z university students as digitally immersed learners and to discuss how their familiarity with digital technologies relates to their use of artificial intelligence in academic contexts. The chapter first outlines the main characteristics of Generation Z as a student cohort. It then explains why the concept of the "digital native" should be treated critically, especially in relation to academic work, critical thinking and ethical AI use. Finally, it prepares the theoretical ground for the empirical part of the monograph, which investigates how technical university students use AI tools in ESP learning and how structured AI-focused instruction may support more responsible and academically meaningful use of these tools.

## 2.1 Generation Z as Digitally Immersed Learners

Generation Z is usually understood as the generation born from the mid-1990s to the early 2010s. Although exact chronological boundaries differ among authors, this cohort is generally associated with growing up in a world of smartphones, wireless internet, social media platforms, online video, digital entertainment and constant access to information. Unlike previous generations, many Generation Z students do not remember a period in which digital technologies were not part of everyday communication, learning and leisure activities. Twenge (2017) characterises this cohort, which she also refers to as iGen, as the first generation to spend adolescence in a fully smartphone-saturated environment.

This digital environment has influenced how Generation Z students communicate, search for information, learn, form opinions and participate in social life. Seemiller and Grace (2016) describe Generation Z college students as a cohort with specific expectations regarding communication, independence, social engagement and learning. They tend to value practical relevance, visual and interactive forms of information, autonomy, immediacy and meaningful connection between education and real-life application. In higher education, these characteristics may influence students' preferences for flexible learning formats, digital resources, collaborative tasks and technology-supported academic work.

Seemiller et al. (2019) further emphasise that Generation Z students often prefer learning that is practical, visually supported, interactive and connected with real-world contexts. Their learning preferences are frequently associated with multimedia resources, online information, short formats, social interaction and opportunities for active participation. Such preferences are relevant to university teaching because students may respond positively to learning tasks that combine digital tools, collaboration, problem-solving and creative output. At the same time, these preferences may also create pedagogical challenges if students expect rapid answers,

simplified explanations or immediate feedback without deeper engagement with complex academic content.

The concept most frequently associated with digitally immersed young people is the idea of the "digital native". Prensky (2001) introduced this influential term to describe students who had grown up surrounded by digital technologies and were therefore assumed to think and learn differently from previous generations. According to this view, young people raised in digital environments are naturally fluent in using digital technologies and may require different educational approaches from those used with earlier generations. Although this concept became widely used in educational discourse, it has also been strongly criticised.

Bennett, Maton and Kervin (2008) argue that the idea of a homogeneous generation of digital natives is too simplistic and may be misleading. Their critique is important because it warns against assuming that all young students possess the same level of technological competence, the same access to digital tools or the same ability to use technology effectively for learning. Digital experience is uneven and depends on social, educational, economic and personal factors. Therefore, even students who use technology frequently may still need explicit instruction in academic digital practices.

Similarly, Margaryan, Littlejohn and Vojt (2011) show that university students' use of digital technologies is often more limited and conventional than the digital native discourse suggests. Their findings indicate that students may use common technologies regularly, but this does not automatically mean that they engage with advanced digital tools for learning or that they possess sophisticated digital learning strategies. This distinction is particularly relevant to AI use. Students may use AI tools frequently and intuitively, but they may still lack the ability to evaluate AI-generated outputs, verify information, recognise bias or apply AI responsibly in academic work.

Kirschner and De Bruyckere (2017) also challenge the myths of the digital native and the multitasker. They argue that being born in a digital age does not automatically make students information-literate, and that extensive exposure to technology does not guarantee effective learning. Their argument is important for the present monograph because it supports the distinction between digital familiarity and AI literacy. Students may be comfortable with digital interfaces, but comfort with technology is not the same as critical, ethical and academically appropriate use of AI.

This distinction is also supported by research on Generation Z in higher education. While Generation Z students may be confident users of digital tools, their learning still requires structure, feedback, guidance and critical reflection. Seemiller and Grace (2016) emphasise that Generation Z students often appreciate independence, but they also value clear expectations and purposeful learning. In academic contexts, this means that students should not be left alone to develop their AI practices through informal experimentation. They need teacher guidance, institutional rules and opportunities to practise responsible use.

The psychological and social characteristics of Generation Z should also be considered. Twenge (2017) argues that this generation is strongly shaped by smartphones and social media, but she

also links this environment with increased anxiety, lower face-to-face interaction and changes in attention and social behaviour. Twenge and Campbell (2019) further discuss the relationship between media use and psychological well-being, pointing to the need for a balanced understanding of digital technology in young people's lives. These perspectives do not suggest that digital technologies are inherently harmful, but they remind educators that digital immersion has complex cognitive, social and emotional consequences.

In relation to artificial intelligence, Generation Z students are often described as more open to experimenting with generative AI than older cohorts. Chan and Lee (2023) examined the AI generation gap and found that Generation Z students tended to express interest in using generative AI for productivity, efficiency and personalised learning. However, the same study also emphasises the importance of responsible use, digital literacy, critical thinking and clear institutional guidelines. This is directly relevant to the present monograph because the aim is not to determine whether students can access AI tools, but whether structured ESP instruction can help them use such tools more critically and responsibly.

Research conducted in the Slovak university context also confirms the relevance of this issue. Pondelíková (2025) examined the integration of AI tools in English language and Anglophone cultures study programmes at Slovak universities, focusing on both students and teachers. Her findings show that AI has already become part of university teaching and learning, while also raising questions related to academic integrity, ethical use, critical thinking and institutional preparedness. This Slovak context is important for the present monograph because it shows that AI use among Generation Z students is not only a global trend, but also a concrete issue within Slovak higher education.

Luprichová (2025) also demonstrates the pedagogical potential and limits of AI tools in university-level British history education. In her study, first-year students used ChatGPT, Perplexity and HeyGen to analyse historical figures, verify AI-generated content and create AI-supported presentations. The findings indicate that AI tools can enhance student engagement, creativity and digital storytelling, but they also reveal challenges in source validation and critical analysis. This is particularly relevant to the present research because it confirms that AI-supported activities can be valuable in humanities and language-related university courses, provided that they include critical verification and structured reflection.

For ESP students at technical universities, the relationship between Generation Z and AI use is especially important. These students usually need English for academic and professional communication, including technical terminology, source work, presentations, project communication, documentation and future workplace interaction. Their digital familiarity may help them adopt AI tools quickly, but it does not ensure that they can use them effectively for specialised academic and professional purposes. In ESP contexts, AI tools may support language development, technical explanation, text reformulation, presentation preparation and source orientation, but only if students learn to evaluate outputs and remain responsible for their own academic work.

Therefore, Generation Z should not be understood simply as a generation that "naturally knows technology". It is more accurate to describe them as digitally immersed learners whose

academic development depends on how their everyday digital experience is transformed into critical, ethical and purposeful academic competence. This distinction forms an important basis for the present monograph. The empirical research focuses on students who already use digital and AI tools, but it investigates whether structured AI-focused ESP instruction can support a more conscious, responsible and academically relevant form of AI use.

The analysis in this subchapter shows that digital immersion is an important characteristic of Generation Z, but it should not be confused with AI literacy. Students' familiarity with digital technologies may create favourable conditions for AI-supported learning, yet it also requires pedagogical guidance, critical evaluation and ethical awareness. In higher education, the task is therefore not only to integrate AI tools into learning, but to help students move from intuitive digital use towards informed, reflective and responsible academic practice.

## 2.2 From Digital Familiarity to Responsible AI Use

The previous subchapter showed that Generation Z university students are digitally immersed learners. However, digital immersion should not be confused with responsible academic use of technology. Students may be highly familiar with smartphones, social media, online communication, search engines and AI tools, but this familiarity does not automatically mean that they can use these tools critically, ethically or effectively for university study. In higher education, the central pedagogical task is therefore to help students move from everyday digital familiarity towards responsible AI use.

Digital familiarity can be understood as regular exposure to digital technologies and confidence in using them for everyday purposes. It usually includes communication through social media, online searching, watching videos, using mobile applications, sharing content and interacting with digital platforms. These practices may create favourable conditions for learning with technology, but they do not necessarily include academic source evaluation, ethical awareness, data protection, authorship, transparency or critical judgement. For this reason, the concept of digital familiarity is broader but less demanding than academic digital competence.

Digital literacy research has long emphasised that effective digital use involves more than technical operation. Eshet-Alkalai (2004) conceptualises digital literacy as a complex set of cognitive skills needed to work effectively in digital environments. These skills include the ability to read visual information, evaluate digital content, construct knowledge from nonlinear information sources and communicate responsibly online. This perspective is relevant to the present monograph because AI use also requires cognitive and evaluative skills, not only the ability to operate a tool.

Similarly, van Deursen and van Dijk (2010) distinguish between different types of internet skills, including operational, formal, information and strategic skills. Their distinction helps explain why frequent technology use does not automatically produce advanced academic competence. A student may know how to access a tool and enter a prompt, but may still struggle to identify reliable information, evaluate relevance, compare sources or use digital output strategically for academic purposes. In the context of AI, this means that basic operational use must be developed into critical and purposeful academic use.

The European Digital Competence Framework also supports this distinction. DigComp 2.2 defines digital competence through areas such as information and data literacy, communication and collaboration, digital content creation, safety and problem solving (Vuorikari et al., 2022). These areas are closely related to AI use because students working with AI tools must search for information, evaluate data, communicate through digital systems, create or adapt content, protect privacy and solve problems in technologically mediated environments. However, generative AI adds a new level of complexity because it does not only help students access information; it produces new texts, summaries, explanations, images, presentations and other outputs.

Responsible AI use therefore requires more than general digital competence. Students need to understand that AI-generated content is not neutral, final or automatically reliable. It must be checked, interpreted, edited and evaluated in relation to the academic task. This is particularly important because generative AI tools are easy to use and often produce fluent, confident and convincing responses. The surface quality of AI output may lead students to overestimate its accuracy or academic value. Therefore, responsible AI use depends on students' ability to combine tool use with critical judgement.

Recent research on generative AI literacy confirms this need. O'Dea et al. (2024), examining university students in the UK and Hong Kong contexts, argue that students should be supported in developing GenAI literacy because generative AI has rapidly become part of study, work and daily life. Their findings indicate that prior learning about AI significantly influences students' generative AI literacy, while age and education level alone are not sufficient predictors. This is important for the present monograph because it supports the view that Generation Z students cannot be assumed to possess AI literacy simply because they belong to a digitally immersed generation.

Annapureddy, Fornaroli and Gatica-Perez (2024) also conceptualise generative AI literacy as a competence-based construct. Their model includes knowledge of generative AI, effective interaction with AI systems, prompting, critical evaluation, ethical and legal considerations and responsible use. This confirms that responsible AI use is not an intuitive ability, but a set of competences that can and should be developed through education. For ESP students, these competences are particularly relevant because they use AI not only for general information searching, but also for language support, technical vocabulary, academic writing, translation, presentations and professional communication.

Responsible AI use is closely connected with academic integrity. Generative AI can support brainstorming, text revision, language improvement, explanation and feedback, but it can also be used to produce complete assignments without sufficient student authorship. Bittle and El-Gayar (2025), in their systematic review of generative AI and academic integrity in higher education, show that GenAI can enhance educational engagement and efficiency, but also creates significant risks related to academic dishonesty. Their findings highlight the need for digital literacy, ethical guidelines and institutional responses that help students understand acceptable and unacceptable uses of AI.

This issue is particularly important in the case of Generation Z students because AI tools are easily accessible and often integrated into platforms they already use. Students may not always perceive a clear boundary between acceptable support and inappropriate substitution of their own work. For example, using AI to clarify instructions, generate possible ideas or improve grammar may be pedagogically acceptable in some contexts, while submitting AI-generated arguments, fabricated references or complete texts as one's own work violates academic integrity. The distinction must therefore be taught explicitly rather than assumed.

Responsible AI use also depends on transparency. Students should know when and how AI use needs to be acknowledged, what kinds of assistance are allowed in a particular course, and what types of AI-supported work are considered inappropriate. Without clear guidance, students may either use AI secretly or avoid useful AI support because they are uncertain about institutional expectations. Dotan, Parker and Radzilowicz (2024) argue that responsible adoption of generative AI in higher education requires attention to institutional values, pedagogical goals, academic freedom and collaborative governance. This perspective suggests that AI use cannot be regulated only through prohibition; it requires context-sensitive academic policies and pedagogical discussion. Miština (2026) similarly shows that targeted curricular intervention can influence university students' awareness and attitudes: in his study of humanities and IT students, exposure to historical female figures in computing increased students' awareness of women's contributions to IT and strengthened support for gender inclusivity.

The Slovak university context reflects similar concerns. Pondelíková (2025), in her monograph on AI tools in English language and Anglophone cultures study programmes at Slovak universities, shows that AI integration brings both opportunities and challenges for students and teachers. Her research points to the importance of AI literacy, ethical use and institutional preparedness in Slovak higher education. This is relevant to the present monograph because it confirms that responsible AI use is not only a global educational issue, but also a concrete challenge for Slovak universities and language-related study programmes.

Luprichová (2025) also demonstrates that AI-supported activities in university-level British history education can increase engagement, creativity and digital storytelling, but they require careful source validation and critical analysis. In her study, students used tools such as ChatGPT, Perplexity and HeyGen to work with historical content, but the pedagogical value of these tools depended on students' ability to verify AI-generated information and construct evidence-based arguments. This finding supports the central argument of the present subchapter: AI tools can enrich learning only when students are guided towards critical, reflective and responsible use.

In ESP contexts, the transition from digital familiarity to responsible AI use is especially significant. Technical university students may use AI tools to reformulate English texts, explain technical terminology, prepare presentations, summarise materials or support written assignments. These uses can be educationally valuable, particularly when students work in a foreign language and need support with academic or professional communication. However, they also require awareness of accuracy, authorship, terminology, confidentiality and source

verification. Responsible AI use in ESP therefore involves both language competence and AI-related academic judgement.

The development of responsible AI use may be understood as a gradual educational process. At the first level, students have digital exposure and everyday familiarity with online tools. At the second level, they develop functional digital skills, such as searching, editing, communicating and creating digital content. At the third level, they develop academic digital competence, including source evaluation, citation, academic communication and ethical use of digital materials. At the fourth level, they develop AI literacy, which includes understanding AI, using AI tools, evaluating outputs and recognising risks. Finally, responsible AI use requires students to apply these competences transparently, critically and ethically in real academic and professional tasks.

The transition from everyday digital familiarity to responsible AI use may be understood as a developmental process. Students first encounter digital technologies in everyday life, then acquire functional digital skills, gradually develop academic digital competence, and only then can these abilities be extended into AI literacy and responsible AI use. This process is summarised in Figure 3.

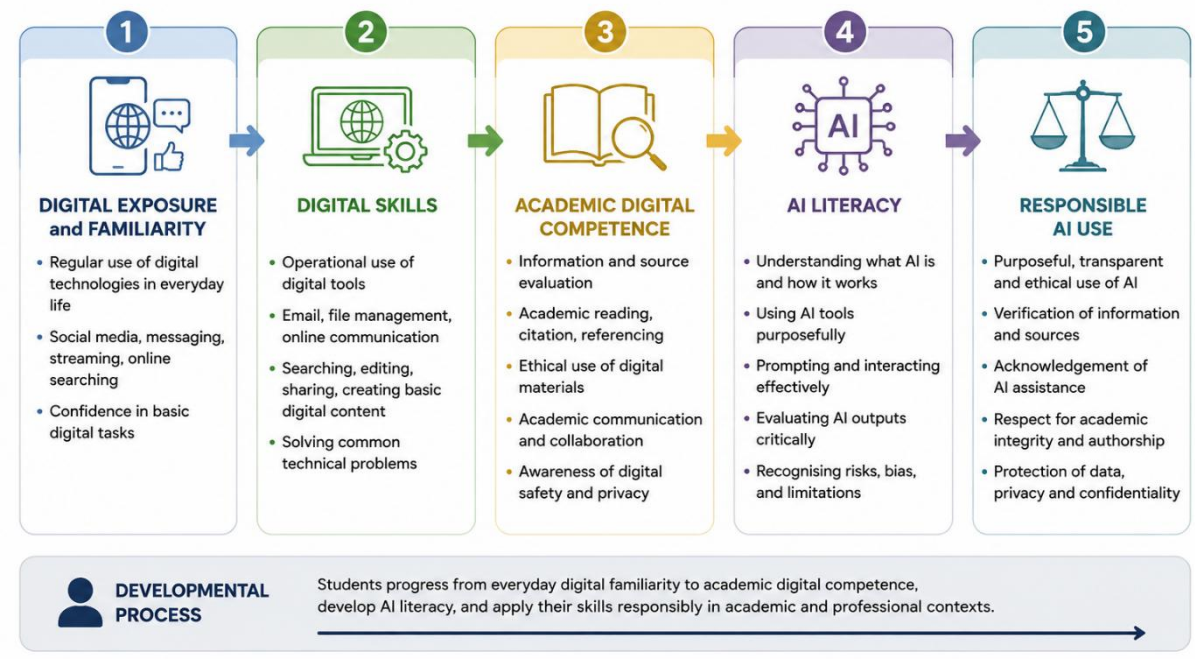



Figure 6: From Digital Familiarity to Responsible AI Use
*Source: Author's own elaboration based on Eshet-Alkalai (2004), van Deursen and van Dijk (2010), Vuorikari et al. (2022), O'Dea et al. (2024), Annapureddy et al. (2024), and Bittle and El-Gayar (2025). Visual design prepared with AI assistance; content checked and edited by the author.*

As Figure 3 illustrates, responsible AI use should not be treated as an automatic consequence of belonging to Generation Z. Although students may be confident users of digital technologies, responsible academic use of AI requires additional competences, including source evaluation, academic communication, understanding of AI-generated outputs, ethical awareness, transparency and respect for academic integrity. This developmental perspective is important

for the present monograph because the empirical intervention was designed precisely to support students in moving from intuitive or everyday use of AI tools towards more purposeful, critical and responsible academic use in ESP contexts.

Such a developmental view is important because it avoids two problematic assumptions. The first is the very optimistic belief that Generation Z students are naturally competent users of all digital and AI tools. The second is the overly pessimistic belief that AI use necessarily weakens learning or academic integrity. A more balanced view recognises that students' AI use depends on guidance, task design, institutional expectations and opportunities for reflection. AI can support learning when it is used as a scaffold for thinking, communication and revision, but it can weaken learning when it replaces students' own reasoning, writing and responsibility.

For the purposes of the present monograph, responsible AI use means using AI tools in a way that supports rather than replaces learning. It includes purposeful selection of AI tools, effective prompting, critical evaluation of outputs, verification of sources, transparent acknowledgement of AI assistance, respect for academic integrity and awareness of ethical and privacy issues. This understanding corresponds with the empirical intervention, which did not simply introduce students to AI tools, but aimed to help them use AI in more informed and academically appropriate ways.

The analysis in this subchapter shows that Generation Z students' digital familiarity provides an important starting point, but it is not sufficient for responsible AI use in higher education. Students need structured opportunities to transform everyday digital practices into academic digital competence and AI literacy. In ESP education, this transformation is particularly valuable because students work at the intersection of language learning, academic communication, technical content and digital technologies. Responsible AI use should therefore be understood as an essential component of contemporary ESP competence.

# 3 AI Literacy in English for Specific Purposes at Technical Universities

The development of AI literacy in higher education cannot be separated from the disciplinary, academic and professional contexts in which students study and communicate. This is particularly important in English for Specific Purposes (ESP), where language learning is closely connected with students' fields of study, future professions and communicative needs. In technical higher education, ESP courses do not focus only on general language competence. They also support students in developing the ability to understand technical texts, work with specialised terminology, present discipline-related content, communicate in academic and professional contexts, and use English as a medium of international cooperation.

The integration of artificial intelligence into ESP instruction therefore needs to be understood as part of a broader transformation of academic and professional communication. Technical university students increasingly use digital and AI-supported tools to search for information, translate or reformulate texts, prepare presentations, support writing, clarify technical concepts and organise learning materials. These practices create new opportunities for ESP learning, but they also require critical evaluation, ethical awareness, source verification and responsible academic use. AI literacy in ESP should therefore be understood not as an isolated digital skill, but as a competence that supports language learning, academic communication and future professional practice.

This chapter examines the role of AI literacy in ESP courses at technical universities. It first outlines the position of ESP in technical higher education and explains why ESP instruction needs to respond to students' disciplinary and professional needs. It then discusses the role of AI tools in ESP learning and academic communication, especially in relation to language support, source work, writing, presentation preparation and multimodal output. Finally, it considers how AI literacy can be integrated into ESP instruction through structured, pedagogically guided activities that help students move beyond spontaneous tool use towards more purposeful, critical and responsible academic practice.

## 3.1 ESP in Technical Higher Education

English for Specific Purposes has traditionally been understood as an approach to language teaching that is shaped by learners' specific academic, professional or disciplinary needs. Unlike general English courses, ESP is not organised primarily around broad communicative competence or general language proficiency. Its content, materials, tasks and outcomes are determined by the contexts in which learners need to use English. Hutchinson and Waters (1987) describe ESP as an approach rather than a product, since it begins with the question of why learners need English and how language learning can serve their particular purposes.

This needs-based orientation remains central to ESP theory and practice. Dudley-Evans and St John (1998) emphasise that ESP is defined by its responsiveness to learners' specific needs, its use of discipline-related content and its focus on language, skills, discourse and genres appropriate to particular activities. In higher education, ESP therefore involves more than vocabulary teaching. It includes academic reading, professional communication, genre awareness, discipline-specific discourse, presentation skills, writing, terminology work and interaction within academic or professional communities.

Hyland (2006) similarly argues that English for Academic Purposes and related ESP contexts are shaped by the specific communicative practices of disciplines. Students need to learn not only language forms, but also how knowledge is constructed, organised and communicated in particular academic fields. For technical university students, this means that language learning is connected with technical explanation, process description, data interpretation, visual presentation, project communication and the ability to communicate specialised knowledge clearly to different audiences.

ESP instruction at technical universities is especially important because English functions as a key language of science, technology, research and international professional cooperation. Students of engineering, materials science, automation, production technologies, informatics or safety-related disciplines encounter English in academic sources, manuals, technical documentation, presentations, professional communication, conferences, mobility programmes and future employment. As Paltridge and Starfield (2013) note, ESP is strongly connected with the social and communicative practices of particular academic and workplace communities. Therefore, technical students need English not only as a foreign language, but as a tool for participating in disciplinary and professional communication.

Basturkmen (2010) points out that ESP course design requires careful consideration of target situations, learner needs and the types of discourse students are expected to understand and produce. In technical higher education, these target situations may include reading technical texts, explaining processes, describing materials and properties, presenting projects, discussing data, communicating safety procedures, writing short professional texts or preparing academic presentations. Such tasks require integration of language knowledge, disciplinary content and communicative strategy.

The Slovak technical university context confirms the relevance of this approach. Chmelíková and Miština (2024) describe ESP course development in engineering and natural-science contexts at selected Slovak universities, including the Slovak University of Technology and the University of Ss. Cyril and Methodius in Trnava. They emphasise that ESP courses at these institutions are based on needs analysis, consultation, local educational policy, labour-market requirements and the development of transferable skills. Their chapter also stresses that students in engineering and science fields often possess strong technical knowledge but need further support in communication, collaboration, presentation skills, creativity, problem-solving and other professional competences.

This is directly relevant to the present monograph because the empirical research was conducted with technical university students in an ESP course. The students did not need English only for general communication, but for academic and professional purposes connected with their study programmes. Their ESP learning involved technical vocabulary, academic communication, presentation skills, work with sources and the preparation of outputs relevant to their future professional profile. AI literacy was therefore integrated into an already professionally oriented language-learning context.

Transferable skills are an important part of ESP in technical higher education. Chmelíková and Miština (2024) argue that ESP materials should support not only language competence, but also

communication, teamwork, presentation competence and other skills that increase students' employability. This view corresponds with broader higher-education expectations that graduates should be able to communicate effectively, cooperate with others, solve problems, think critically and adapt to changing professional environments. In technical fields, where disciplinary knowledge is essential but not sufficient, ESP can serve as a space in which students practise the communicative and transferable competences needed in professional life.

Presentation skills represent one of the most visible areas of ESP instruction at technical universities. Students are often expected to present projects, explain technical processes, describe innovations, interpret data or communicate research-related information. However, many students have limited previous experience with presenting, even in their mother tongue. Chmelíková and Miština (2024) therefore highlight presentation skills as a key component of ESP courses in engineering and natural sciences. This point is also relevant to AI-enhanced ESP instruction, because AI tools can support presentation planning, slide preparation, visual design and language revision, but students still need to remain responsible for content accuracy, structure, delivery and academic integrity.

Material development is another important issue in ESP. Since commercial coursebooks rarely meet the specific needs of particular technical university programmes, ESP teachers often need to adapt, supplement or create their own materials. Cirocki, Sapp and Farrelly (2024) argue that contemporary ELT materials should be understood broadly, including not only coursebooks and traditional printed resources, but also digital tools, multimedia materials, online resources, presentations, videos, tasks and projects. This broader understanding is important for AI-enhanced ESP because AI tools may become part of the materials ecosystem when they are used to support learning activities, source work, writing, presentations or reflection.

At the same time, material development must remain principled. Cirocki et al. (2024) emphasise that materials should be connected with curriculum and context, support authentic communication, engage learners intellectually and emotionally, promote collaboration, develop autonomy and encourage critical thinking. These principles are particularly relevant in ESP at technical universities. AI-supported activities should not be added to ESP courses only because they are technologically new. They should be integrated when they help students achieve meaningful academic, linguistic and professional outcomes.

Academic literacy is also central to ESP in higher education. Students must learn how to read academic and professional sources, identify relevant information, summarise content, formulate their own position and use sources ethically. Garcia-Yeste and Pettersson (2024) argue that academic writing instruction should help L2 university students move from summarising sources towards stance-taking. Their emphasis on genre pedagogy, academic literacies and source evaluation is useful for ESP contexts in which students work with academic or semi-academic materials. In AI-enhanced ESP, this becomes even more important because students may use AI tools to summarise texts, suggest sources or reformulate information. Without explicit guidance, such support may weaken students' own academic judgement.

The problem is not only whether students can use AI tools, but whether they can use them in academically meaningful ways. Students may ask AI to explain technical concepts, simplify

texts, translate terminology, generate outlines or prepare draft formulations. These practices can support language learning and academic communication, especially for students working in English as a foreign language. However, AI-generated outputs must be checked, revised and connected with reliable sources. ESP instruction can therefore provide a suitable space for teaching students how to combine language support with critical verification and responsible authorship.

Martin and Anderson (2024) warn that an abundance of digital materials may fragment learning if it is not organised coherently. Their discussion of digital authoring tools, flipped learning and critical-thinking-oriented tasks is relevant to AI-enhanced ESP instruction because it shows that digital tools should not simply multiply materials. Instead, they should help structure learning, support independent preparation, and create opportunities for meaningful classroom engagement. This is an important principle for AI integration: AI tools should be embedded into a clear pedagogical sequence rather than used as isolated applications.

The role of ESP teachers is therefore expanding. ESP teachers are not only language instructors; they are also course designers, materials developers, facilitators of academic communication and mediators between language, disciplinary content and professional skills. In the AI era, they also need to help students understand how AI tools can support learning while recognising their limitations. This does not mean that ESP teachers must become AI specialists. Rather, they need sufficient AI literacy to design tasks in which students use AI critically, ethically and productively.

For technical university students, ESP provides a particularly appropriate environment for developing AI literacy because it is already oriented towards practical and professional communication. AI literacy can be integrated into tasks such as preparing technical presentations, improving written abstracts, comparing AI-generated explanations with textbook or scholarly sources, verifying terminology, creating visual materials, analysing AI-supported translations or reflecting on responsible tool use. These activities connect language learning with digital competence, academic literacy and future professional communication.

In this sense, AI literacy can be understood as a natural extension of contemporary ESP instruction. ESP has always responded to changes in academic, professional and workplace communication. As digital and AI-supported communication becomes increasingly common, ESP courses need to prepare students not only to use English in technical contexts, but also to use digital and AI tools responsibly within those contexts. This requires an integrated approach in which linguistic competence, disciplinary awareness, transferable skills and responsible AI use develop together.

The analysis in this subchapter shows that ESP in technical higher education is a needs-based, context-sensitive and professionally oriented form of language education. It supports technical students in developing academic and professional communication skills, transferable competences, presentation abilities and source-related academic practices. These aims create a strong foundation for AI literacy development. If AI tools are integrated into ESP instruction in a structured and reflective way, they can support students' language learning and academic

communication while also helping them develop the critical and ethical competences needed for responsible participation in AI-mediated academic and professional environments.

## 3.2 AI Tools in ESP Learning and Academic Communication

The use of artificial intelligence in ESP learning should be understood within the broader development of technology-supported language education. Digital tools have long been used in language teaching for vocabulary development, grammar practice, pronunciation, writing support, online communication, collaborative learning and access to authentic materials. However, generative AI has introduced a qualitatively different type of support because it can respond to prompts, generate texts, reformulate language, summarise information, provide explanations, create visual outputs and simulate interaction. In ESP contexts, this development is particularly significant because students work with specialised language, academic sources, technical terminology and professionally oriented communication.

AI tools can support ESP learning in several interconnected areas: language assistance, academic writing, terminology work, source orientation, translation support, presentation preparation and multimodal communication. These areas correspond closely with the needs of technical university students, who often have to read technical texts, prepare presentations, communicate discipline-specific content, process academic information and produce written or oral outputs in English. AI-supported ESP learning should therefore not be reduced to using chatbots for quick answers. It should be understood as a pedagogically guided use of tools that can support academic and professional communication when students remain critically engaged with the process.

One important area is language support. ESP students may use AI-powered tools to check grammar, reformulate sentences, improve clarity, compare alternative expressions, expand vocabulary and adapt the level of language to academic or professional contexts. Godwin-Jones (2022) argues that intelligent writing assistance has become increasingly relevant for instructed language learning, especially because such tools can offer immediate support for revision and language improvement. For ESP students, this may be valuable when they need to express technical content in English but are not fully confident in grammar, style or terminology.

At the same time, AI-supported writing should not be understood as a replacement for language learning. Automated suggestions may improve the surface quality of student writing, but students still need to understand why changes are made and whether they are appropriate in a specific academic or technical context. Ranalli (2018) points out that automated written corrective feedback can support writing development only when learners are able to interpret and use feedback productively. This is relevant to ESP because students need to develop not only more accurate texts, but also awareness of academic register, disciplinary meaning and communicative purpose.

Academic writing is another area in which AI tools may influence ESP learning. Students can use AI to generate outlines, organise ideas, suggest transitions, reformulate paragraphs or identify possible weaknesses in structure. However, academic writing is not only a linguistic activity. It also involves argumentation, source use, disciplinary knowledge, authorial voice and stance. Swales and Feak (2012) emphasise that academic writing requires understanding of

rhetorical patterns, audience expectations and disciplinary conventions. In AI-enhanced ESP instruction, students therefore need to learn how to use AI for support without allowing it to replace their own reasoning and responsibility for content.

This issue is closely related to academic literacies and source work. Garcia-Yeste and Pettersson (2024) show that university students need guidance in moving from summarising sources towards stance-taking. Their work is relevant to AI-enhanced ESP because generative AI can summarise materials quickly, but it cannot replace students' own academic judgement, evaluation of source reliability or ability to develop a position. ESP students should therefore be taught to use AI-generated summaries or suggestions only as preliminary support, while the final academic interpretation must be based on verified sources and the student's own understanding.

The ability to evaluate sources is particularly important when students use AI for academic source orientation. AI tools can suggest search terms, explain unfamiliar concepts, summarise abstracts or help students identify possible directions for further reading. These uses can be helpful, especially when students encounter difficult technical or academic texts in English. However, AI tools may also generate incomplete, inaccurate or fabricated information. For this reason, AI-supported source work must be combined with information literacy, source verification and direct reading of original academic texts. This is one of the most important areas in which ESP instruction can contribute to AI literacy.

Terminology work is another important part of ESP learning at technical universities. Students need to understand specialised vocabulary, collocations, word formation, definitions, process descriptions and discipline-specific phraseology. AI tools may help students explain terms, compare synonyms, create glossaries, generate example sentences or reformulate technical descriptions. However, terminology is context-sensitive, and AI-generated explanations may simplify or distort technical meaning. ESP teachers should therefore encourage students to compare AI-generated terminology explanations with course materials, textbooks, specialised dictionaries, academic articles and discipline-specific sources.

Translation and multilingual support also play an important role in ESP contexts. Technical university students frequently work between Slovak and English when reading sources, preparing presentations or writing short academic texts. Absolon (2024) argues that AI and large language models are reshaping the translation industry and changing the professional role of translators from traditional text transfer towards post-editing, localisation management and technologically mediated language work. This perspective is relevant to ESP education because students need to understand AI-supported translation not only as a convenient tool, but also as part of a broader transformation of language professions and multilingual academic communication. Machine translation can help them access foreign-language content and compare formulations. Bowker and Ciro (2019) argue that machine translation literacy is increasingly important for academic communities, because users need to understand both the potential and the limitations of machine translation. In ESP instruction, this means that translation tools can be used pedagogically, but students should learn to post-edit outputs, check terminology and recognise cases where machine translation is not sufficiently reliable.

The role of machine translation is especially relevant for students who work with technical texts. AI-supported translation may handle general language effectively, but specialised terminology, abbreviations, discipline-specific meanings and context-dependent expressions still require human control. Welnitzová (2024) similarly emphasises that machine translation has become an important communication tool, but that its quality depends on factors such as the translation system, language pair, source text type and human pre-editing or post-editing. In ESP learning, this supports the argument that translation tools should be treated as aids for comprehension and revision, not as final authorities.

AI tools can also support oral and multimodal academic communication. Technical university students are often required to present projects, describe processes, explain technical solutions, interpret visual information or prepare poster presentations. AI-supported tools such as presentation generators, design platforms, video tools and image generators may help students prepare visual materials, organise content or practise explanations. Hafner and Miller (2011) show that digital video projects in English for science can support learner autonomy, collaboration and communication in technologically mediated learning environments. This is relevant to AI-enhanced ESP because multimodal tasks can connect language learning with technical content, creativity and professional communication.

Multimodal communication is increasingly important in academic and professional contexts. Students do not communicate only through written texts; they also use slides, posters, diagrams, videos, images, tables and spoken explanations. Hafner (2014) argues that digital projects can be understood as multimodal ensembles in which learners combine different semiotic resources to communicate meaning. In ESP courses, AI-supported multimodal tools can therefore help students practise communication that resembles real academic and workplace situations. However, students must also evaluate whether AI-generated visuals, slides or scripts accurately represent the technical content and whether they are appropriate for the intended audience.

Presentation preparation is one of the areas where AI tools can be useful but potentially problematic. AI can help students generate an outline, improve slide language, simplify complex explanations or propose visual structures. However, it may also produce generic, superficial or inaccurate content. Chmelíková and Miština (2024) stress the importance of presentation skills in ESP courses for engineering and natural-science students, particularly because students need to communicate technical content effectively and develop transferable skills. In AI-enhanced ESP instruction, presentation tools should therefore support students' preparation, but students must remain responsible for the accuracy, logic, structure and delivery of their presentations.

The use of AI tools in ESP also raises questions about materials design. AI tools may become part of learning materials when they are incorporated into tasks, prompts, worksheets, presentation preparation, peer discussion or reflection. Cirocki, Sapp and Farrelly (2024) argue that contemporary ELT materials should be understood broadly and should include digital tools, multimedia resources, online activities and projects. This broader understanding is useful for AI-enhanced ESP because it allows AI tools to be viewed not as external additions, but as components of a structured learning environment.

Nevertheless, digital and AI-supported materials need careful organisation. Martin and Anderson (2024) warn that the large quantity of digital resources can lead to overload and fragmentation if materials are not pedagogically structured. Their discussion of digital tools and decluttering in higher education is relevant to ESP because students may already face many platforms, sources and digital tasks. AI tools should therefore be integrated selectively and purposefully, not added simply because they are new. A limited number of well-designed AI-supported tasks may be more effective than excessive exposure to many tools without clear learning objectives.

Another important issue is learner autonomy. AI tools can support independent learning because students can ask for explanations, practise language, revise texts or generate examples outside classroom contact hours. However, autonomy does not mean unregulated dependence on tools. Benson (2011) understands learner autonomy as the capacity to take control of one's own learning. In AI-enhanced ESP, autonomous learning requires students to decide when AI support is useful, when it should be questioned, and when they need to rely on their own knowledge, teacher feedback or verified academic sources.

AI-supported ESP learning also requires prompt literacy. Students need to understand that the quality of AI output depends partly on the quality, specificity and context of the prompt. In ESP tasks, vague prompts may produce generic answers, while more precise prompts can help students obtain more useful support. However, effective prompting is not only a technical skill. It also requires students to understand the task, the audience, the genre, the disciplinary content and the expected output. Prompting can therefore be used pedagogically to help students clarify their own thinking before asking AI for assistance.

From the perspective of academic communication, AI tools can be especially valuable when used for comparison and reflection. Students can compare their own draft with an AI-revised version, evaluate differences between two AI-generated summaries, check whether a generated presentation outline is logically organised, or discuss whether an AI-generated explanation is technically accurate. Such activities encourage students to treat AI output as material for evaluation rather than as a finished product. This approach corresponds with the broader aim of AI literacy: students should not only use AI, but also question, revise and critically interpret its outputs.

In technical ESP contexts, AI tools can also support professional communication tasks. Students may practise writing emails, preparing abstracts, describing products, explaining processes, giving safety instructions, summarising technical information or preparing short spoken presentations. Anthony (2018) emphasises that ESP instruction is shaped by specific learner needs and target situations. AI tools can therefore be useful when they are embedded into realistic ESP tasks that reflect students' academic and future professional communication needs. However, such tasks should always include human evaluation and reflection.

The role of the ESP teacher remains central. AI tools may provide immediate language support, but they cannot replace the teacher's role in selecting relevant tasks, explaining disciplinary expectations, guiding ethical use, designing assessment criteria and helping students interpret feedback. Kessler (2018) argues that technology in language teaching should be understood in

relation to pedagogy, teacher decision-making and learner engagement rather than as a neutral solution. In AI-enhanced ESP, the teacher's role is therefore not diminished; it becomes more complex because the teacher must help students navigate the relationship between language, technology, academic standards and professional communication.

The use of AI in ESP learning also needs to be connected with assessment. If students are allowed to use AI tools for certain tasks, expectations must be clear. They should know whether AI can be used for brainstorming, grammar revision, translation comparison, presentation design or source orientation, and whether its use must be acknowledged. Without clear criteria, students may misunderstand the boundary between legitimate support and academic misconduct. This issue has already been discussed in relation to responsible AI use, but it becomes especially concrete in ESP because many tasks involve written and oral outputs that can be heavily influenced by AI tools.

For the purposes of the present monograph, AI tools in ESP learning are understood as pedagogical supports that may enhance language development, academic communication and professional preparation when they are used critically and transparently. They are not treated as replacements for student learning, teacher guidance or disciplinary expertise. Their educational value depends on task design, student reflection, source verification, ethical awareness and the extent to which students remain actively involved in producing and evaluating their own academic work.

The analysis in this subchapter shows that AI tools can support ESP learning in multiple ways, particularly in language revision, academic writing, terminology work, translation, source orientation, presentation preparation and multimodal communication. However, these opportunities are inseparable from risks related to accuracy, authorship, over-reliance and superficial task completion. Therefore, AI tools should be integrated into ESP instruction through structured tasks that require students to compare, verify, revise and reflect. In this way, ESP courses can help technical university students develop not only better English for academic and professional purposes, but also the AI-related competences needed for responsible communication in contemporary academic and workplace environments.

## 3.3 Integrating AI Literacy into ESP Instruction

The previous subchapters have shown that ESP instruction at technical universities is shaped by students' academic, disciplinary and professional needs, and that AI tools increasingly influence how students work with English, sources, terminology, writing and presentations. The next question is therefore not whether AI should be mentioned in ESP courses, but how AI literacy can be integrated into ESP instruction in a pedagogically meaningful way. In the context of the present monograph, AI literacy is not understood as an additional topic separate from language learning. Rather, it is treated as a competence that can be developed through ESP tasks involving academic communication, technical vocabulary, source work, presentation preparation, multimodal content and ethical reflection.

Integrating AI literacy into ESP instruction requires a shift from tool demonstration to competence development. Students may be introduced to AI tools, but the educational aim should not be limited to showing them how a particular chatbot, writing assistant or presentation

generator works. Tools change rapidly, and specific platforms may become outdated. What remains educationally important is the ability to understand AI-supported processes, formulate appropriate prompts, evaluate outputs, verify information, revise language, acknowledge AI assistance and use AI in ways that support rather than replace learning. This corresponds with the view that AI literacy should include understanding, practical use, critical evaluation, ethical awareness and transfer into academic and professional contexts (Long and Magerko, 2020; Ng et al., 2021; UNESCO, 2024).

A useful way of integrating AI literacy into ESP instruction is to connect AI-supported activities with already existing ESP objectives. Technical university students need to understand specialised terminology, describe processes, explain technical content, prepare presentations, work with academic or professional sources and communicate clearly in English. AI tools can support these activities if they are integrated into tasks that require students to remain active decision-makers. For example, students may compare AI-generated explanations of a technical term with textbook definitions, revise an AI-generated presentation outline, verify AI-suggested sources or evaluate whether an AI-generated summary accurately represents an academic text.

Task design is therefore central. Chapelle (2001) argues that technology-mediated language learning should be evaluated not only in terms of technological innovation, but in relation to language learning potential, learner fit, meaning focus, authenticity and positive impact. This principle remains relevant in the AI era. An AI-supported ESP task is pedagogically justified only if it contributes to language learning, academic communication, disciplinary understanding or responsible professional practice. If AI use merely makes a task faster without requiring students to think, evaluate or communicate, its educational value remains limited.

The same point is reflected in research on technology and language teaching more broadly. Levy and Stockwell (2006) emphasise that technology in language education should be selected and implemented in relation to pedagogical purpose, learner needs and classroom context. AI tools should therefore not be treated as universal solutions. In ESP instruction, their value depends on whether they support the specific communicative situations students are expected to face, such as explaining a technical process, preparing a professional presentation, summarising a technical text, reformulating a formal email or discussing discipline-related information.

AI literacy can be integrated into ESP instruction through a staged pedagogical sequence. At the first stage, students need guided familiarisation with AI tools and their possible uses in academic and ESP-related tasks. At the second stage, they need to practise using AI tools for specific purposes, such as terminology explanation, language revision, source orientation or presentation planning. At the third stage, they need to evaluate and compare AI-generated outputs with reliable sources, peer feedback or teacher guidance. At the fourth stage, they should reflect on ethical boundaries, authorship, transparency and the role of AI in their own learning. Such a sequence prevents AI use from remaining intuitive or superficial.

Prompting can be used as an explicit learning activity in ESP. Students often assume that AI tools produce better or worse answers independently of user input. However, the quality of output depends strongly on the clarity of the task, context, audience, purpose and required

format. Prompt formulation can therefore help students clarify what they want to communicate, who the audience is, what genre they are working in and what criteria the output should meet. In this sense, prompting is not only a technical skill, but also a form of task analysis and communicative planning.

For example, in an ESP course, students may be asked to write different prompts for different communicative purposes: explaining a technical term to a non-specialist audience, preparing a short professional email, summarising a technical process, improving the clarity of a presentation slide or generating possible questions for a discussion. After receiving AI-generated outputs, students can compare the results, identify which prompt produced the most useful response and explain why. This type of activity connects AI literacy with genre awareness, audience awareness and language precision.

AI literacy should also be connected with source work. Technical university students increasingly use AI tools to search for information, summarise texts or identify possible directions for academic assignments. However, AI-supported source work must be carefully controlled because generative AI may produce fabricated references or misleading summaries. Garcia-Yeste and Pettersson (2024) argue that academic writing instruction should help university students move from summarising sources towards stance-taking. In AI-enhanced ESP instruction, this means that students should not only ask AI to summarise information; they should learn to evaluate sources, compare claims, select relevant evidence and formulate their own academically responsible position.

A practical ESP activity may therefore involve asking students to generate a preliminary explanation or list of possible sources using AI, then verify each claim through academic databases, library resources or teacher-approved materials. Students can then reflect on which AI suggestions were useful, which were inaccurate and how verification changed their understanding of the topic. This type of task develops both academic literacy and AI literacy because students learn that AI output is not evidence in itself.

AI literacy can also be integrated into terminology work. ESP students need to understand and use specialised vocabulary accurately, especially in technical fields. AI tools can provide definitions, examples and paraphrases, but they may oversimplify or misrepresent specialised concepts. Students can therefore be asked to compare AI-generated definitions with specialist dictionaries, textbooks, lecture notes or academic sources. Such activities develop terminology awareness, reading skills and critical evaluation of AI-generated language. They also help students understand that technical accuracy is more important than linguistic fluency alone.

Translation and post-editing activities represent another suitable area for AI literacy development in ESP. Students may use machine translation or AI-supported translation tools to understand technical texts or prepare English outputs. However, as Absolon (2024) argues, AI and large language models are reshaping translation and language professions, shifting attention towards post-editing, localisation management and technologically mediated language work. ESP students therefore need to understand AI-supported translation not only as a convenient shortcut, but also as a professional practice that requires human evaluation, terminology control and contextual awareness.

In ESP instruction, students can compare a human translation, a machine translation and an AI-assisted reformulation of the same short technical text. They can identify differences in terminology, register, sentence structure and accuracy, then propose an improved version. This type of task helps students develop post-editing skills, language awareness and critical control over AI-generated language. It also supports the broader goal of preparing students for academic and professional communication in multilingual and AI-mediated environments.

Presentation preparation offers another meaningful way to integrate AI literacy. Technical university students often need to present projects, describe processes, explain results or communicate innovation. AI tools can help them generate outlines, improve slide language, propose visuals or prepare speaker notes. However, students must be taught to evaluate whether AI-generated content is accurate, coherent, relevant and suitable for the audience. Chmelíková and Miština (2024) emphasise that presentation skills are crucial in ESP courses for engineering and natural-science students, and that materials for presentation training need to be carefully designed because students often have limited previous experience with presentations.

AI-supported presentation tasks can therefore combine language learning, presentation skills and responsible AI use. Students may first prepare their own presentation outline, then compare it with an AI-generated version. They can identify strengths and weaknesses, revise the structure, check terminology and decide which elements to keep or reject. The teacher can then guide discussion on audience awareness, visual clarity, academic accuracy and ethical use of AI-generated materials. In this way, AI does not replace presentation training; it becomes a stimulus for reflection and improvement.

Multimodal tools such as Canva, Gamma, Vidnoz or video-generation platforms can also support AI literacy in ESP when they are used critically. These tools may help students create slides, short videos, visual explanations or simulated professional outputs. However, multimodal AI-supported production raises questions of visual appropriateness, copyright, representation, accuracy and over-simplification. Hafner (2014) shows that digital projects can support multimodal literacy because students combine language, images, sound, layout and spoken explanation to communicate meaning. In AI-enhanced ESP, multimodal tasks should therefore include not only production, but also evaluation of the relationship between content, visual form and communicative purpose.

Ethical awareness must be embedded throughout AI-enhanced ESP instruction. It should not appear only as a separate warning at the end of a lesson. Students need repeated opportunities to discuss acceptable and unacceptable uses of AI in different academic contexts. For example, using AI to brainstorm ideas, check grammar or improve clarity may be acceptable when allowed and acknowledged. Using AI to generate a complete assignment, invent sources or avoid one's own intellectual effort may be inappropriate. These distinctions should be connected with concrete ESP tasks so that ethical principles become practical and understandable.

The role of transparency is particularly important. Students should learn how to state whether and how they used AI tools, especially in academic assignments or presentations. Transparency does not necessarily mean that AI use is wrong. Rather, it allows teachers, peers and institutions

to understand the extent and purpose of AI assistance. This is consistent with broader discussions of responsible AI in higher education, which emphasise academic integrity, accountability and human responsibility (European Commission, 2022; Dignum, 2019).

AI-enhanced ESP instruction should also preserve the role of human interaction. AI tools can provide immediate feedback, but they cannot replace peer discussion, teacher feedback, classroom negotiation of meaning or collaborative problem-solving. Warschauer and Kern (2000) argue that network-based language teaching is valuable when it supports interaction, collaboration and meaningful communication. This principle remains relevant for AI-supported ESP: students should not work only individually with AI tools, but should discuss outputs, compare interpretations, justify revisions and learn from one another.

Collaboration is especially important in technical ESP because students often work on projects and presentations. AI tools may support group work by helping students organise ideas, distribute tasks or prepare materials, but the group still needs to negotiate decisions, evaluate content and produce a coherent final output. Collaborative AI-supported tasks can therefore develop communication, teamwork, problem-solving and critical judgement at the same time. This corresponds with the broader role of ESP in supporting transferable skills in technical higher education (Chmelíková and Miština, 2024).

The Slovak ESP/LSP context also shows why AI literacy integration should be realistic and context-sensitive. Hurajová and Chmelíková (2025) point out that ESP/LSP teachers at technical universities must often develop their own materials, consult disciplinary teachers and respond to fast-changing professional and technological fields. They also note that AI has become part of university education and that students may adopt AI tools faster than teachers. This supports the argument that ESP teachers need practical models for integrating AI into instruction without losing the central focus on language, discipline-specific communication and professional preparation.

From the perspective of materials development, AI literacy can be integrated through worksheets, guided prompts, comparison tasks, checklists, reflection questions and assessment rubrics. Cirocki, Sapp and Farrelly (2024) emphasise that contemporary ELT materials should be contextualised, meaningful, collaborative, autonomy-supportive and connected with critical thinking. AI-supported materials should therefore help students do more than produce outputs. They should guide students through the process of planning, generating, evaluating, revising and reflecting.

Assessment also needs to be considered. If AI tools are part of ESP instruction, assessment criteria should focus not only on final products, but also on process, justification and reflection. Students may be asked to explain how they used AI, what they changed, which sources they verified, what limitations they noticed and what they learned from the activity. Such reflective assessment reduces the risk of uncritical AI dependence and encourages students to take responsibility for their own learning. It also makes AI use visible and discussable.

Teacher guidance remains essential at every stage. Kessler (2018) argues that technology in language teaching must be understood through pedagogy and learner engagement rather than

through the tool itself. In AI-enhanced ESP, the teacher designs the task, sets the rules, explains ethical expectations, selects suitable tools, supports language development and helps students evaluate outputs. The teacher's role therefore becomes more complex, not less important. AI can assist learning, but it cannot determine the academic, linguistic and professional value of learning activities without human pedagogical judgement.

For the purposes of the present monograph, integrating AI literacy into ESP instruction means designing structured learning activities in which students use AI tools for specific academic and professional communication purposes, while also evaluating their outputs and reflecting on ethical use. Such integration is consistent with ESP principles because it responds to students' real communicative needs and future professional contexts. It is also consistent with AI literacy principles because it develops practical use, critical evaluation, ethical awareness and transfer.

The empirical intervention described in the following part of the monograph was designed according to this logic. Students were not simply introduced to AI tools as technological novelties. They worked with chatbots, prompting, AI-supported source orientation, presentation tools and visual or video-generation applications in order to practise academic and ESP-related tasks. These activities were intended to support students in using AI more purposefully, critically and responsibly in relation to English, academic communication and technical university study.

The analysis in this subchapter shows that AI literacy can be integrated into ESP instruction when AI tools are linked to meaningful language, academic and professional tasks. Such integration requires careful task design, source verification, ethical discussion, transparency, teacher guidance and student reflection. In technical higher education, ESP courses offer a particularly suitable environment for this process because they already combine language learning, disciplinary communication, transferable skills and preparation for professional practice. AI literacy should therefore be understood as an emerging component of contemporary ESP competence.

## 3.4 From Theoretical Framework to Empirical Research

The theoretical part of the monograph has established the conceptual basis for the empirical research. Chapter 1 showed that artificial intelligence has become an important part of higher education and that AI literacy should be understood as a multidimensional competence. This competence includes understanding AI, using and applying AI tools, evaluating AI-generated outputs, recognising ethical implications and transferring AI-supported skills into academic and professional contexts (Long and Magerko, 2020; Ng et al., 2021; UNESCO, 2024). Chapter 2 then demonstrated that Generation Z students are digitally immersed learners, but that digital familiarity does not automatically lead to responsible academic AI use. Chapter 3 finally situated AI literacy within ESP at technical universities, where language learning is closely connected with academic communication, disciplinary content, professional preparation and transferable skills.

Taken together, these chapters support the central assumption of the empirical research: AI literacy should not be left to students' spontaneous experimentation with AI tools. Although technical university students may already use AI in everyday study practices, they still need pedagogical guidance in prompt formulation, source verification, academic integrity, translation and terminology work, presentation preparation and critical evaluation of outputs. ESP provides a suitable environment for such guidance because it connects language learning with academic and professional communication needs.

The empirical research therefore follows directly from the theoretical framework. It investigates whether structured AI-enhanced ESP instruction can support technical university students in moving from intuitive or tool-based AI use towards more purposeful, critical and ethically aware academic application. The intervention was not designed to teach artificial intelligence as an isolated technological topic. Instead, it integrated AI-related activities into ESP tasks connected with chatbots, prompting, academic source retrieval, presentation preparation and AI-supported multimodal content creation.

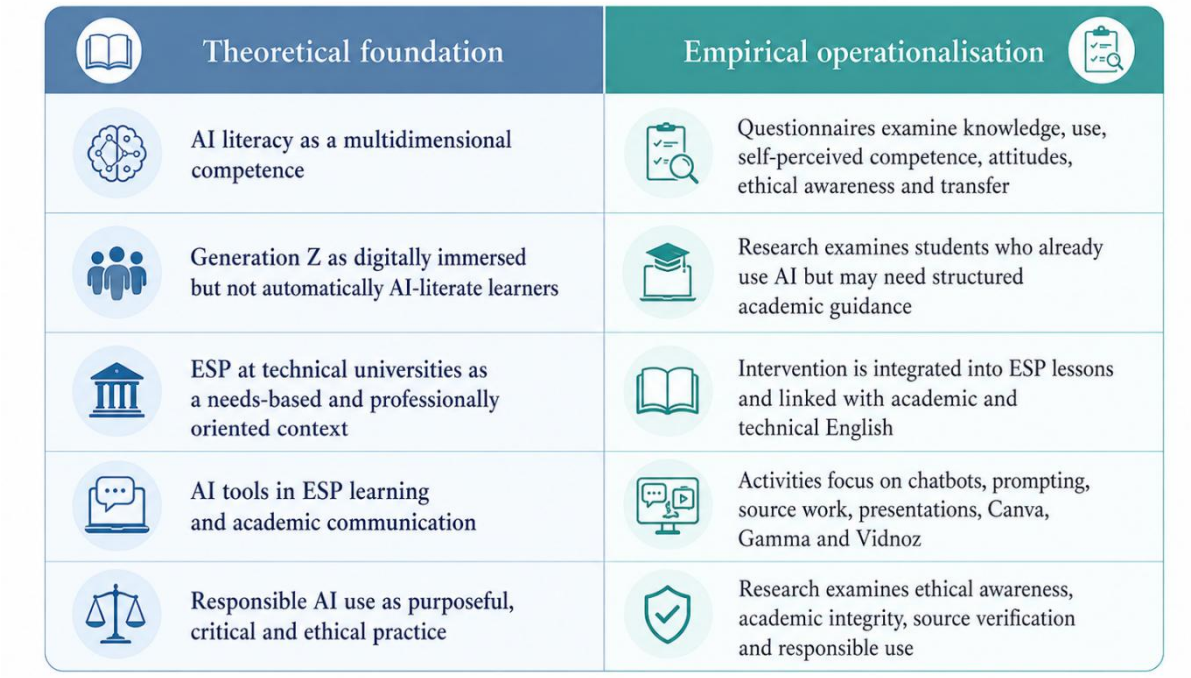



Figure 4: Relationship between the theoretical framework and the empirical research design
*Source: Author's own elaboration based on the theoretical framework and empirical research design of the present monograph; visual design prepared with AI assistance and checked by the author.*

As Figure 4 shows, the empirical part does not stand separately from the theoretical discussion. It operationalises the main theoretical concepts in a concrete educational context. AI literacy is examined through students' knowledge, practical use, self-perceived competence, ethical awareness, attitudes and transfer into academic practice. Generation Z is represented by second-year technical university students who are familiar with digital technologies and AI tools, but whose academic AI use requires further development. ESP provides the instructional setting in

which AI literacy can be connected with language learning, source work, terminology, presentation skills and professional communication.

The research design also reflects the balanced position adopted throughout the theoretical part. AI is not treated as an automatically beneficial solution, nor as a technology that should be rejected from education. Instead, the empirical study examines how AI can be used under pedagogical guidance and within clearly defined academic boundaries. This corresponds with the view that the value of AI in higher education depends on how it is used, evaluated, reflected upon and connected with learning objectives (European Commission, 2022; Farrokhnia et al., 2024; Bearman et al., 2024).

For this reason, the empirical part focuses not only on whether students use AI more frequently after the intervention, but also on whether they report development in AI-related skills, ethical awareness, attitudes and transfer of AI-supported competences into academic and ESP-related practice. This approach corresponds with the multidimensional understanding of AI literacy presented in the theoretical part. It also reflects the practical orientation of ESP, where students are expected to use English for academic, technical and professional purposes.

The following empirical part therefore examines the implementation and outcomes of AI-enhanced ESP instruction at the Faculty of Materials Science and Technology of the Slovak University of Technology in Trnava. It first presents the methodological framework of the research, including the research design, aim, objectives, research questions, hypotheses, research setting, sample, intervention, instruments and ethical considerations. It then analyses the pre-intervention and post-intervention questionnaire findings and interprets them in relation to the research objectives and theoretical framework developed in the preceding chapters.

# 4 Theoretical Background of the Research and Literature Review

The rapid development of artificial intelligence, and particularly the public accessibility of generative AI tools, has significantly changed the ways in which university students search for information, process academic texts, prepare assignments, create presentations, and communicate in foreign languages. In higher education, artificial intelligence is no longer perceived only as a technological phenomenon belonging to computer science or engineering. It has become a cross-disciplinary educational issue that affects academic writing, language learning, research practices, assessment, academic integrity, and students' preparation for professional life. For this reason, AI literacy is increasingly understood as one of the key competences that university students need in order to function responsibly and effectively in contemporary academic and professional environments.

A useful starting point for defining AI literacy is the work of Long and Magerko (2020), who conceptualise AI literacy as a set of competences that enables individuals to critically evaluate AI technologies, communicate and collaborate effectively with AI, and use AI as a tool in everyday, academic, and professional contexts. Their definition is particularly relevant to the present research because it moves beyond a narrow technical understanding of AI and emphasises critical evaluation, interaction with AI systems, and purposeful use. In this sense, AI literacy does not mean that students must become AI developers or programmers. Rather, they need to understand what AI tools can and cannot do, how to formulate effective prompts, how to evaluate generated outputs, and how to use such tools responsibly in connection with their own learning.

A broader conceptual framework is offered by Ng, Leung, Chu, and Qiao (2021), who identify four central dimensions of AI literacy: knowing and understanding AI, using and applying AI, evaluating and creating with AI, and understanding ethical issues related to AI. This model is highly applicable to the present monograph because the AI-focused ESP intervention was designed not only to introduce students to selected AI tools, but also to develop their ability to use AI critically, evaluate outputs, and reflect on ethical boundaries in academic work. The four-dimensional model also corresponds with the structure of the pre- and post-intervention questionnaires used in this research, which examined students' experience with AI, their frequency of use, attitudes, self-perceived competence, and ethical awareness.

The importance of AI literacy has also been recognised in international educational policy. UNESCO's *AI Competency Framework for Students* (2024) emphasises that students should develop a human-centred understanding of AI, ethical awareness, knowledge of AI techniques and applications, and the ability to use AI tools responsibly. This is directly relevant to higher education because students are increasingly expected to work with AI-supported tools while still maintaining academic responsibility, critical thinking, and personal accountability. UNESCO (2024) also stresses that AI literacy should not be limited to technical knowledge, but should include values, attitudes, and responsible decision-making. In the context of the present research, this supports the view that ESP students at a technical university need AI literacy as part of both their academic development and future professional competence.

In the European context, the need for AI literacy is strengthened by the EU Artificial Intelligence Act. Article 4 of the AI Act requires providers and deployers of AI systems to take measures to ensure a sufficient level of AI literacy among persons who work with AI systems, taking into account their technical knowledge, education, training, and the context in which AI systems are used (artificialintelligenceact.eu). Although the regulation is primarily legal and institutional in nature, it has clear implications for education. Universities should prepare students not only to use AI tools, but also to understand their limitations, risks, and social consequences. For technical university students, this is particularly important because many of them may later work in professional environments where AI-supported systems are used in engineering, production, automation, safety, management, and technical communication.

The ethical dimension of AI use in education is also addressed by the European Commission's guidelines on the ethical use of AI and data in teaching and learning. These guidelines emphasise that AI should be used in ways that support human agency, transparency, fairness, and accountability. For the present research, this policy perspective is important because students were not trained to use AI only as a productivity tool. The instructional intervention also aimed to help them understand the difference between acceptable AI-supported assistance and academically inappropriate dependence on AI-generated content.

The OECD (2023) similarly points out that generative AI can support learning when it is used with clear pedagogical guidance, but warns that if students merely outsource tasks to AI, apparent performance may improve without real learning gains. This distinction is essential for ESP courses. AI may help students generate vocabulary lists, summarise technical texts, improve grammar, prepare presentations, or practise professional communication. However, without teacher guidance, students may also use AI to bypass the learning process. Therefore, AI literacy in ESP should include both practical tool use and metacognitive awareness of how AI affects learning.

The integration of AI into language education has received growing scholarly attention, especially since the introduction of generative AI tools such as ChatGPT, Copilot, Gemini, Claude, DeepSeek, Canva, Gamma, and other applications. In language learning, these tools may support vocabulary development, text revision, translation comparison, summarisation, grammar explanation, idea generation, and simulated communication. However, their use also requires students to assess accuracy, register, relevance, and appropriateness of AI-generated outputs. This is particularly important in English for Specific Purposes, where students need to communicate within discipline-specific and professional contexts.

Recent research on AI literacy in English for Academic Purposes is especially relevant to the present monograph. Ngo and Hastie (2025) developed and implemented a 10-week AI-integrated EAP module and introduced the concept of AI for Academic Purposes. The study showed that integrating AI literacy into academic English instruction can help students develop technological proficiency together with ethical awareness. This is closely connected with the present research, which investigates the development of AI literacy in ESP courses for technical university students. Although EAP and ESP differ in their immediate orientation, both require

students to use English for academic and professional purposes, work with sources, prepare written and oral outputs, and follow academic integrity standards.

The relevance of AI for ESP has also been discussed in studies focusing on English for engineering and professional communication. Research on the use of ChatGPT in English for engineering classes suggests that AI tools can increase student engagement, enrich learning experiences, and provide additional opportunities for practising technical English (Synekop et al., 2024). Similarly, research on AI tools in ESP pedagogy highlights their potential for discipline-specific vocabulary learning, professional communication, and more flexible access to learning support (Boeru, 2024). These findings are significant for the present study because the participants were students of technical study programmes at the Faculty of Materials Science and Technology of the Slovak University of Technology in Trnava. Their English learning needs are connected not only with general language competence, but also with the ability to use English in technical, academic, and professional contexts.

The use of AI in education is, however, not without risks. Farrokhnia et al. (2024) conducted a SWOT analysis of ChatGPT in education and identified several strengths, weaknesses, opportunities, and threats. The strengths include support for personalised learning, immediate feedback, and assistance with idea generation. At the same time, the weaknesses and threats include inaccurate information, over-reliance, plagiarism, reduced critical thinking, and problems with academic integrity. These concerns are directly relevant to ESP students because AI can support their learning, but it can also lead to superficial task completion if they do not understand how to use AI critically and responsibly.

Academic integrity has become one of the most discussed issues in relation to generative AI in higher education. A systematic literature review by Bittle (2025) shows that generative AI creates both opportunities and challenges for academic honesty in higher education. AI tools may help students understand difficult content, improve drafts, and receive formative support; however, they may also be misused to produce assignments without sufficient student authorship. This makes ethical awareness a necessary component of AI literacy. In the present research, ethical awareness is therefore treated as a central research dimension, not as a secondary issue.

Research on student responses to generative AI also indicates that students' attitudes are not uniform. Wu et al. (2025), in a systematic review of responses, attitudes, and behaviours related to generative AI in higher education classrooms, show that students often recognise the usefulness of AI tools, but their behaviour depends on confidence, institutional guidance, perceived risks, and clarity of academic rules. This supports the need for explicit AI instruction in university courses. Students should not be expected to develop responsible AI practices intuitively. Instead, they need structured opportunities to test tools, compare outputs, discuss limitations, and reflect on acceptable academic use.

From the perspective of future employability, AI literacy is also connected with broader labour-market expectations. The World Economic Forum's *Future of Jobs Report 2025* identifies technological literacy, analytical thinking, creative thinking, resilience, flexibility, and lifelong learning as important skills for the changing labour market. For technical university students,

this is especially relevant because their future professional work will likely involve digital systems, automation, AI-supported tools, data processing, and technical communication. ESP courses can therefore contribute not only to language development, but also to broader professional competence by integrating AI-supported academic and communication tasks.

The present research is built on the assumption that AI literacy is multidimensional. It includes cognitive, affective, and conative components. The cognitive dimension refers to students' knowledge and understanding of AI tools, their functions, possibilities, and limitations. The affective dimension refers to students' attitudes, confidence, trust, motivation, concerns, and perceived usefulness of AI. The conative dimension refers to actual behaviour, including frequency of AI use, purposes of use, and students' willingness to apply AI-supported skills in academic practice. This structure corresponds with the design of the empirical research, which used pre- and post-intervention questionnaires to examine students' experience, attitudes, ethical awareness, and self-perceived competence before and after AI-focused ESP instruction.

The empirical context of the present monograph is specific. The research was conducted with 75 second-year undergraduate students enrolled in ESP courses at the Faculty of Materials Science and Technology of the Slovak University of Technology in Trnava during the winter semester of the academic year 2025/2026. The instructional intervention consisted of five 50-minute AI-focused training sessions integrated into a 13-week ESP course. The training addressed practical work with chatbots, effective prompt formulation, AI-supported source retrieval, academic use of AI, presentation creation through tools such as Canva and Gamma, and AI-supported video content creation. The research objectives, research questions and hypotheses in the empirical part reflect this pre-/post-intervention logic (see subchapter 5.2).

The pre-intervention questionnaire showed that all respondents had already used AI tools before the training, most frequently ChatGPT, Copilot, Gemini, Gamma, Canva, DeepSeek, Claude, DALL·E, and similar tools. The questionnaire also examined students' frequency of AI use, purposes of use, knowledge of AI, attitudes, ethical perception, educational needs, and self-assessed competence. The post-intervention questionnaire then focused on AI use after ESP activities, self-assessed development of AI-related skills, ethical awareness, attitudes to AI, and transfer of AI skills into academic practice.

Research carried out in the Slovak academic context also supports the relevance of AI tools in university teaching. Pondelíková and Luprichová (2024) examined the use of ChatGPT, Perplexity, and Gemini in history and literature courses focused on Anglophone cultures. Their findings suggest that AI-supported activities can enhance students' reading comprehension, critical thinking, and gender awareness by offering personalised explanations, supporting multiple interpretations of texts, and encouraging more active engagement with culturally complex topics. The study also highlights the value of design thinking in workshop-based activities with Generation Z students and points to the importance of addressing digital bias, inclusive language, and responsible AI use. The reported outcomes indicate improvement mainly in vocabulary development and writing style, while progress in grammatical accuracy was more limited. Pondelíková (2025) further confirms that AI tools, when used with

appropriate pedagogical guidance, can enrich university teaching and increase student engagement.

The reviewed literature therefore provides a strong foundation for the present research. Existing studies and policy documents agree that AI literacy should include knowledge, practical use, critical evaluation, ethical awareness, and responsible application. At the same time, research on AI in language education and ESP suggests that AI tools can support language learning, academic writing, technical communication, and student engagement when they are used under clear pedagogical guidance. The present monograph contributes to this discussion by examining how structured AI-focused ESP instruction may influence technical university students' self-perceived AI competence, frequency and purposes of AI use, attitudes toward AI, and ethical awareness in academic contexts.

# 5 Research methodology

This chapter presents the methodological framework of the empirical research. It explains the research design, the aim of the study, research objectives, research questions and hypotheses. It also describes the research setting, the research sample, the AI-enhanced ESP instructional intervention, the research instruments, data collection procedures and the methods used for data analysis. Since the study was designed as a small-scale educational intervention, the chapter also clarifies the methodological boundaries within which the findings should be interpreted.

## 5.1 Research Design and Methodological Framework

Educational research requires a systematic methodological framework that makes it possible to examine not only measurable outcomes, but also students' attitudes, perceptions and interpretations of their learning experience. The present research was designed to investigate the development of AI literacy among technical university students enrolled in English for Specific Purposes courses. It focused on students' initial experience with AI tools, their frequency and purposes of AI use, their self-perceived AI-related competence, their attitudes towards artificial intelligence and their ethical awareness in academic contexts.

The research used a **mixed-metho**ds design combining **quantitative questionnaire data**, **qualitative open-ended questionnaire responses** and **supplementary informal classroom-based reflections**. Mixed-methods research is suitable when a research problem cannot be sufficiently understood through numerical data alone, as it allows the researcher to integrate measurable tendencies with interpretative insight. Creswell and Plano Clark define mixed-methods research as an approach that combines quantitative and qualitative forms of data collection and analysis in order to provide a more comprehensive understanding of the research problem (Creswell - Plano Clark, 2018). Similarly, Dawadi, Shrestha and Giri (2021) emphasise that mixed-methods research is particularly useful for complex educational issues because it brings together statistical tendencies and contextual explanations.

The quantitative component of the research was based on closed questionnaire items included in the **pre-intervention** and **post-intervention questionnaires**. These items consisted of multiple-choice questions, frequency questions and Likert-scale statements. They enabled the researcher to identify general patterns in students' AI use, examine selected aspects of their responses before and after the instructional intervention and analyse students' self-perceived development in selected areas of AI literacy. Closed questions are appropriate in survey-based research because they generate structured and comparable data that can be processed numerically and used to identify tendencies across the whole research group. In this study, the closed questionnaire items were used to examine the cognitive, affective and conative dimensions of AI literacy in a structured form.

The qualitative component of the research was based primarily on open-ended, interview-style questions included in the pre-intervention questionnaire. These questions allowed students to express their own views on artificial intelligence in their own words, including how they perceived AI, what opportunities or risks they associated with it and how they would like to use AI in their studies. Open-ended questions are valuable because they allow respondents to answer in their own words and provide richer insight into their reasoning, motivations,

expectations and concerns. Hansen (2023) confirms the usefulness of open-ended questions in surveys, especially when the researcher needs to understand attitudes and meanings behind structured responses. Rosala (2024) similarly points out that open-ended questions can reveal deeper insights, while closed questions provide more structured and comparable data.

In the present research, the **open-ended questions** did not function as fully developed semi-structured interviews in the strict methodological sense, because they were not conducted as a separate oral interview session. However, they fulfilled a similar interpretative function: they gave students space to formulate their own explanations and reflections. For this reason, they are described in this monograph as qualitative written responses collected through open-ended, **interview-style prompts**. This formulation accurately reflects the nature of the data while avoiding the methodological inaccuracy of labelling them as formal interviews. Qualitative interviewing is generally used to explore participants' lived experiences and interpretations in depth (Brinkmann - Kvale, 2015), and the open-ended prompts in this research served a more limited but related purpose: they supplemented the quantitative questionnaire data with students' own written reflections.

In addition to the questionnaire data, brief **informal classroom-based group reflections** were conducted after the AI-enhanced ESP activities. These reflections took place naturally in ESP classes and were used to obtain supplementary qualitative feedback on students' perceptions of the training. They were not designed as formal semi-structured interviews, were not recorded or transcribed verbatim and were not used for statistical analysis. Instead, they served as contextual qualitative evidence helping to interpret the **post-intervention questionnaire findings**. During these reflections, students commented on the usefulness of the practical AI activities, the tools they found most relevant for their studies and their interest in further AI-focused training in ESP classes.

The combination of closed questionnaire items and open-ended qualitative prompts was chosen because AI literacy is a complex construct that cannot be reduced only to frequency of use or numerical self-assessment. It includes knowledge and understanding of AI tools, practical ability to use them, attitudes towards their usefulness, confidence in using them, ethical awareness, and actual behaviour in academic tasks. The research design therefore followed three interconnected dimensions: the **cognitive dimension**, referring to students' knowledge and understanding of AI tools and their functions; the **affective dimension**, referring to attitudes, confidence, trust, and concerns related to AI use; and the **conative dimension**, referring to actual usage, frequency, and application of AI tools. These dimensions were explicitly incorporated into the design of the pre- and post-intervention questionnaires.

The research also had the character of a **small-scale educational intervention**. The instructional intervention was integrated into ESP lessons and consisted of AI-focused activities dealing with chatbots, ethical issues related to AI in academic work, effective prompt formulation, AI-supported searching for academic sources, AI-assisted presentation preparation and video content creation. The intervention included work with tools such as ChatGPT, Canva, Gamma and Vidnoz. The same group of students completed the pre-intervention questionnaire

at the beginning of the semester and the post-intervention questionnaire after completing the instructional activities.

The research was conducted at the **Faculty of Materials Science and Technology of the Slovak University of Technology in Trnava** during the winter semester of the academic year **2025/2026**. The participants were undergraduate students enrolled in ESP courses and involved in AI-enhanced ESP instruction. A detailed description of the research sample, including gender, age, study programmes, and group distribution, is provided in the following subchapter. At this point, it is sufficient to state that the participants represented a technical university context, which is particularly relevant for research into AI literacy because technical students are expected to use digital and AI-supported tools in both academic and future professional settings. The empirical part states that the sample consisted of 75 second-year full-time bachelor's students who participated in the AI-enhanced ESP instruction (for more information see subchapter 5.4).

The research instruments consisted of two questionnaires: a **pre-intervention questionnaire** administered before the AI-focused ESP training and a **post-intervention questionnaire** administered after the completion of the instructional activities. The pre-intervention questionnaire examined students' previous experience with AI tools, frequency and purposes of AI use, knowledge and understanding of AI, attitudes, ethical perception, educational needs, self-assessed competence and open-ended reflections. The open-ended questions asked students, for example, how they perceived artificial intelligence and whether they considered it an opportunity, a threat or a neutral tool. The post-intervention questionnaire focused on students' AI use after the ESP activities, self-assessed development of AI-related skills, development of specific AI competences, ethical awareness, attitudes towards AI and transfer of AI skills into academic practice.

The use of a pre-/post-intervention design was appropriate because the research aimed to compare students' initial position with their self-reported perceptions after the AI-enhanced ESP training. However, the study should not be understood as a strict experimental design. The pre- and post-intervention questionnaires were not fully identical in all items. Therefore, the comparison of findings is interpreted primarily as descriptive and indicative rather than as a strict item-by-item statistical measurement of change. Where identical or closely corresponding items are available, the findings are compared directly. In other areas, the post-intervention questionnaire is used to examine students' self-reported development, perceived competence and reflections after the AI-enhanced ESP activities.

From an ethical perspective, participation in the research was voluntary and based on informed consent. Both questionnaires included an informed consent section, and all respondents agreed to participate in the research. The data were collected anonymously and used exclusively for research purposes. This was particularly important because the topic of AI use in academic contexts may involve sensitive issues, especially students' views on academic integrity, responsible AI use and the boundary between support and misuse.

Taken together, the methodological framework of the research enabled the study to examine AI literacy as a multidimensional educational phenomenon. The closed questionnaire items

provided structured quantitative data, while the open-ended, interview-style prompts generated qualitative written responses that gave students space to explain their attitudes, expectations and concerns. The supplementary classroom reflections further contextualised the post-intervention findings. The combination of these forms of data strengthened the interpretative value of the research and provided a suitable basis for analysing the role of AI-enhanced ESP instruction in developing technical university students' AI literacy.

## 5.2 Research Aim, Objectives, Research Questions and Hypotheses

The overall aim of the research was to examine the development of AI literacy among second-year technical university students enrolled in English for Specific Purposes courses. More specifically, the study investigated how structured AI-focused instructional activities integrated into ESP lessons influenced students' self-perceived AI-related competence, frequency and purposes of AI tool use, attitudes towards artificial intelligence, and ethical awareness of AI use in academic contexts.

The research was designed as a small-scale educational intervention based on pre-intervention and post-intervention data collection. The pre-intervention phase focused on students' initial experience with AI, their existing patterns of AI use, their understanding of AI, and their expectations regarding the use of AI in their studies. The post-intervention phase examined students' perceived development after completing AI-enhanced ESP activities focused on chatbots, prompting strategies, AI-supported academic source retrieval, AI-assisted presentations, and video content creation. The instructional intervention included tools such as ChatGPT, Canva, Gamma, and Vidnoz.

To achieve the overall aim of the study, the following research objectives were established:

**RO1:** To identify the initial level of AI literacy, frequency of AI tool usage, and ethical awareness among second-year ESP students before participating in AI-focused instructional activities.

**RO2:** To examine the development of students' self-perceived AI-related skills after completing structured AI-enhanced ESP instruction focused on chatbots, prompting strategies, academic source retrieval, and AI-supported content creation.

**RO3:** To analyse changes in the frequency and purposes of AI tool usage after the completion of ESP-based AI training.

**RO4:** To investigate the development of students' ethical awareness and responsible attitudes towards the use of artificial intelligence in academic contexts after the instructional intervention.

**RO5:** To explore students' attitudes towards AI after completing the AI-enhanced ESP course and to describe the relationship between students' AI usage frequency and their self-perceived AI competence.

These objectives reflect the multidimensional understanding of AI literacy adopted in the study. The research focused on the cognitive dimension, referring to students' knowledge and understanding of AI tools and their functions; the affective dimension, referring to attitudes,

confidence, and perceptions related to AI use; and the conative dimension, referring to actual use, frequency, and application of AI tools. These dimensions were explicitly considered in the design of the pre- and post-intervention questionnaires.

Based on the research aim and objectives, the following research questions were formulated:

**RQ1:** What is the initial level of AI literacy, frequency of AI usage, and ethical awareness among ESP students before participating in AI-focused instructional activities?

**RQ2:** To what extent does students' self-perceived AI competence related to selected AI applications change after completing AI-enhanced ESP instruction?

**RQ3:** How does the frequency and purpose of AI tool usage change after the completion of AI training integrated into ESP courses?

**RQ4:** How does participation in AI-focused ESP instruction influence students' ethical awareness regarding the responsible academic use of artificial intelligence?

**RQ5:** How do students' attitudes towards artificial intelligence change after completing AI-enhanced ESP activities?

**RQ6:** Is there a relationship between students' frequency of AI usage and their self-perceived AI competence after completing the ESP course?

The first research question is descriptive in nature and therefore does not require a hypothesis. RQ6 is also exploratory in nature, as it examines a possible relationship between students' frequency of AI use and their self-perceived AI competence. Since this relationship was not tested through formal correlation analysis, RQ6 is not accompanied by a separate hypothesis. The hypotheses are therefore formulated only for those research questions that concern expected post-intervention changes in students' self-perceived AI-related skills, frequency of AI use, ethical awareness and attitudes.

**H1:** Students report a significantly higher level of self-perceived AI-related skills after completing AI-focused ESP instructional activities compared to the pre-intervention stage.

**H2:** The frequency of AI tool usage among ESP students increases after the completion of AI-enhanced ESP instruction.

**H3:** Students demonstrate higher levels of ethical awareness related to the academic use of AI after the instructional intervention.

**H4:** Students' attitudes towards artificial intelligence become more positive after participating in AI-integrated ESP instruction.

The formulation of the research questions and hypotheses corresponds with the structure of the research instruments. The pre-intervention questionnaire examined students' prior experience with AI, knowledge and understanding of AI, attitudes, ethical perception, educational needs, self-assessed competence, and open-ended reflections on the role of AI in study. The post-intervention questionnaire focused on AI usage after ESP activities, self-assessed change in AI-

related skills, development of specific AI competences, ethical awareness, attitudes towards AI, and the transfer of AI skills into academic practice.

The hypotheses are based on the assumption that systematic, pedagogically guided exposure to AI tools in ESP instruction may support the development of students' AI literacy. Since AI literacy includes knowledge, practical competence, attitudes, ethical awareness and actual use, the hypotheses were designed to capture expected changes in students' self-perceived competence, frequency of AI use, ethical awareness and attitudes. The relationship between frequency of AI use and self-perceived competence is addressed descriptively through RQ6 rather than through a separate hypothesis.

Since the research is based on a small-scale educational intervention and self-reported questionnaire data, the hypotheses are formulated primarily as directional assumptions concerning expected changes in students' AI-related competence, frequency of AI use, ethical awareness, and attitudes. In accordance with methodological principles of quantitative educational research, statistical significance will be discussed only where the data allow an appropriate statistical comparison of pre- and post-intervention responses (Creswell and Creswell, 2018; Cohen, Manion, and Morrison, 2017).

## 5.3 Rationale for Selecting the Research Setting: ESP, Technical Higher Education and AI Literacy

The present research was conducted at the Faculty of Materials Science and Technology of the Slovak University of Technology in Trnava within English for Specific Purposes courses. The selection of this research setting was intentional and directly connected with the aim of the monograph, which examines the development of AI literacy among technical university students. ESP classes at a technical university represent an appropriate environment for this type of research because they combine language development with discipline-related communication, technical terminology, academic tasks, presentation skills and digital competences.

The choice of STU MTF is supported by previous Slovak research on English, ESP and internationalisation in non-philological higher education. Hurajová, Luprichová and Chmelíková (2022) argue that the internationalisation of higher education has strengthened the role of English as a lingua franca and has increased the need to build an English Education Environment at non-philological universities. Their research, conducted at STU MTF within the CLIL-HET Visegrad+ project, showed that internationalisation requires cooperation between disciplinary teachers and ESP/CLIL specialists, as disciplinary teachers need linguistic and didactic support when working in English, while ESP teachers contribute to students' language readiness and to the development of academic communication in English.

This argument is relevant to the present monograph because the development of AI literacy is not isolated from the broader internationalisation process. Students at technical universities need English not only for general communication, but also for reading professional literature, describing technical processes, preparing presentations, participating in projects and potentially studying selected subjects in English. At the same time, they increasingly need to use AI tools

when working with specialised terminology, academic sources, written assignments and visual outputs. ESP courses therefore provide a meaningful space in which English competence and AI literacy can be developed together.

The current ESP syllabus at STU MTF in the academic year 2025/2026 confirms the suitability of this research context. Students attend one 100-minute ESP lesson per week in both the winter and summer terms. The winter term focuses on an introductory lesson and language-level diagnosis, numerals, university and faculty terminology, geometric shapes and solids, basic parameters, materials, properties of materials, poster presentation skills, poster presentations and the final test. The summer term continues with graph interpretation, classical and alternative energy sources, hybrid and electric cars, instructions, description of a car production plant and flow charts, business-related topics, recycling of materials, basics of argumentation, company description, robotics, artificial intelligence, AI assistants such as Siri and Alexa, ethical dilemmas in AI assistants, team presentations, presentation evaluation and feedback. These topics show that ESP at STU MTF already integrates technical vocabulary, visual data, professional communication, presentations, robotics, AI and ethical reflection.

The integration of AI-focused training into ESP was therefore pedagogically justified. It did not introduce an unrelated topic into the course, but extended already existing ESP objectives. Students were trained to work with chatbots, formulate effective prompts, search for academic sources with AI support, prepare AI-assisted presentations and create AI-supported visual or video content. The empirical part of the monograph specifies that the intervention included chatbots, ethical considerations of AI in academic work, effective prompt formulation, AI-supported academic source retrieval, Canva, Gamma and Vidnoz.

The rationale is also supported by research on ESP/LSP in the era of artificial intelligence. Hurajová and Chmelíková (2025) argue that ESP/LSP courses can support internationalisation by helping students develop specialised communication, organise and express ideas, collaborate in team projects and participate in professional discussion. The authors also emphasise that AI tools have potential to support ESP/LSP education through individualised learning, international communication, language support and the connection between language proficiency and specialised knowledge. At the same time, they warn that AI integration requires attention to privacy, access to AI tools, teacher-student interaction, algorithmic bias and teacher training. Their STU MTF survey also indicated a knowledge gap regarding AI tools among teachers and students and showed that AI was used mainly for text formulation, information search, grammar correction, academic writing, term explanation and translation, while broader applications such as course development remained underused.

Earlier research by Hurajová, Chmelíková and Luprichová (2023) similarly showed that AI is already entering higher education and language teaching, but its use requires systematic training. Their questionnaire-based study found that students used AI for text preparation, text processing, fact searching, translation, image creation and learning support, while teachers used AI for foreign language learning, academic writing, translation, lesson preparation and course content creation. The authors concluded that both teachers and students need training in AI-

powered tools and that ethical awareness, accuracy and quality of AI-generated information should become central issues in academic debate.

The relevance of ESP material development in technical fields is further supported by Chmelíková and Miština (2024), whose Springer chapter focuses on developing materials for ESP courses in engineering and natural sciences at selected Slovak universities. The chapter confirms its focus on ESP material development for engineering and natural-science students. This is important for the present research because ESP at technical universities requires flexible, field-sensitive and regularly updated materials, especially in disciplines affected by rapid technological change.

The broader Slovak technical university context also supports the selection of STU MTF. English-medium study opportunities exist not only at STU MTF, where the master's programme Materials Engineering and Technologies is offered in English, but also at other Slovak technical universities (Faculty of Materials Science and Technology STU in Bratislava, n.d.). For example, the Technical University of Košice (Faculty of Electrical Engineering and Informatics TUKE, n.d.) has announced an English-taught joint master's programme in Artificial Intelligence developed in cooperation with STU FIIT and NVIDIA, and the Technical University in Zvolen lists doctoral study programmes offered in English (Technical University in Zvolen, n.d.). These examples indicate that English-medium technical education and AI-related professional preparation are becoming increasingly relevant in Slovakia.

The planned development of ESP at STU MTF makes this research even more timely. From the following academic year 2026/2027, the newly accredited ESP programme is expected to increase the number of ESP lessons from one 100-minute lesson per week to two 100-minute lessons per week. The number of ESP terms is also expected to increase to three terms in the bachelor's degree and one term in the engineering degree. The aim is to provide students with stronger English-language preparation so that they can later study selected academic subjects in English or participate more effectively in English-medium second-degree study or later in doctoral study programme. In this context, AI literacy becomes a logical extension of ESP because students need to use English and AI tools together when working with academic sources, terminology, presentations, written outputs and digital communication.

For these reasons, second-year ESP students at STU MTF represented a suitable research group. They had already entered the technical university environment and were developing discipline-related English, while still being at a stage where their academic habits and AI-related practices could be shaped through systematic instruction. The research sample consisted of 75 undergraduate students enrolled in ESP courses during the winter semester of the academic year 2025/2026. They were organised into five ESP groups and participated in comparable AI-enhanced ESP instruction.

This section has shown that, STU MTF and its ESP courses provided a relevant research setting because they combine technical higher education, English for academic and professional purposes, internationalisation, digital transformation and the emerging need for responsible AI use. The present monograph builds on this context by examining whether structured AI-focused

ESP instruction can help technical university students move from initial curiosity about AI tools towards more competent, critical and ethically aware academic use of artificial intelligence.

## 5.4 Research Sample

The research sample consisted of **75 undergraduate students** enrolled in English for Specific Purposes courses at the **Faculty of Materials Science and Technology of the Slovak University of Technology in Trnava**. All respondents were second-year full-time bachelor's degree students who attended ESP lessons during the winter semester of the academic year **2025/2026**. The sample was selected intentionally, as the students represented a clearly defined group participating in the same AI-enhanced ESP instructional intervention. The empirical part already states that the students were organised into five ESP groups and all groups were exposed to comparable instructional content during the 13-week semester.

The decision to work with this research sample was closely connected with the aim of the monograph, which focuses on the development of AI literacy in ESP courses for technical university students. The participants represented a relevant target group because their academic and future professional context is strongly connected with digital technologies, automation, technical communication, and the practical use of digital tools. For this reason, the selected group provided an appropriate research context for examining students' experience with artificial intelligence, their self-perceived AI-related competence, their attitudes towards AI, and their ethical awareness of AI use in academic work.

In terms of gender distribution, the research sample was predominantly male, which corresponds with the usual demographic composition of many technical study programmes. Male students represented **88%** of the respondents, while female students represented **12%**. No respondent selected the "other" gender category.

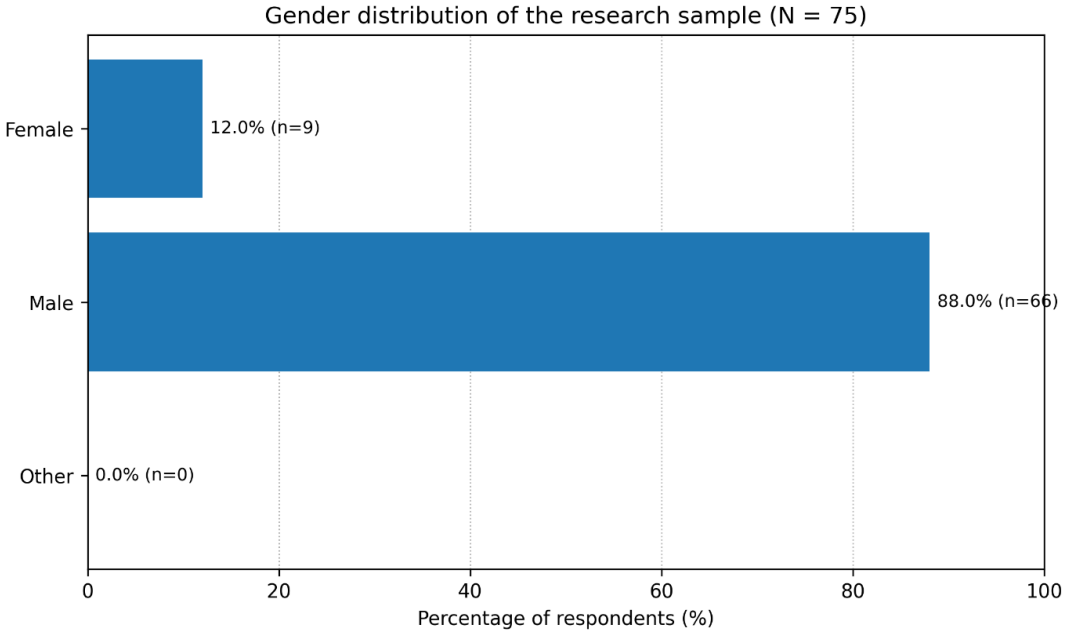



Figure 5: Gender distribution of the research sample

*Source: Author's own elaboration based on the obtained data. Visual design prepared with AI assistance; content checked and edited by the author.*

With regard to age, the majority of participants belonged to the traditional university-age cohort, as seen in the Figure 5. Most respondents were aged **18–20**. This group represented **69.3%** of the sample. Students aged **21–23** accounted for **28%**, while only **2.7%** of respondents were aged **24 or more**. This age distribution shows that the research sample was relatively homogeneous not only in terms of study level, but also in terms of age.

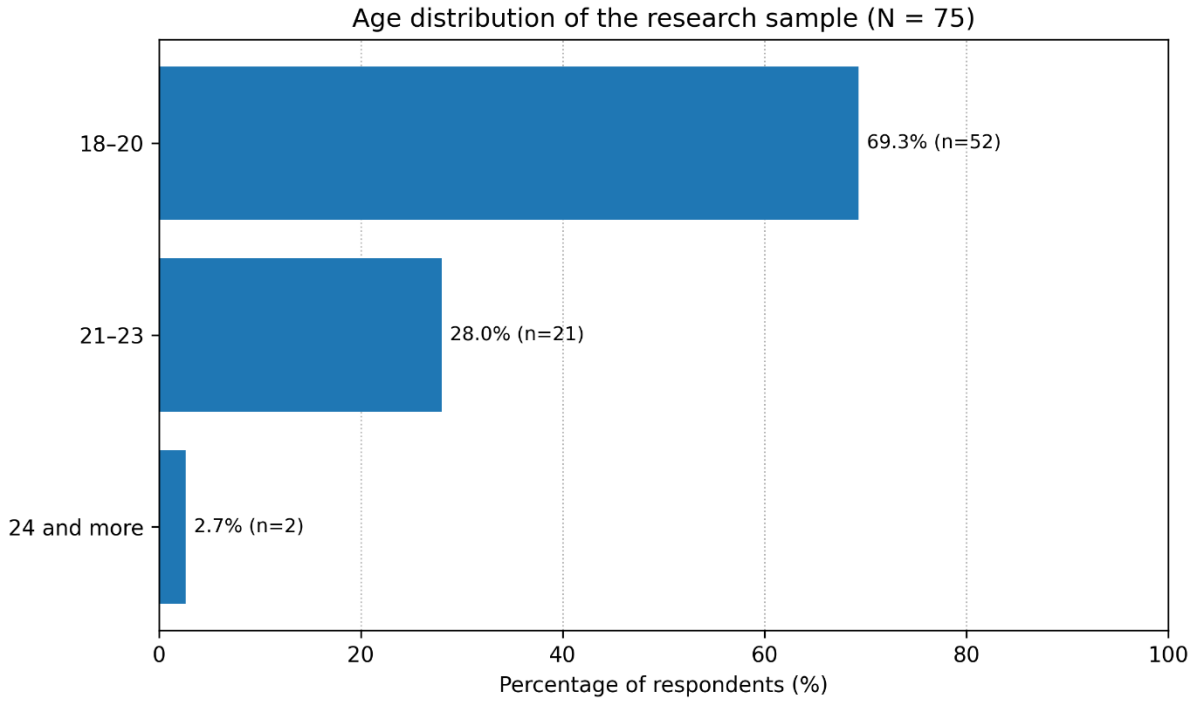



Figure 6: Age distribution of the research sample
*Source: Author's own elaboration based on the obtained data. Visual design prepared with AI assistance; content checked and edited by the author.*

The participants were enrolled in several technical study programmes offered at the faculty. The largest group, as seen in the Figure 6, consisted of students of **Applied Informatics and Automation in Industry**, who represented **62.7%** of the sample. The second largest group was formed by students of **Computer-Aided Manufacturing Technologies**, accounting for **24%**. Students of **Integrated Safety** represented **12%**. Other study programmes were represented only marginally, together accounting for **1.3%** of the sample, including Materials Engineering, Mechatronics in Technological Equipment, Industrial Management, Production Technologies, and Production Equipment and Systems.

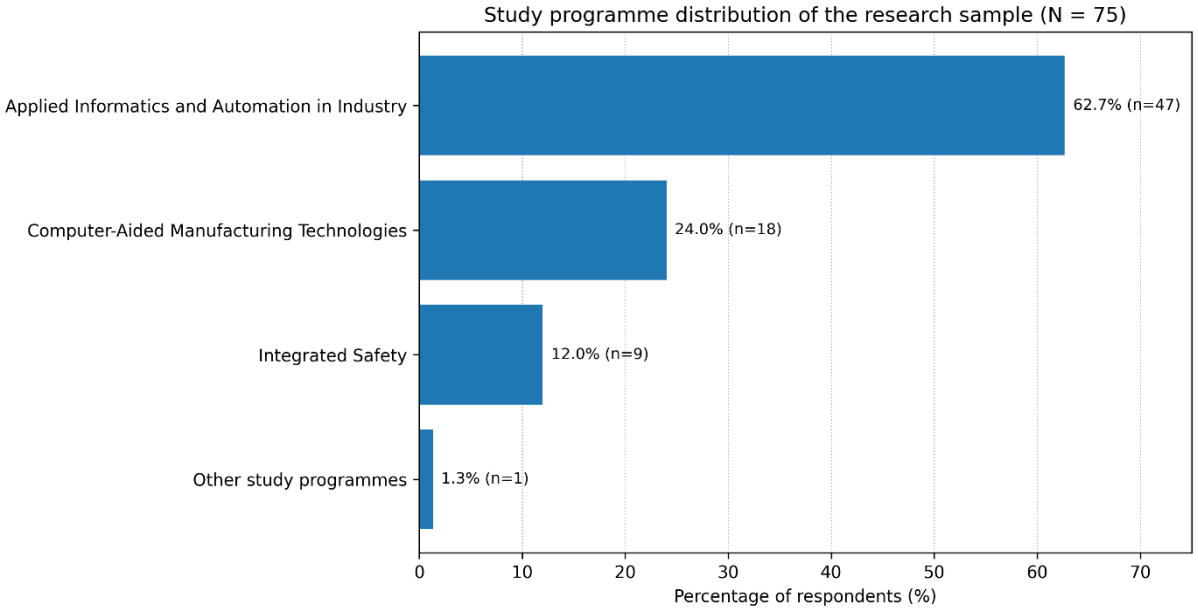



Figure 7: Study programme distribution of the research sample
*Source: Author's own elaboration based on the obtained data. Visual design prepared with AI assistance; content checked and edited by the author.*

The structure of the research sample, as seen in the Figure 7, is important for the interpretation of the findings. Since the respondents were students of technical study programmes enrolled in ESP courses, their answers may reflect a practical orientation towards AI tools, digital applications, technical problem-solving, academic source work, and presentation-related tasks. This corresponds with the specific character of ESP instruction at STU MTF, where English is taught in connection with technical terminology, professional communication, visual data, materials, processes, presentations, and topics related to robotics and artificial intelligence. At the same time, the sample was limited to one faculty, one academic semester, and one specific ESP learning context. Therefore, the findings should be interpreted as context-bound evidence of how structured AI-focused ESP instruction may support the development of AI literacy among technical university students. Although the results may offer useful insights for similar ESP environments at technical universities, they should not be automatically generalised to all university students, all study programmes, or all ESP learning contexts.

## 5.5 Description of the AI-Enhanced ESP Instructional Intervention

The instructional intervention was implemented during the winter semester of the academic year 2025/2026 as part of regular English for Specific Purposes instruction at the Faculty of Materials Science and Technology of the Slovak University of Technology in Trnava. It consisted of five AI-focused training sessions, each lasting 50 minutes, integrated into the 13-week ESP course. The intervention was designed to develop students' AI literacy in connection with academic and technical English, rather than to teach artificial intelligence as an isolated technological topic. It was implemented as part of regular ESP instruction with the formal approval of the Head of the Department of Languages, Humanities and Social Sciences and did not interfere with students' study obligations or the standard fulfilment of course requirements.

The intervention reflected the multidimensional understanding of AI literacy adopted in the research. It addressed the cognitive dimension by introducing students to selected AI tools, their functions, possibilities, and limitations. It addressed the affective dimension by encouraging students to reflect on their attitudes, confidence, trust, and concerns related to AI use. It also addressed the conative dimension by providing students with opportunities to use AI tools actively for academic and ESP-related tasks. This structure corresponded with the design of the pre- and post-intervention questionnaires, which examined students' knowledge, attitudes, ethical awareness, self-perceived competence, and frequency of AI use.

The first training session focused on students' initial orientation in artificial intelligence and the use of AI chatbots. Students were introduced to the basic principles of working with conversational AI tools, particularly ChatGPT and similar applications. The session emphasised the difference between using AI as a supportive learning tool and relying on AI as a replacement for students' own academic work. In the ESP context, students practised using chatbots for vocabulary explanation, simplification of technical terminology, reformulation of sentences, and support in understanding professional texts.

The second session was dedicated to effective prompt formulation. Students were guided to understand that the quality of AI-generated output depends strongly on the clarity, specificity, and contextualisation of the prompt. They practised formulating prompts for ESP-related tasks, such as explaining technical terms, generating examples of professional vocabulary, preparing short definitions, improving the structure of a technical description, and adapting language to an academic or presentation context. This session was directly connected with students' future academic tasks, because prompt formulation was treated not only as a technical skill, but also as a transferable communication skill.

The third session focused on AI-supported academic source retrieval and work with information. Students were introduced to the possibilities and limitations of using AI tools when searching for information for seminar papers, bachelor's theses, and academic presentations. Particular attention was paid to the need to verify AI-generated information, distinguish between reliable and unreliable sources, and avoid uncritical copying of AI outputs. The session also addressed the ethical use of AI in academic work, including transparency, responsibility, and the boundary between acceptable support and academic misconduct.

The fourth session focused on AI-assisted presentation preparation. Students worked with tools such as Canva and Gamma, which can support the creation of visual presentations and structured content. The aim was not only to generate presentation slides, but also to help students evaluate the quality, accuracy, visual clarity, and linguistic appropriateness of AI-supported outputs. This session was aligned with the ESP syllabus, as students at STU MTF are required to develop poster and presentation skills as part of their English course.

The fifth session dealt with AI-supported video content creation, including the use of Vidnoz. Students were introduced to possibilities of creating short AI-supported video outputs for academic or presentation purposes. The session also encouraged discussion about the

credibility, authenticity, and ethical implications of AI-generated audiovisual content. In this way, the intervention connected practical digital skills with critical reflection on the responsible use of AI-generated materials.

Across all five sessions, AI tools were presented as supportive instruments for learning, communication, and academic preparation. The intervention did not aim to replace students' own thinking, writing, speaking, or decision-making. Instead, it aimed to help students use AI tools more consciously, critically, and ethically in tasks connected with ESP learning. This was particularly important because the pre-intervention questionnaire showed that students had already used several AI tools before the training, including ChatGPT, Copilot, Gemini, Gamma, Canva, DeepSeek, Claude, DALL·E and similar applications. The training therefore responded to an existing practice and attempted to transform spontaneous AI use into more informed academic use.

The intervention was identical in its general structure across all five ESP groups. Although the specific pace of classroom interaction may have differed slightly according to group dynamics, the same instructional focus, tools, and learning objectives were maintained. This consistency supported the comparability of the intervention and made it possible to examine students' self-reported development through the pre- and post-intervention questionnaires.

A structured overview of the five AI-focused ESP intervention sessions is provided in Appendix A (see APPENDIX A). The appendix presents the pedagogical focus, selected tools and platforms, main classroom activities, expected student outputs, Bloom's taxonomy focus and intended AI literacy dimensions of each session. It does not reproduce the complete teaching materials used during the lessons, but offers a transparent methodological overview of the intervention design.

## 5.6 Research Instruments and Data Collection

The research data were collected through two questionnaires: a pre-intervention questionnaire (see APPENDIX B) and a post-intervention questionnaire (see APPENDIX C). Both instruments were administered to the same group of second-year ESP students at the Faculty of Materials Science and Technology of the Slovak University of Technology in Trnava during the winter semester of the academic year 2025/2026.

The pre-intervention questionnaire was administered before the AI-focused ESP activities. Its purpose was to identify students' initial experience with AI tools, frequency and purposes of AI use, basic understanding of AI, attitudes towards AI, ethical perception, educational needs, self-assessed competence and open-ended reflections on the role of AI in their studies.

The post-intervention questionnaire was administered after students had completed the AI-enhanced ESP activities. It focused on students' AI use after the intervention, perceived development of AI-related skills, post-intervention AI competences, ethical awareness, attitudes towards AI and the possible transfer of AI skills into academic and ESP-related practice.

Both questionnaires combined closed and open-ended items. The closed questions included multiple-choice items, frequency questions and Likert-scale statements, which made it possible to identify general tendencies in students' responses. The open-ended questions provided

supplementary qualitative insight into students' perceptions, expectations and reflections. In addition, brief informal classroom-based group reflections were conducted after the AI-enhanced ESP activities to obtain contextual feedback on students' experience with the training.

Participation in the research was voluntary and anonymous. Both questionnaires included an informed consent section, and the collected data were used exclusively for research purposes.

## 5.7 Data Analysis and Ethical Considerations

The collected data were analysed using descriptive quantitative and qualitative procedures. The closed questionnaire items were processed quantitatively through frequencies and percentages. This made it possible to identify general tendencies in students' AI use, self-perceived competence, attitudes and ethical awareness before and after the AI-enhanced ESP intervention.

The open-ended questionnaire responses were analysed qualitatively through thematic categorisation. Students' answers were read, compared and grouped into recurring themes, such as AI as an opportunity, AI as a neutral tool, concerns about over-reliance, intended academic uses of AI and expectations regarding further AI training. This qualitative analysis provided additional insight into students' own perceptions and helped interpret the numerical findings.

The supplementary classroom reflections were used as contextual qualitative evidence. Since they were informal, classroom-based and not recorded or transcribed verbatim, they were not treated as formal interview data or as a separate qualitative dataset. Their purpose was to support the interpretation of the post-intervention questionnaire findings and to capture students' immediate reactions to the AI-focused activities.

Ethical principles were observed throughout the research process. Participation in the study was voluntary and anonymous. Both questionnaires included an informed consent section, and respondents were informed that the data would be used only for research purposes. No personally identifiable information was collected or used in the analysis.

The implementation of the research and the AI-enhanced ESP instructional intervention was carried out with the formal approval of the Head of the Department of Languages, Humanities and Social Sciences. The intervention was integrated into regular ESP instruction and was designed in accordance with the pedagogical objectives of the course. Participation in the research did not interfere with the fulfilment of students' study obligations, course requirements or assessment procedures. Similarly, the implementation of the intervention did not affect the author's regular teaching responsibilities. The AI-focused activities were used as part of ordinary ESP classroom practice and served to support, rather than replace or disrupt, the planned learning outcomes of the course.

# 6 Initial AI Literacy before the ESP Intervention: Analysis of the Pre-Intervention Questionnaire Findings

The respondents in the present research belong to Generation Z, a cohort whose academic and everyday lives have been strongly shaped by digital technologies, smartphones, social media, online communication and rapid access to information. Twenge (2017) characterises this generation, often referred to as *iGen*, as the first generation that does not remember a time before the internet and whose development has been closely connected with smartphones and social media. However, digital immersion should not be interpreted automatically as technological competence. Twenge also points to a more complex psychological profile of this generation, including increased uncertainty, lower confidence, stronger safety orientation and higher levels of anxiety compared with previous generations (Twenge, 2017; Twenge and Campbell, 2019).

In higher education, Generation Z is often described as a group of students with specific motivations, learning styles, skills and social concerns. Seemiller and Grace (2016), in their study of more than 1,100 Generation Z college students, argue that this generation differs from previous cohorts in the way it approaches learning, communication, independence and social engagement. At the same time, students' familiarity with digital environments does not necessarily mean that they possess advanced critical, academic or ethical competences in the use of emerging technologies. This distinction is particularly important in relation to generative artificial intelligence.

Recent research on the AI generation gap suggests that Generation Z students tend to perceive generative AI positively, especially in relation to productivity, efficiency and personalised learning. However, the same research also emphasises the need for responsible use, digital literacy, critical thinking and clear institutional guidelines for the integration of generative AI into higher education. This perspective is directly relevant to the present monograph, which does not examine whether students can access AI tools, but whether structured AI-focused ESP instruction can support their more competent, critical and ethically aware use (Chan and Lee, 2023).

This issue is particularly important in English for Specific Purposes courses at technical universities. Technical university students need English for academic and professional communication, including technical terminology, source work, presentations, written assignments and communication related to their field of study. At the same time, they increasingly use AI tools for searching information, reformulating texts, preparing presentations, supporting language production and solving academic or technical tasks. Therefore, AI literacy in this context should be understood not simply as familiarity with AI tools, but as the ability to use them purposefully, evaluate their outputs, recognise their limitations and apply them responsibly in academic work.

The present chapter analyses findings obtained from the pre-intervention questionnaire administered to second-year ESP students at the Faculty of Materials Science and Technology of the Slovak University of Technology in Trnava. The questionnaire examined students' initial experience with AI tools, frequency and purposes of AI use, knowledge and understanding of

AI, attitudes towards AI, ethical perception, educational needs, self-assessed competence and open-ended reflections on the role of AI in their studies.

The analysis follows the research aim, objectives and research questions formulated in the methodological part of the monograph, especially RO1 and RQ1, which focus on students' initial AI literacy, frequency of AI use and ethical awareness before the AI-enhanced ESP intervention. The chapter first presents students' previous experience with AI tools and their frequency and purposes of use. It then analyses their initial knowledge and understanding of AI, attitudes towards AI, ethical perception, educational needs and self-assessed competence. Finally, students' open-ended responses are interpreted thematically in order to provide deeper insight into how they perceived artificial intelligence before participating in the AI-focused ESP activities.

## 6.1 Initial Experience with AI before the ESP Intervention

The first part of the analysis focuses on students' initial experience with artificial intelligence before participating in the AI-enhanced ESP instructional intervention. This section is directly connected with **RQ1**, which examined the initial level of AI literacy, frequency of AI use, and ethical awareness among ESP students before the AI-focused activities. It is also related to **RO1**, which aimed to identify students' starting position before the instructional intervention.

The pre-intervention questionnaire showed that artificial intelligence was already familiar to all respondents before the training. All 75 students stated that they had already used AI tools before participating in the AI-enhanced ESP activities. This finding is important because it indicates that the intervention did not introduce artificial intelligence as a completely new phenomenon. Rather, it responded to an already existing practice and aimed to transform students' spontaneous or intuitive use of AI into more informed, purposeful and academically responsible use.

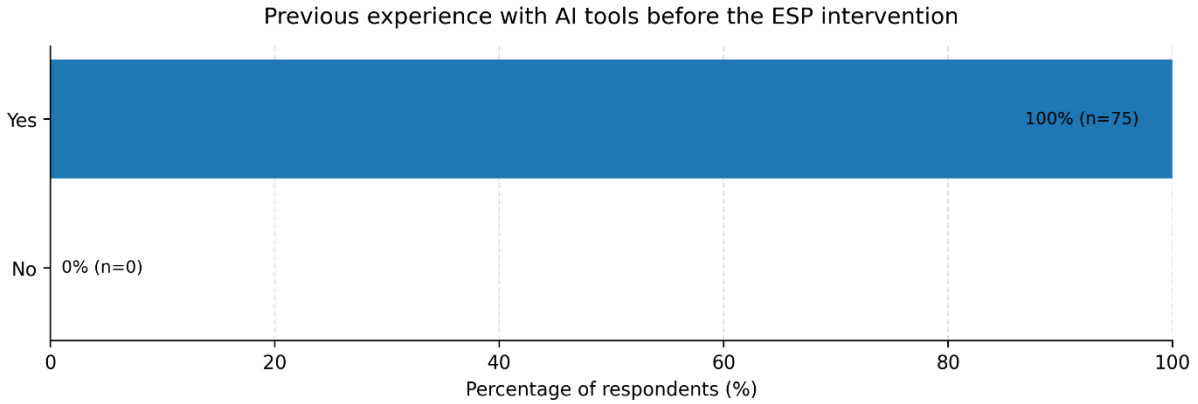



Figure 8: Previous experience with AI tools before the ESP intervention
*Source: Author's own elaboration based on the obtained data. Visual design prepared with AI assistance; content checked and edited by the author.*

The range of AI tools mentioned by students above also shows that their experience was relatively diverse. The most frequently mentioned tool was ChatGPT, which appeared in the majority of responses. Other tools included Copilot, Gemini, Gamma, Canva, DeepSeek,

Claude, DALL·E, Grok, Perplexity, Mistral AI, Sora, Stable Diffusion, HeyGen, Suno, Apple Intelligence, and several other applications. This variety suggests that students did not perceive AI only through one dominant platform, although ChatGPT clearly represented the most visible and commonly used tool. The responses also show that students associated AI mainly with text generation, information search, presentation preparation, image generation, translation, programming support and general learning assistance.

The frequency of AI use before the intervention confirms that AI tools had already become part of students' academic and everyday routines. Before the training, 28% of respondents reported using AI tools daily, 40% used them several times a week, 20% several times a month, and 12% rarely. No respondent selected the option "never". This means that 68% of the students used AI either daily or several times a week even before the AI-focused ESP training.

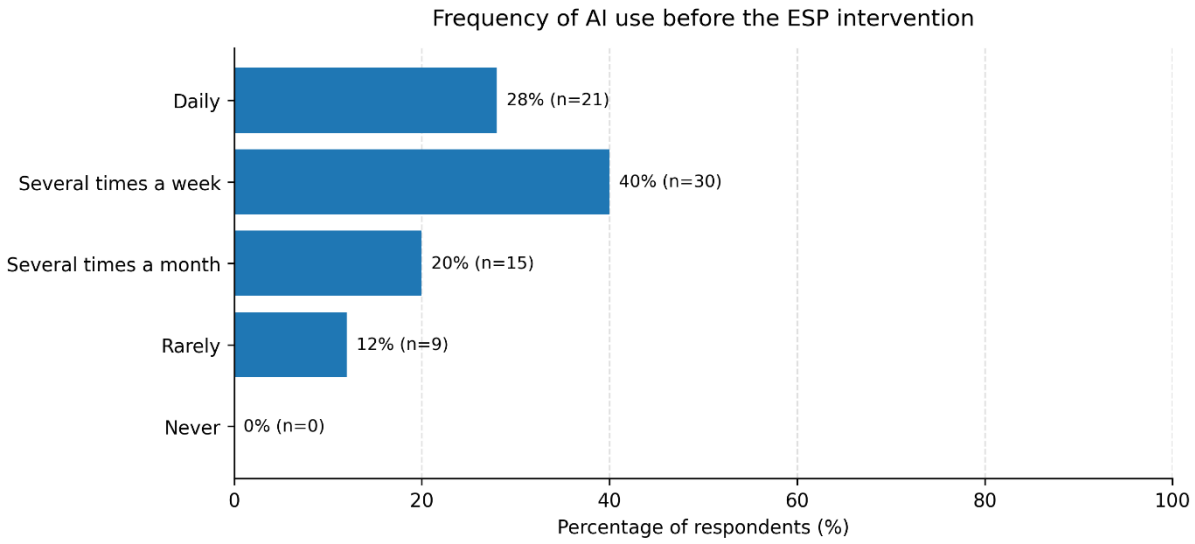



Figure 9: Frequency of AI use before the ESP intervention
*Source: Author's own elaboration based on the obtained data. Visual design prepared with AI assistance; content checked and edited by the author.*

These results above suggest a high level of practical exposure to AI tools among the respondents. However, frequent use should not be automatically interpreted as advanced AI literacy. Students may use AI regularly without being able to formulate effective prompts, evaluate the accuracy of generated outputs, identify ethical risks, or distinguish between acceptable academic support and inappropriate dependence on AI-generated content. This distinction is central to the present research. The intervention, therefore, did not aim merely to increase the number of students using AI, but to support more conscious, critical and academically appropriate use of AI in ESP-related tasks.

The purposes for which students used AI before the intervention further confirm the practical orientation of the research sample. The most common purpose was searching for information and sources, which was selected by 84% of respondents. Technical problem-solving or solving technical tasks was selected by 49.3% of students. Writing texts, including seminar papers or similar assignments, was selected by 46.7% of respondents. Creating presentations or graphic

outputs was selected by 40% of students. Other answers appeared only marginally and included individual purposes such as summarising texts, obtaining quick information, programming support, or personal interests.

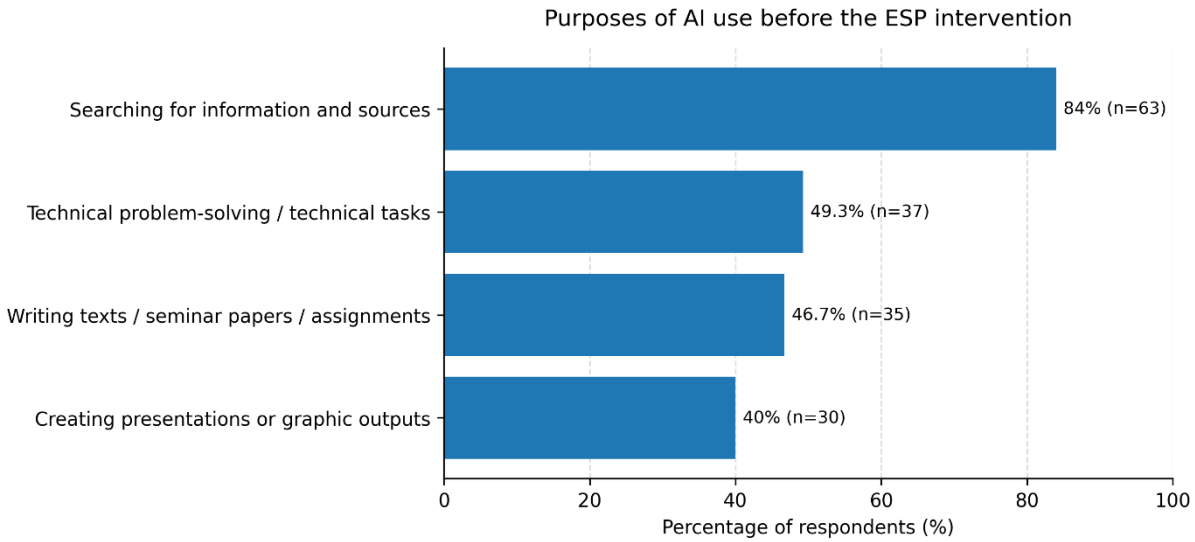



Figure 10: Purposes of AI use before the ESP intervention
*Source: Author's own elaboration based on the obtained data. Visual design prepared with AI assistance; content checked and edited by the author.*

As seen in the Figure 10, the dominance of information searching is particularly relevant for the interpretation of the findings. It shows that students often used AI as an alternative or supplement to traditional search engines. In academic contexts, this practice requires careful attention because AI-generated information may be incomplete, inaccurate, insufficiently sourced, or presented without clear distinction between verified and unverified content. For ESP students, this is especially important because they are expected to work with professional terminology, academic sources, presentations, seminar papers and later bachelor's theses. Therefore, the high percentage of students using AI for information search confirms the need for instruction focused on source verification, critical evaluation and responsible academic use.

The relatively high percentage of students using AI for writing texts also raises important questions related to academic integrity and student authorship. AI can support students in generating ideas, improving grammar, reformulating sentences or organising text. However, it can also be misused to produce complete assignments without sufficient student input. This finding therefore supports the inclusion of ethical issues in the AI-focused ESP intervention.

The use of AI for technical problem-solving corresponds with the profile of the respondents as students of technical study programmes. Their AI use was not limited to language learning or general academic tasks; it was also connected with programming, technical assignments, calculations, debugging, and problem-solving in their field of study. This confirms the relevance of conducting the research in a technical university context. For these students, AI literacy is linked not only to English language learning, but also to technical thinking, digital work, academic communication and future professional practice.

Taken together, the pre-intervention findings show that the respondents entered the AI-enhanced ESP course with substantial previous experience of AI tools. All students had already used AI, and most of them used it regularly. Their most frequent purposes of use were information search, technical tasks, writing and presentation preparation. These findings answer the first part of **RQ1** and show that the initial level of practical exposure to AI was high. At the same time, they justify the need for structured AI-literacy training, because frequent use alone does not guarantee critical evaluation, ethical awareness or academically responsible application.

## 6.2 Initial Knowledge and Understanding of AI before the ESP Intervention

After analysing students' previous experience with AI tools, the next part of the pre-intervention questionnaire focused on students' initial knowledge and understanding of artificial intelligence. This section is connected with **RQ1**, which examined the initial level of AI literacy among ESP students before the instructional intervention, and with **RO1**, which aimed to identify students' starting position before participating in AI-focused ESP activities.

The questionnaire included five statements related to students' basic understanding of AI. These statements focused on whether students could explain the meaning of artificial intelligence, whether they knew at least three AI-based tools, whether they understood the difference between generative and analytical AI, whether they could recognise AI-generated text or images, and whether they knew that AI can make mistakes and that its outputs should be verified.

The results suggest that students entered the intervention with a relatively high level of general familiarity with AI, especially in relation to practical awareness of tools and awareness of possible AI errors. Most respondents stated that they were able to explain what artificial intelligence means. More specifically, 57.3% of students rather agreed and 29.3% completely agreed with this statement. Together, this means that 86.6% of respondents expressed agreement. Only one respondent rather disagreed, and 12% were unable to assess their knowledge.

A similarly strong result was found in relation to students' knowledge of AI-based tools. Altogether, 77.4% of respondents agreed that they knew at least three tools based on artificial intelligence, with 18.7% rather agreeing and 58.7% completely agreeing. This corresponds with the previous finding that all students had already used AI tools before the intervention and that they mentioned a wide range of tools, including ChatGPT, Copilot, Gemini, Gamma, Canva, DeepSeek, Claude, DALL·E and others.

The weakest area of initial knowledge concerned the distinction between generative and analytical AI. Only 46.6% of respondents agreed that they understood this difference, while 25.3% disagreed and 28% were unable to assess their understanding. This finding is important because it shows that although students were familiar with AI tools in practical terms, their conceptual understanding of different types of AI was less developed. This confirms the need for structured AI-literacy training, especially in areas that go beyond everyday tool use.

Students evaluated their ability to recognise AI-generated text or images more positively. In total, 70.7% of respondents agreed that they could detect when a text or image was created by AI. However, 21.3% selected the neutral option and 8% disagreed. This result suggests that many students had confidence in recognising AI-generated content, but a considerable proportion remained uncertain. From the perspective of academic work, this is relevant because students need to understand that AI-generated content may be difficult to identify reliably and that detection based only on intuition may not always be sufficient.

The strongest result in this section concerned awareness of AI errors and the need for verification. Altogether, 94.7% of respondents agreed that AI can make mistakes and that they verify its outputs. Specifically, 28% rather agreed and 66.7% completely agreed. This is a very important finding because it indicates that most students already had some initial awareness of the limitations of AI-generated information before the intervention. At the same time, this self-reported awareness does not necessarily mean that students always verify outputs effectively in practice. Therefore, the intervention needed to develop not only awareness, but also practical strategies for checking AI-generated information and using it responsibly in academic tasks.

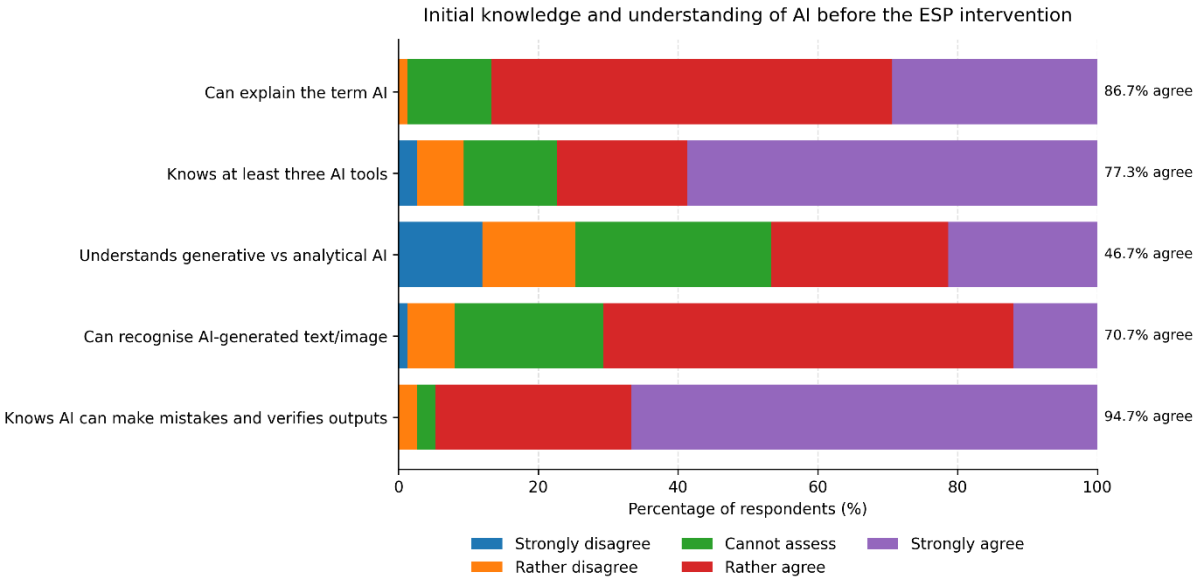



Figure 11: Initial knowledge and understanding of AI before the ESP intervention
*Source: Author's own elaboration based on the obtained data. Visual design prepared with AI assistance; content checked and edited by the author.*

Overall, the results above show that students' initial AI literacy was uneven. They demonstrated strong practical familiarity with AI tools and a high level of awareness that AI outputs may contain errors. However, their conceptual understanding of AI was weaker, especially in relation to the difference between generative and analytical AI. These findings support the need for AI-focused ESP instruction that does not only introduce tools, but also helps students understand how different AI systems function, what their limitations are, and how their outputs should be evaluated in academic contexts.

## 6.3 Initial Attitudes towards AI before the ESP Intervention

After analysing students' initial knowledge and understanding of artificial intelligence, the next part of the pre-intervention questionnaire focused on students' attitudes towards AI. This section is connected with **RQ1**, which examined students' initial AI literacy, including their attitudes and ethical awareness before the instructional intervention. It also provides a baseline for later comparison with post-intervention responses related to **RQ5** and **H4**, which focus on possible changes in students' attitudes after completing the AI-enhanced ESP activities.

The questionnaire included five statements addressing students' perceived usefulness of AI for study, confidence in using AI tools, trust in AI-generated outputs, concern about the possible reduction of critical thinking, and the role of AI in university education. The results show that students entered the intervention with generally positive but also cautious attitudes towards artificial intelligence.

The strongest positive attitude was expressed in relation to the usefulness of AI for study. Altogether, 81.3% of respondents agreed that they considered the use of AI beneficial for their studies. More specifically, 44% rather agreed and 37.3% completely agreed with this statement. Only 8% rather disagreed, while 10.7% were unable to assess the statement. This finding confirms that most students perceived AI as a useful academic support tool even before the instructional intervention.

Students' confidence in using AI tools was also relatively high, although less pronounced than their perception of usefulness. In total, 58.7% of respondents agreed that they felt confident when working with AI tools, with 37.3% rather agreeing and 21.3% completely agreeing. However, 26.7% were unable to assess their confidence, and 14.7% expressed disagreement. This suggests that while many students had already used AI tools, their confidence was not equally developed across the whole group.

The most cautious responses appeared in relation to trust in AI-generated results. Only 29.3% of respondents rather agreed that they trusted the results provided by AI, and no respondent selected the option "completely agree". At the same time, 33.3% disagreed and 37.3% were unable to assess this statement. This finding is important because it shows that students did not accept AI-generated outputs uncritically. Their practical use of AI was therefore accompanied by a considerable degree of uncertainty or scepticism regarding reliability.

A strong level of concern was visible in relation to critical thinking. Altogether, 77.3% of students agreed that AI may reduce the need for critical thinking. Specifically, 44% rather agreed and 33.3% completely agreed. Only 9.3% rather disagreed, while 13.3% were unable to assess the statement. This result shows that students were already aware of one of the central risks connected with AI use in education: the possibility that AI may encourage superficial learning or reduce students' own intellectual effort.

The final statement focused on whether AI should be part of university education. In total, 60% of respondents agreed with this statement, with 42.7% rather agreeing and 17.3% completely agreeing. However, 29.3% were unable to assess this issue, and 10.7% rather disagreed. These results suggest that although students generally recognised the relevance of AI for university

learning, a relatively large group was still uncertain about its formal integration into higher education.

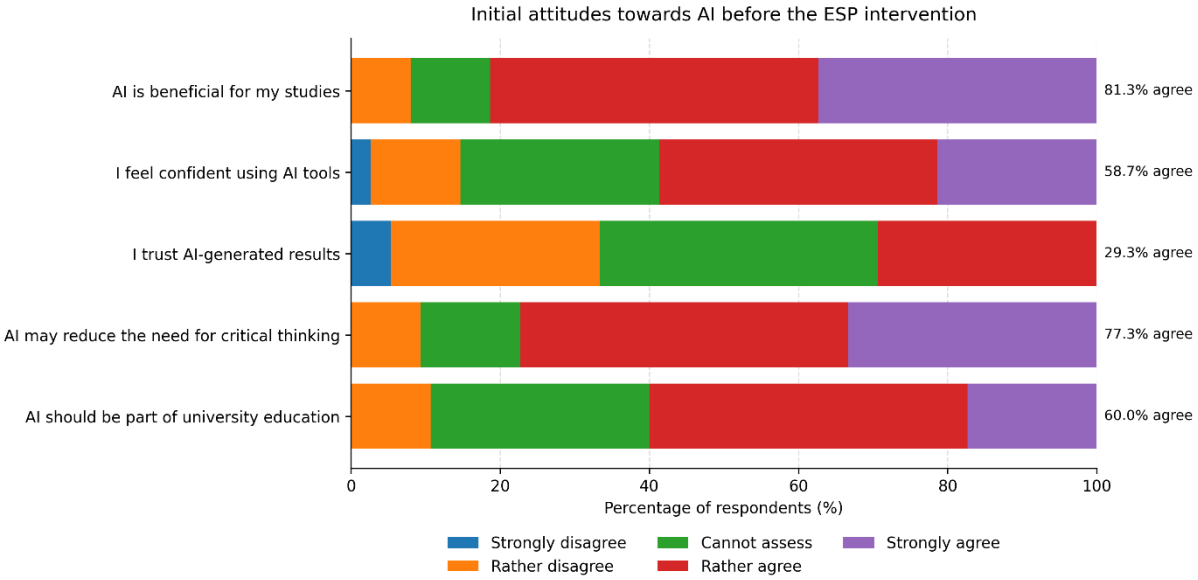



Figure 12: Initial attitudes towards AI before the ESP intervention
*Source: Author's own elaboration based on the obtained data. Visual design prepared with AI assistance; content checked and edited by the author.*

The evidence from this section, as seen in the Figure 12, indicates that the findings show that students' initial attitudes towards AI were positive but not uncritical. Most respondents considered AI beneficial for their studies and more than half felt confident using AI tools. At the same time, students expressed limited trust in AI-generated results and strong concern that AI may reduce the need for critical thinking. This combination of usefulness, confidence, scepticism and concern confirms that students approached AI pragmatically. They recognised its academic potential, but they were also aware of risks connected with reliability, over-reliance and reduced independent thinking. These findings support the need for structured AI-focused ESP instruction that develops not only practical tool use, but also critical evaluation and responsible academic decision-making.

## 6.4 Initial Ethical Perception and Academic Integrity before the ESP Intervention

The next section of the pre-intervention questionnaire examined students' ethical perception of AI and their understanding of academic integrity in relation to AI-supported learning. This part of the analysis is directly connected with **RQ1**, which explored students' initial AI literacy and ethical awareness before the intervention. It also provides an important baseline for **RQ4** and **H3**, which focus on whether students' ethical awareness improved after the AI-enhanced ESP activities.

The questionnaire included five statements dealing with the acceptable use of AI as a support tool, the inappropriate use of AI to produce whole assignments, the need to acknowledge AI use in academic writing, the role of students' own thinking, and the need for clear university rules on AI use. The results show that students already had a relatively strong ethical awareness before the intervention, especially in relation to independent thinking and the inappropriate replacement of student work by AI.

The first statement focused on whether the use of AI in school assignments is acceptable if AI is used only as a helper. A very high proportion of respondents agreed with this statement. In total, 89.3% of students expressed agreement, with 44% rather agreeing and 45.3% completely agreeing. Only 4% disagreed, while 6.7% were unable to assess the statement. This suggests that students did not reject AI use in education. Instead, they tended to accept AI as a legitimate support tool, provided that it does not replace the student's own work.

The second statement addressed whether it is inappropriate for a student to ask AI to write an entire assignment instead of them. Altogether, 81.3% of respondents agreed with this statement, including 20% who rather agreed and 61.3% who completely agreed. This result indicates that most students understood the ethical difference between using AI as support and using AI as a substitute for their own academic performance. However, 12% disagreed and 6.7% were unable to assess the statement, which shows that some uncertainty or disagreement was still present before the intervention.

The third statement focused on transparency, namely whether students know that AI use in writing must be acknowledged. Here, the level of agreement was lower than in the previous two statements. In total, 72% of respondents agreed, with 32% rather agreeing and 40% completely agreeing. At the same time, 12% disagreed and 16% were unable to assess the statement. This finding is important because it shows that although most students were aware of the need to acknowledge AI use, this knowledge was not universal. Therefore, explicit instruction on transparency, citation practices, and responsible academic use of AI was necessary.

The strongest ethical position was expressed in relation to the statement that AI should not replace students' own thinking. Altogether, 93.3% of respondents agreed with this statement, including 26.7% who rather agreed and 66.7% who completely agreed. Only 4% rather disagreed and 2.7% were unable to assess the issue. This result is particularly important because it confirms that the majority of students already recognised independent thinking as a central value in academic learning.

The final statement concerned the need for clear university rules on the use of AI. In total, 76% of respondents agreed that universities should have clear rules about AI use, with 22.7% rather agreeing and 53.3% completely agreeing. However, 18.7% were unable to assess the statement and 5.3% disagreed. These results suggest that many students expected institutional guidance, but a notable group had not yet formed a clear opinion. This supports the need for transparent rules and explicit classroom-level guidance on what is acceptable, what must be acknowledged, and what constitutes misuse.

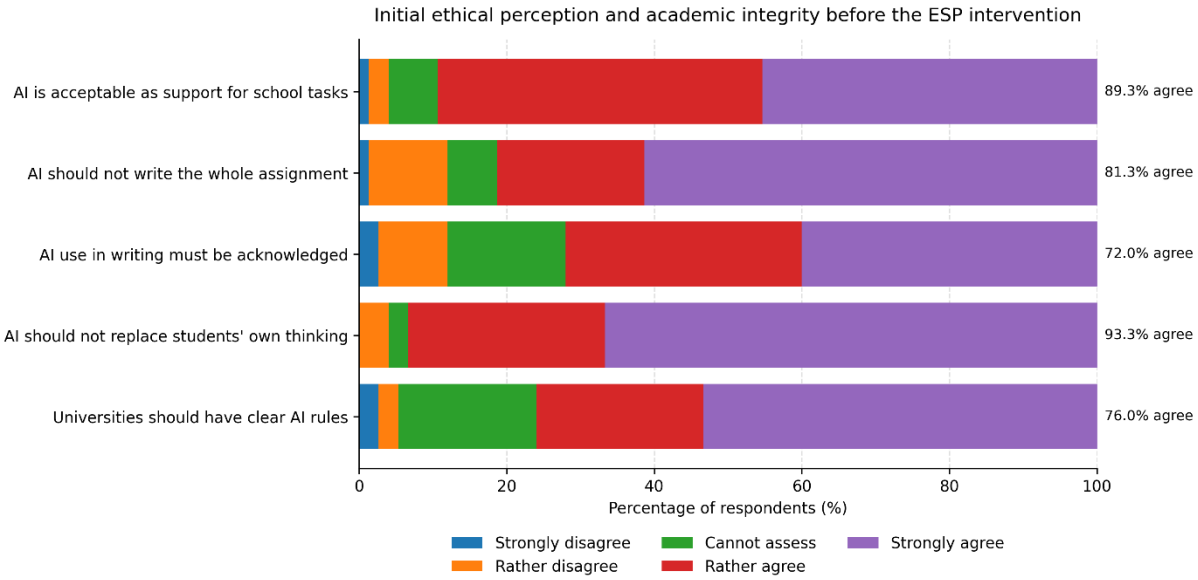



Figure 13: Initial ethical perception and academic integrity before the ESP intervention
*Source: Author's own elaboration based on the obtained data. Visual design prepared with AI assistance; content checked and edited by the author.*

The findings in the Figure 13 therefore suggest that students entered the intervention with a relatively strong initial ethical awareness. Most respondents accepted AI as a support tool but rejected its use as a replacement for complete academic work. They also strongly agreed that AI should not replace students' own thinking. Nevertheless, the results also reveal areas requiring further development, especially transparency in acknowledging AI use and understanding institutional rules. This confirms the relevance of including ethical AI use as a specific component of the ESP intervention, rather than treating AI only as a practical productivity tool.

## 6.5 Educational Needs and Expectations before the ESP Intervention

The next part of the pre-intervention questionnaire focused on students' educational needs and expectations in relation to AI. This section is important because previous findings showed that students had already used AI tools and had generally positive, although cautious, attitudes towards them. However, previous experience with AI does not automatically mean that students feel prepared to use AI effectively, critically, and ethically in academic contexts. Therefore, this part of the questionnaire examined whether students wanted to develop specific AI-related competences during the ESP course.

This section is connected with **RO1** and **RQ1**, as it helps identify students' initial educational needs and expectations related to AI before the ESP intervention. It is also relevant to **RO2**, because students' expressed needs provide a rationale for the design of the AI-enhanced ESP activities, particularly in the areas of chatbot use, AI-supported source searching, presentation preparation and ethical AI use. Indirectly, the findings also support the interpretation of **RQ2** and **RQ3**, as they show which AI-related competences and purposes of use students considered important before the intervention. Since this section focuses on needs and expectations rather than measured change, it is not used for direct hypothesis testing.

The questionnaire included four statements related to students' interest in learning how to use chatbots effectively, creating presentations and visuals with AI, searching for scientific sources with AI, and participating in short training on ethical AI use during the semester. The results show that students' strongest educational needs were connected with practical academic use of AI, especially chatbot use and AI-supported source searching.

The highest level of interest was identified in relation to AI-supported searching for scientific sources. Altogether, 80% of respondents agreed that they would like to learn how to search for scientific sources using AI. More specifically, 37.3% rather agreed and 42.7% completely agreed with this statement. Only 5.3% disagreed, while 14.7% were unable to assess it. This finding is particularly relevant for university ESP instruction because students need to work with academic and professional information, prepare presentations, process technical texts, and gradually develop the skills required for seminar papers and final theses.

A similarly strong interest was expressed in learning how to use chatbots effectively. In total, 77.3% of respondents agreed with this statement, with 34.7% rather agreeing and 42.7% completely agreeing. Only 9.3% disagreed, and 13.3% were unable to assess the statement. This result confirms that students did not only use chatbots spontaneously, but also expressed a clear need for guidance in their more effective use. In the context of ESP, this includes prompt formulation, vocabulary explanation, text reformulation, clarification of technical terminology, and support in academic communication.

Students' interest in creating presentations and visuals with AI was more moderate. Altogether, 54.7% of respondents agreed that they were interested in creating presentations and visual materials with AI tools such as Canva or Gamma. However, 30.7% disagreed, and 14.7% were unable to assess this statement. This result suggests that although presentation and visual-content tools were relevant for a considerable group of students, they were not perceived as equally important by all respondents. One possible explanation is that students may have associated AI more strongly with text-based tools, information search, and technical problem-solving than with visual or presentation-oriented work.

The lowest level of agreement was recorded in relation to interest in short training on ethical AI use during the semester. In total, 50.7% of respondents agreed with this statement, while 29.3% disagreed and 20% were unable to assess it. This does not mean that students considered ethical AI use unimportant. Previous findings showed that they were already aware of several ethical issues, including the need for independent thinking, the inappropriate use of AI to write whole assignments, and the importance of university rules. However, students may have perceived ethical training as less immediately practical than learning how to use chatbots or search for scientific sources.

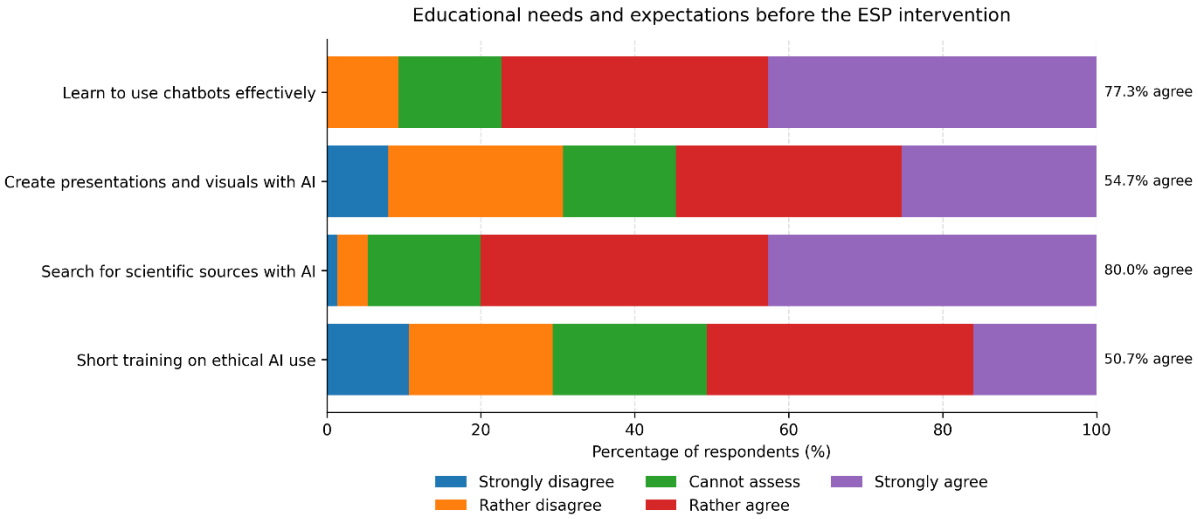



Figure 14: Educational needs and expectations before the ESP intervention
*Source: Author's own elaboration based on the obtained data. Visual design prepared with AI assistance; content checked and edited by the author.*

In general terms, the findings above point to that students entered the intervention with clear educational expectations. Their strongest needs were connected with the effective use of chatbots and AI-supported academic source searching. These areas correspond directly with the aims of the AI-enhanced ESP intervention, which focused on prompt formulation, academic source retrieval, AI-supported content preparation, and responsible use of AI in study-related tasks. At the same time, the lower level of explicit interest in ethical training suggests that ethical AI use should be integrated into practical activities rather than taught as a separate abstract topic only. This supports the methodological decision to combine technical, linguistic, academic, and ethical aspects of AI literacy within the ESP course.

## 6.6 Self-Assessed Competence in Using AI Tools before the ESP Intervention

The final closed question in the pre-intervention questionnaire focused on students' self-assessed competence in using different types of AI tools. While the previous sections examined students' experience, knowledge, attitudes, ethical awareness, and educational expectations, this section provides a more specific picture of how competent students felt when working with particular AI applications before the ESP intervention.

This section is directly connected with **RO1** and **RQ1**, as it identifies students' initial self-perceived AI competence before the ESP intervention. At the same time, it provides the pre-intervention baseline for **RO2** and **RQ2**, which examine the development of students' self-perceived AI-related skills after the AI-focused ESP activities. The results are also relevant to **H1**, which assumes that students will report higher self-perceived AI-related skills after the intervention. However, at this stage of the analysis, the data are interpreted only as baseline findings; the hypothesis can be evaluated only after comparison with the post-intervention questionnaire.

Students were asked to evaluate their current competence on a five-point scale, where **1** meant not competent at all and **5** meant very competent. The evaluated areas included chatbots, presentation tools, image and video generators, writing and proofreading tools, source search and processing tools, and AI tools used in technical or programming tasks.

The highest self-assessed competence was reported in relation to chatbots, such as ChatGPT, Gemini, and Copilot. The mean score for this category was **4.00**, which indicates a relatively high level of perceived competence. More specifically, 49.3% of respondents selected rating 4 and 29.3% selected rating 5. This means that 78.6% of students rated their competence in using chatbots as high or very high. This result corresponds with the previous finding that ChatGPT was the most frequently mentioned AI tool before the intervention.

The second strongest area was AI use in technical or programming tasks, such as ChatGPT for coding or GitHub Copilot. The mean score for this category was **3.45**. In total, 33.3% of respondents selected rating 4 and 25.3% selected rating 5, which means that 58.6% of students evaluated their competence in this area positively. This finding is consistent with the technical orientation of the research sample, especially the high proportion of students from programmes related to applied informatics, automation, manufacturing technologies, and technical problem-solving.

In contrast, students reported considerably lower competence in the remaining categories. Presentation tools, such as Canva Magic Write and Gamma, reached a mean score of **2.36**. Only 14.7% of respondents selected rating 4 or 5, while 58.7% selected rating 1 or 2. This suggests that although some students had already used presentation-related AI tools, they did not feel broadly competent in this area before the intervention.

A similar result was found for AI tools used for writing and proofreading, such as Grammarly, Quillbot, or WordTune. This category also reached a mean score of **2.36**. Only 21.3% of students selected rating 4 or 5, while 57.3% selected rating 1 or 2. This finding is important for ESP instruction because writing, correction, reformulation, and improvement of academic or professional texts are directly connected with language learning and specialised communication.

The lowest self-assessed competence was reported in relation to AI tools for searching and processing sources, such as Perplexity, Elicit, and Consensus. The mean score for this category was **2.12**. Only 12% of respondents rated their competence as high or very high, while 66.7% selected rating 1 or 2. This result is particularly significant because the previous section showed that 80% of students wanted to learn how to search for scientific sources using AI. The contrast between high educational interest and low self-assessed competence strongly supports the inclusion of AI-supported academic source work in the ESP intervention.

Image and video generators, such as DALL·E, Ideogram, Runway, and Pika Labs, also received a low mean score of **2.20**. Only 13.3% of respondents selected rating 4 or 5, while 58.7% selected rating 1 or 2. This suggests that before the intervention, students were much less familiar with multimodal and visual AI tools than with text-based chatbots.

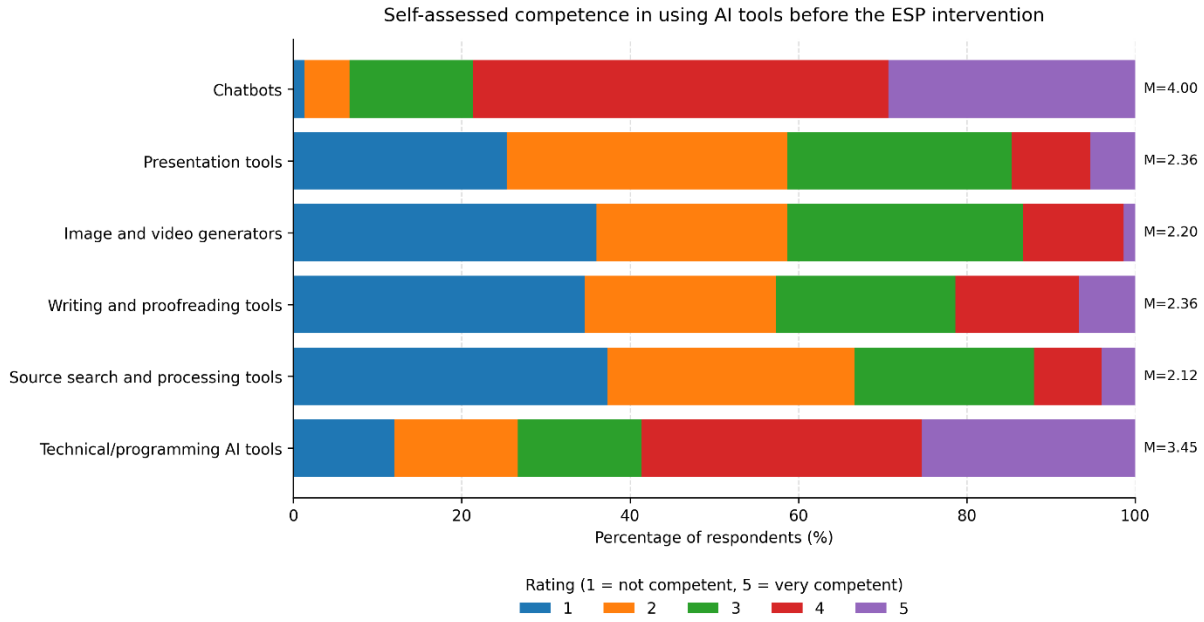



Figure 15: Self-assessed competence in using AI tools before the ESP intervention
*Source: Author's own elaboration based on the obtained data. Visual design prepared with AI assistance; content checked and edited by the author.*

The results of this section, as seen in the Figure 15, reveal a clear imbalance in students' self-assessed AI competence before the intervention. Students felt most competent when using chatbots and, to a lesser extent, AI tools for technical or programming tasks. However, their perceived competence was much lower in areas connected with academic source searching, presentation preparation, visual-content creation, and language-support tools for writing and proofreading. This confirms that students' initial AI literacy was largely tool-specific and uneven. The results therefore support the need for structured ESP-based AI training that broadens students' competence beyond general chatbot use and connects AI more directly with academic, linguistic, technical, and ethical learning tasks.

## 6.7 Students' Initial Perception of AI: Opportunity, Threat or Neutral Tool

The final part of the pre-intervention analysis focused on students' qualitative responses to the open-ended question: "How do you perceive artificial intelligence – rather as an opportunity, a threat, or a neutral tool? Why?" Unlike the previous closed questions, this item allowed respondents to formulate their views in their own words. For this reason, the responses were analysed thematically and used to complement the quantitative findings related to students' initial AI literacy, attitudes and ethical awareness before the ESP intervention.

This question is particularly relevant to **RO1** and **RQ1**, as it provides qualitative insight into students' initial AI literacy, attitudes and ethical awareness before the intervention. At the same time, the responses indirectly support the interpretation of **RO4/RQ4/H3**, which focus on ethical awareness, and **RO5/RQ5/H4**, which concern students' attitudes towards AI. However, since Question 13 is an open-ended qualitative item, it is not used for direct statistical

hypothesis testing. Instead, it provides interpretative evidence that helps explain students' initial perceptions of AI before the AI-enhanced ESP activities.

This question is methodologically important because it belongs to the qualitative component of the mixed-methods research design. While the previous sections provided measurable data in the form of frequencies, percentages and mean values, this open-ended question offered deeper insight into how students interpreted the role of AI in education, everyday life and future professional contexts. The responses were coded into five main categories: AI as a neutral tool, AI as an opportunity, AI as both opportunity and threat, AI as a threat, and unclear responses.

The largest group of respondents perceived AI primarily as a neutral tool. This category included 28 responses, representing 37.3% of the sample. Students in this group usually emphasised that AI itself is neither good nor bad, but that its value depends on how it is used. Several responses described AI as a tool, assistant or helper whose impact depends on the user, the purpose of use and the level of responsibility. This finding is important because it shows that many students did not approach AI in a one-sided way. Instead, they understood AI as a technological instrument that can support learning, but also requires responsible human decision-making.

The second largest category consisted of students who perceived AI mainly as an opportunity. This group included 26 responses, representing 34.7% of the sample. Students in this category highlighted the benefits of AI, especially faster access to information, support in learning, increased productivity, easier problem-solving, and the possibility of self-development. AI was often described as a useful helper that can save time, simplify routine tasks, support studying, explain difficult content, or provide new ideas. These responses correspond with the quantitative findings showing that most students considered AI beneficial for their studies and were interested in learning how to use AI tools more effectively.

A third group of responses expressed an ambivalent or conditional perception of AI. This category included 17 responses, representing 22.7% of the sample. These students recognised the usefulness of AI, but at the same time explicitly mentioned possible risks. Their answers often contained formulations such as AI can be both useful and dangerous, it depends on how it is used, or it is an opportunity only if it is used responsibly. The most frequent concerns in this category were loss of critical thinking, over-reliance on AI, misuse in education, manipulation, misinformation, and the need for regulation. These responses are particularly relevant because they show that some students already demonstrated a developing ethical awareness before the intervention.

Only three respondents, representing 4% of the sample, perceived AI primarily as a threat. These answers referred mainly to the possible replacement of human work, future danger, misuse, or harmful social consequences. Although this group was small, it is important for interpretation because it confirms that negative perceptions of AI were present, but not dominant. One response was coded as unclear because it did not provide sufficient interpretable content.

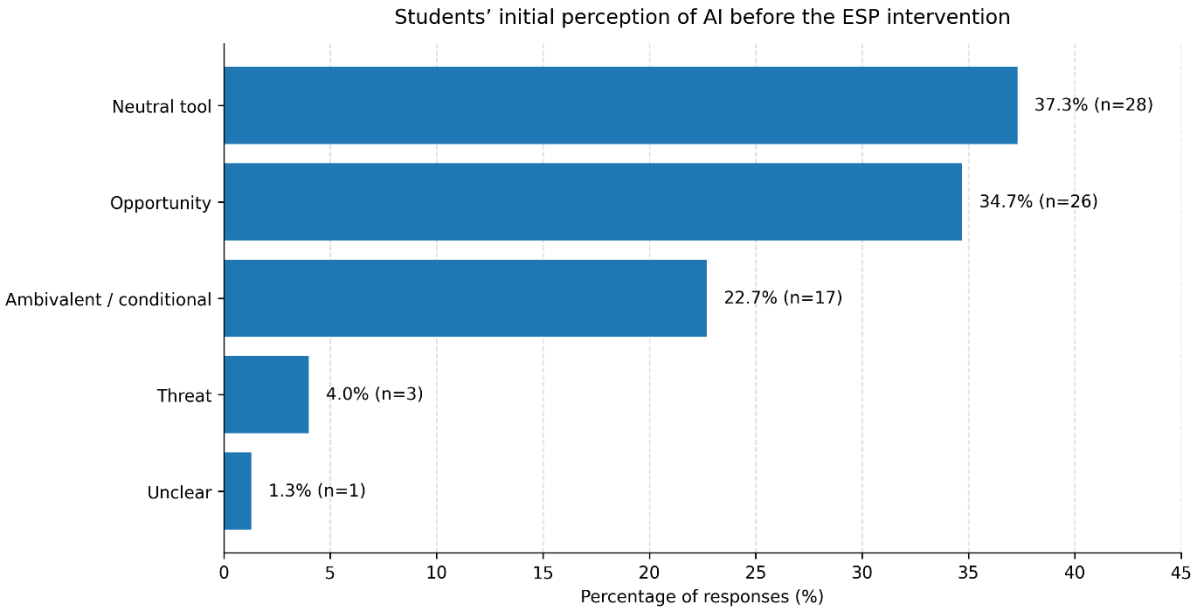



Figure 16: Students' initial perception of AI before the ESP intervention
*Source: Author's own elaboration based on the obtained data. Visual design prepared with AI assistance; content checked and edited by the author.*

The qualitative findings in the Figure 16 show that students' initial perception of AI was generally pragmatic rather than extreme. Most respondents did not reject AI. They either viewed it as a useful opportunity or as a neutral tool whose value depends on human use. At the same time, a considerable number of students recognised risks connected with uncritical use, dependence, loss of critical thinking, misuse and lack of regulation. This confirms that students entered the ESP intervention with a relatively balanced but still developing understanding of AI.

These findings contribute mainly to answering RQ1, as they provide qualitative evidence of students' initial AI literacy, attitudes and ethical awareness before the instructional intervention. They also support the interpretation of RQ4 and RQ5, because students' responses show early awareness of ethical issues and reveal their initial attitudes towards AI. However, the responses should not be treated as statistical hypothesis testing. Instead, they provide interpretative support for later discussion of changes in ethical awareness and attitudes after the AI-enhanced ESP activities.

In summary, the analysis of Question 13 confirms the relevance of including AI literacy in ESP instruction. Students were already familiar with AI and generally open to its use, but their responses also showed uncertainty, caution and concern. Therefore, the intervention needed to focus not only on how to use AI tools, but also on how to use them critically, responsibly and meaningfully in academic and professional communication.

## 6.8 Intended Uses of AI in Students' Studies before the ESP Intervention

The last open-ended question in the pre-intervention questionnaire asked students what they would specifically like to use AI for in their studies. This question complemented the previous qualitative item by shifting attention from students' general perception of AI to their concrete

study-related expectations and intended uses. As with Question 13, the responses were analysed thematically, because students formulated their answers in their own words and often mentioned more than one possible use of AI.

This question is connected mainly with **RO1** and **RQ1**, as it helps identify students' initial AI-related needs, expectations and study practices before the intervention. It is also relevant to **RO3** and **RQ3**, because it provides baseline information about the purposes for which students expected or intended to use AI before the AI-enhanced ESP activities. Indirectly, the findings also support the interpretation of **RO2** and **RQ2**, as they help explain why the intervention focused on prompt formulation, AI-supported source searching, text work, presentations, and technical or programming-related uses of AI. Since the question is qualitative, it is not used for direct hypothesis testing. However, it provides interpretative support for later discussion of changes in students' AI-related skills and purposes of use after the intervention.

The analysis identified several recurring categories. Since many students mentioned more than one intended use of AI, the coding was carried out as multi-response thematic coding. This means that one response could be assigned to more than one category, for example when a student mentioned both searching for information and correcting a text. Therefore, the percentages in Figure 13 do not add up to 100%.

The most frequent category was **information and source searching**, mentioned by 25 respondents, representing 33.3% of the sample. Students wanted to use AI to search for information, find sources, work with study literature, search in scripts, locate documents, or verify information. This finding is consistent with the earlier quantitative results, where searching for information and sources was already one of the most common purposes of AI use before the intervention. It also supports the relevance of including AI-supported academic source retrieval and critical verification of information in the ESP course.

The second major area was **learning, explanation and study support**, mentioned by 19 respondents, or 25.3% of the sample. Students wanted to use AI to explain difficult topics, simplify terminology, prepare notes, support exam preparation, create questions for self-testing, or provide tutoring-like support. These responses show that students perceived AI not only as a tool for completing assignments, but also as a possible learning assistant. In the ESP context, this is particularly relevant because students may use AI to understand specialised terminology, technical texts and complex study materials.

The same number of responses, 19 respondents or 25.3%, referred to **writing, text correction and translation**. This category included text improvement, grammar correction, stylistic editing, translation, reformulation, and support in writing longer academic texts. This finding is important for ESP instruction because writing, reformulating and improving academic or professional texts are directly connected with language development. At the same time, this category also requires ethical guidance, especially when students use AI for seminar papers, reports or final theses.

A closely related category was **programming, technical tasks and calculations**, mentioned by 18 respondents, representing 24% of the sample. Students referred to coding, debugging,

code review, programming practice, technical problem-solving, mathematical or physical calculations, and PLC programming. This result reflects the technical orientation of the research sample and confirms that students saw AI as useful not only for language-related tasks, but also for their disciplinary and professional development.

Another category included **assignments, projects, theses and protocols**, mentioned by 11 respondents, or 14.7% of the sample. Students referred to help with school assignments, seminar papers, bachelor theses, protocols, or longer study-related tasks. This category is methodologically important because it shows a potential area of tension between legitimate support and academic misconduct. The responses therefore support the need to discuss boundaries between AI as assistance and AI as replacement of students' own academic work.

The same number of respondents, 11 students or 14.7%, mentioned **presentations, visuals or image generation**. Their answers referred to presentation creation, visual content, presentation ideas, images, and graphic materials. This finding corresponds with the ESP course content, where students often work with presentations, visual information and professional communication. It also supports the inclusion of AI tools such as Canva, Gamma or image-generation tools in the intervention, although earlier findings showed that students' self-assessed competence in these tools was relatively low.

A smaller group of students mentioned **ideas, creativity or inspiration**. This category included 7 responses, representing 9.3% of the sample. Students wanted to use AI to generate ideas, support creativity, or receive inspiration for tasks and presentations. Although this was not one of the dominant categories, it shows that some students perceived AI as a tool for ideation rather than only for information retrieval or text production.

Four respondents, representing 5.3% of the sample, were coded as **no clear intention, uncertainty or resistance**. These responses included uncertainty, lack of interest, avoidance of AI in academic work, or the opinion that AI should not be part of serious education. Although this category was small, it confirms that not all students entered the intervention with the same level of openness towards AI-supported learning.

Two less frequent categories were also identified. Three respondents mentioned **automation, organisation or routine-task support**, for example processing tables, organising work or simplifying repetitive tasks. Another three respondents gave broad answers suggesting that AI could be used for almost everything. These answers indicate that some students perceived AI in a very general way, without specifying a clearly defined academic purpose.

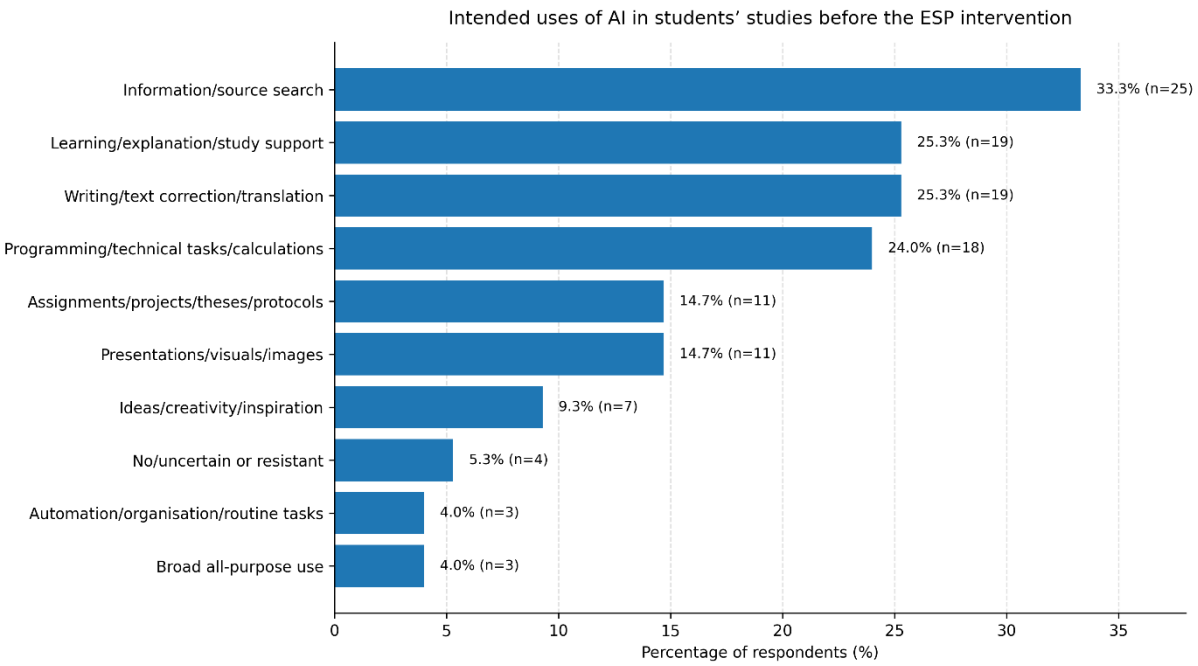



Figure 17: Intended uses of AI in students' studies before the ESP intervention
*Source: Author's own elaboration based on the obtained data. Visual design prepared with AI assistance; content checked and edited by the author.*

These results above indicate that students' expected uses of AI were strongly practical and study-oriented. The dominant areas were information searching, learning support, writing and correction, and programming or technical tasks. These findings correspond closely with the profile of technical university students enrolled in ESP courses. They also justify the design of the AI-enhanced ESP intervention, which focused on the effective use of chatbots, prompt formulation, academic source searching, presentation preparation, language support, and responsible use of AI in study-related contexts.

At the same time, the findings show that students' intended uses of AI were not limited to simple productivity. Several responses indicated that students wanted AI to help them understand difficult content, organise study materials, improve texts, verify information, or develop technical skills. This supports the view that AI literacy in ESP should not be reduced to tool use only. It should include the ability to formulate appropriate prompts, evaluate AI outputs, distinguish between support and replacement of one's own work, and apply AI meaningfully in academic and professional communication.

# 7 Analysis of the Post-Intervention Questionnaire Findings

After analysing the data collected before the AI-enhanced ESP intervention, the following chapter presents the findings from the second questionnaire, which was administered after students had completed the AI-focused educational activities integrated into their ESP course. While the first questionnaire examined students' initial experience, knowledge, attitudes, ethical awareness, educational needs and self-assessed competence, the post-intervention questionnaire focused on students' perceptions and practices after the training.

The aim of this part of the analysis is to identify whether and how students' use of AI tools, self-perceived AI-related skills, ethical awareness and attitudes developed after the instructional intervention. The findings are analysed in relation to the relevant research objectives, research questions and hypotheses, particularly those concerned with changes in AI use, perceived competence, responsible AI use and students' attitudes towards AI in academic and ESP-related contexts. The results presented in this chapter also create the basis for the following comparative chapter, where pre- and post-intervention findings will be evaluated together.

## 7.1 Frequency of AI Use after the ESP Intervention

The first section of the post-intervention questionnaire focused on students' frequency of AI use after completing the AI-enhanced ESP activities. This section is directly connected with **RO3** and **RQ3**, as it examines how students used AI tools after the completion of ESP-based AI training. It is also relevant to **H2**, which assumes that the frequency of AI tool usage increases after the instructional intervention. However, the full evaluation of H2 requires comparison with the pre-intervention questionnaire; therefore, the present subchapter first analyses the post-intervention findings separately.

The results show that AI use remained a regular part of students' study-related practices after the ESP intervention. Altogether, 28% of respondents reported using AI tools daily, while 44% used them several times a week. This means that 72% of students used AI tools at least several times a week after completing the ESP activities. A further 21.3% used AI several times a month, and only 6.7% reported rare use. No respondent selected the option "never".

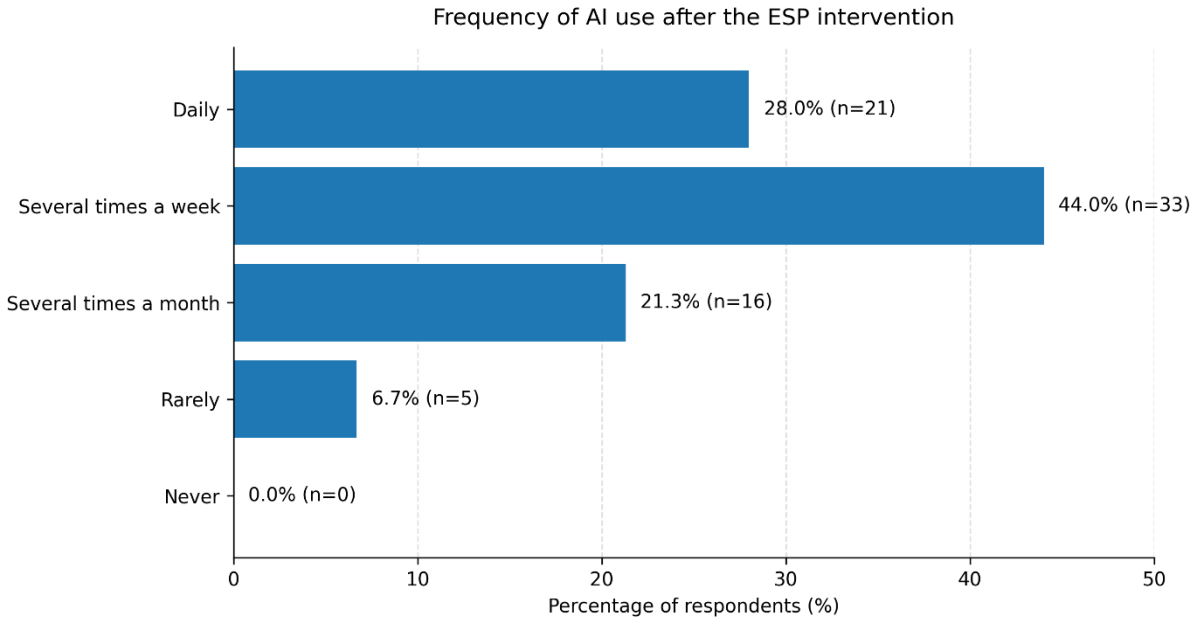



Figure 18: Frequency of AI use after the ESP intervention

*Source: Author's own elaboration based on the obtained data. Visual design prepared with AI assistance; content checked and edited by the author.*

These findings in the Figure 18 indicate that AI tools were not perceived as isolated or one-time classroom tools. Instead, students continued to use them beyond the specific instructional activities. The fact that no respondent reported never using AI after the intervention suggests that AI had become part of the students' academic or study-related environment. This is important because the purpose of the intervention was not only to introduce selected AI tools, but also to support their more purposeful, critical and academically relevant use.

The post-intervention questionnaire also examined how frequently students used AI for specific types of activities. The results show that the most frequent activity was work with chatbots, such as using AI for explanation, text suggestions or other forms of support. In this category, 40% of respondents reported using chatbots often, and 26.7% used them very often. Together, this means that 66.7% of students used chatbots often or very often after the intervention. This finding confirms the central role of chatbot-based tools in students' AI practices and corresponds with the intervention focus on prompt formulation and effective communication with AI tools.

The use of AI for editing and optimising texts also appeared as a relevant post-intervention activity. In this category, 20% of respondents reported using AI often, and 13.3% used it very often. This means that 33.3% of students used AI for text-related work often or very often. At the same time, 30.7% selected "sometimes", which indicates that text-related AI support was present among a broader group of students, even if not always used intensively. In the ESP context, this is important because text editing, reformulation and improvement of academic or professional language are directly connected with the development of specialised communication skills.

AI-supported presentation creation was used less frequently than chatbots, but it still represented a visible area of application. In total, 20% of respondents used AI for creating presentations often, and 8% used it very often. This means that 28% of students used AI for presentation creation often or very often after the intervention. A further 33.3% selected "sometimes". These findings suggest that presentation tools were relevant for many students, but they were not adopted as strongly as chatbot-based tools. This may be because students perceive chatbots as more flexible and more immediately useful across different study tasks.

The use of AI for searching academic sources was more moderate. In this category, 12% of respondents used AI often, while no respondent selected "very often". A relatively large group selected "sometimes" (34.7%) or "rarely" (37.3%), and 16% reported that they never used AI for this purpose. This finding is important because the pre-intervention questionnaire showed strong interest in learning how to search for scientific sources with AI, but students may still need further support in using specialised tools for academic source retrieval confidently and responsibly. The result also suggests that source searching is more demanding than general chatbot use because it requires evaluation of reliability, relevance and academic quality.

The least frequent activity was AI-supported video creation, for example with tools such as Vidnoz. More than half of the respondents, 50.7%, reported that they never used AI for video creation after the intervention, and 30.7% used it rarely. Only 2.7% used it often and 1.3% very often. This result is not surprising because video creation is a more specific task and may not be needed as frequently as chatbots, text optimisation or presentation preparation. However, its inclusion in the intervention still had pedagogical value because it introduced students to multimodal AI-supported communication.

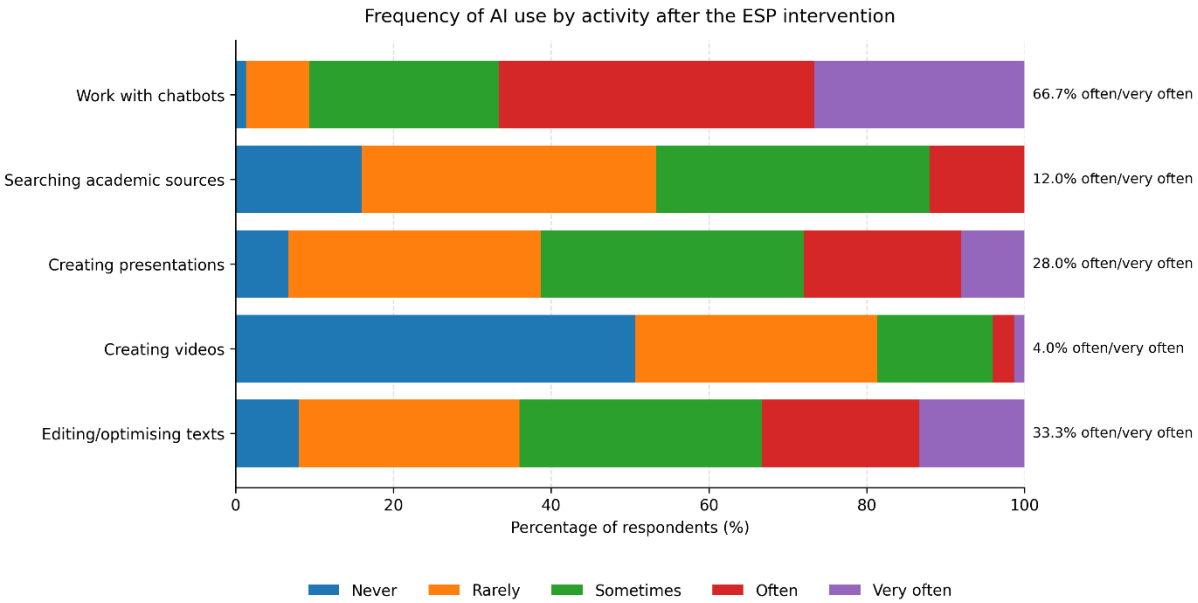



Figure 19: Frequency of AI use by activity after the ESP intervention
*Source: Author's own elaboration based on the obtained data. Visual design prepared with AI assistance; content checked and edited by the author.*

Overall, the findings above show that students used AI regularly after completing the ESP intervention, with chatbots clearly remaining the dominant tool type. The results suggest that the intervention supported students' continued engagement with AI, particularly in areas connected with explanation, text work and study support. At the same time, the findings also show that not all AI-related activities were used equally. Students appeared to prefer flexible and broadly applicable tools, especially chatbots, while more specialised applications, such as academic source searching or video creation, were used less frequently.

These post-intervention findings provide the basis for the later comparison with the pre-intervention data. Such comparison will make it possible to evaluate whether the frequency and purposes of AI use changed after the ESP intervention and whether the results support **H2**. At this stage, the findings indicate that AI use after the intervention was frequent and study-oriented, but the strength of change must be interpreted in relation to the baseline data from the first questionnaire.

## 7.2 Development of Self-Perceived AI-Related Skills after the ESP Intervention

The next section of the post-intervention questionnaire examined how students perceived the development of their AI-related skills after completing the AI-enhanced ESP activities. This subchapter is directly connected with **RO2** and **RQ2**, as it focuses on the development of students' self-perceived AI competence after structured AI-focused ESP instruction. It is also relevant to **H1**, which assumes that students will report higher self-perceived AI-related skills after the intervention. However, the final evaluation of H1 requires comparison with the pre-intervention questionnaire; therefore, this section first presents the post-intervention findings separately.

Students were asked to evaluate how their skills changed in five areas: working with chatbots, using AI tools for obtaining sources, using presentation tools, creating videos with AI, and effective prompting. The response options ranged from "significantly worsened" to "significantly improved". The findings show that students most frequently reported improvement in presentation tools, chatbots and effective prompting.

The strongest perceived development was identified in relation to AI-supported presentation tools, such as Canva and Gamma. In this category, 32% of respondents stated that their skills improved, and another 32% reported that their skills significantly improved. Together, this means that 64% of students perceived improvement in this area. This is an important finding because the pre-intervention questionnaire showed relatively low self-assessed competence in presentation tools. The post-intervention results therefore suggest that the ESP activities helped students become more familiar with AI-supported presentation preparation.

A similarly positive result was found in relation to working with chatbots. Altogether, 68% of respondents reported improvement in this area, with 49.3% stating that their skills improved and 18.7% stating that they significantly improved. This finding confirms the central role of chatbot-based tools in the intervention. Since students had already used tools such as ChatGPT before the training, the intervention did not introduce chatbots as completely new tools. Rather,

it appears to have supported more purposeful and effective use, especially in relation to explanation, text suggestions, language support and academic communication.

The ability to prompt effectively also showed a clear positive shift. In total, 61.3% of respondents reported improvement, with 40% stating that their prompting skills improved and 21.3% stating that they significantly improved. This result is particularly relevant because prompt formulation was one of the key components of the AI-enhanced ESP activities. The finding suggests that students became more aware of how to communicate with AI tools more precisely and intentionally.

Students also reported improvement in the use of AI tools for obtaining sources. In this category, 34.7% of respondents stated that their skills improved, and 21.3% reported that they significantly improved. Together, this represents 56% of the sample. At the same time, 38.7% reported no change. This result suggests that although source-related AI tools were included in the intervention, this area may remain more demanding for students than general chatbot use or presentation preparation. Academic source retrieval requires not only technical tool use, but also critical evaluation of relevance, reliability and scholarly value.

AI-supported video creation showed the lowest level of perceived improvement. In total, 50.7% of respondents reported improvement or significant improvement, while 37.3% reported no change. This result is understandable because video creation is a more specialised activity and may not be used as frequently in students' regular academic work. Nevertheless, half of the respondents perceived some development, which indicates that the intervention introduced students to a broader range of AI-supported multimodal tools.

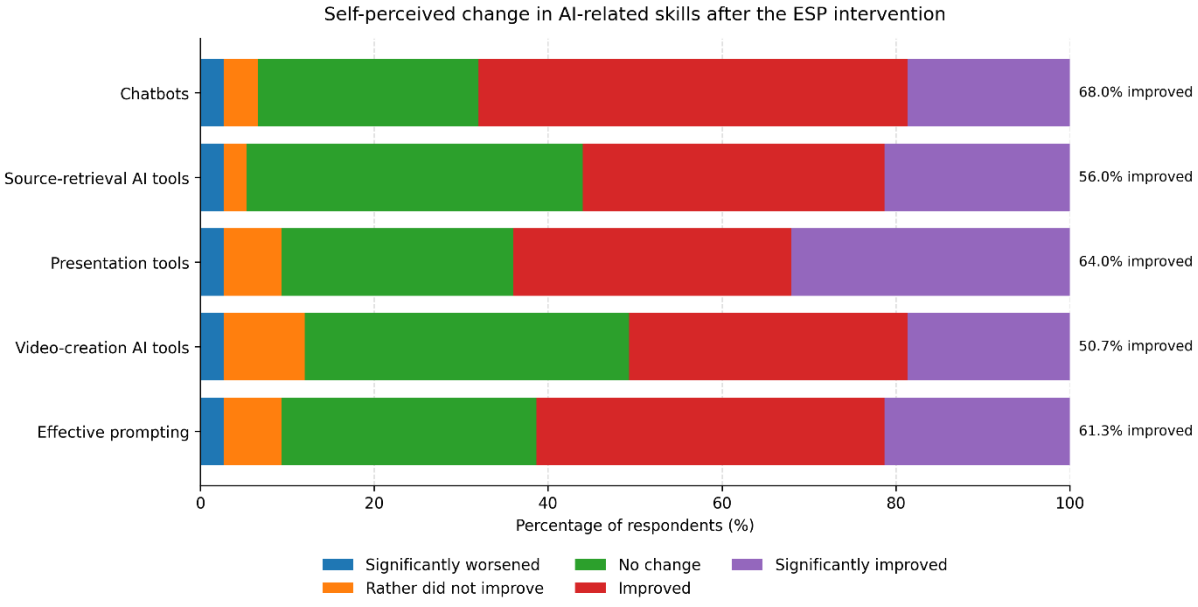



Figure 20: Self-perceived change in AI-related skills after the ESP intervention
*Source: Author's own elaboration based on the obtained data. Visual design prepared with AI assistance; content checked and edited by the author.*

This section has shown that the findings in the Figure 20 show that students perceived development across all five AI-related skill areas after the ESP intervention. The strongest improvements were reported in chatbot use, presentation tools and effective prompting. More moderate, but still positive, development was reported in source-retrieval tools and AI-supported video creation. These results suggest that the intervention broadened students' AI-related competences beyond their initial spontaneous use of AI tools and helped them apply AI more purposefully in academic and ESP-related tasks.

At this stage, the findings provide post-intervention evidence that students perceived their AI-related skills as improved. However, the final interpretation of **H1** requires comparison with the pre-intervention baseline, especially the earlier self-assessment of competence in different AI tool categories. Therefore, the results presented in this subchapter will be further discussed in the comparative chapter, where pre- and post-intervention findings are evaluated together.

## 7.3 Post-Intervention AI-Related Competences in Academic and ESP Tasks

After examining students' perceived development of AI-related skills, the following section focuses on their specific AI-related competences after completing the AI-enhanced ESP intervention. While the previous subchapter analysed whether students felt their skills had improved, this section examines how students evaluated their ability to apply AI in selected academic and ESP-related tasks after the intervention.

This subchapter is directly connected with **RO2** and **RQ2**, as it examines students' self-perceived AI competence after structured AI-enhanced ESP instruction. It is also relevant to **H1**, which assumes that students will report higher self-perceived AI-related skills after the intervention. In addition, the item focused on critical evaluation of AI outputs is connected with **RO4** and **RQ4**, as it reflects students' responsible and critical engagement with AI-generated content. As in the previous subchapter, the final evaluation of H1 requires comparison with the pre-intervention questionnaire; therefore, the present section analyses the post-intervention data as a separate stage of the findings.

The questionnaire included five statements related to students' ability to formulate prompts effectively, use AI to obtain relevant academic or professional sources, create professional presentations with AI support, critically evaluate AI outputs, and combine several AI tools in one task. The results show that students evaluated their post-intervention competences positively in all five areas.

The strongest result was recorded in relation to students' ability to combine several AI tools in one task. Altogether, 77.3% of respondents agreed with this statement, with 40% rather agreeing and 37.3% completely agreeing. This finding suggests that the intervention helped students understand AI use as a broader workflow rather than as isolated use of a single tool. This is important in ESP instruction because students may need to combine different tools when preparing presentations, searching for information, editing texts or creating multimodal outputs.

A similarly strong result was found in relation to effective prompt formulation. In total, 76% of respondents agreed that they could formulate prompts purposefully and effectively. More specifically, 57.3% rather agreed and 18.7% completely agreed. This confirms the importance

of prompt formulation as one of the central skills developed during the intervention. Since prompt quality directly influences the quality and relevance of AI-generated outputs, this competence is particularly important for academic and professional communication.

The ability to critically evaluate the quality of AI outputs was also evaluated positively. Altogether, 76% of respondents agreed with this statement, with 52% rather agreeing and 24% completely agreeing. This finding is significant because it shows that students did not perceive AI use only as a technical or productivity-related activity. They also recognised the need to assess AI-generated outputs critically. This competence is essential for responsible academic use of AI, especially when students use AI for text suggestions, explanations, source-related work or presentation preparation.

The statement concerning the use of AI to obtain relevant professional or academic sources was supported by 73.3% of respondents. Specifically, 60% rather agreed and 13.3% completely agreed. This result suggests that most students felt able to use AI for source-related work after the intervention. However, the relatively lower percentage of "completely agree" responses indicates that this competence may still require further development. This is consistent with the previous finding that academic source searching was used less frequently than chatbot work after the intervention.

The lowest, although still positive, level of agreement was found in relation to creating professional presentations with AI support. Altogether, 69.3% of respondents agreed with this statement, with 41.3% rather agreeing and 28% completely agreeing. Although this was the lowest agreement level among the five statements, it still shows that more than two thirds of students felt capable of preparing presentations with AI support after the training. This result is important because presentation preparation was one of the practical ESP-related activities included in the intervention.

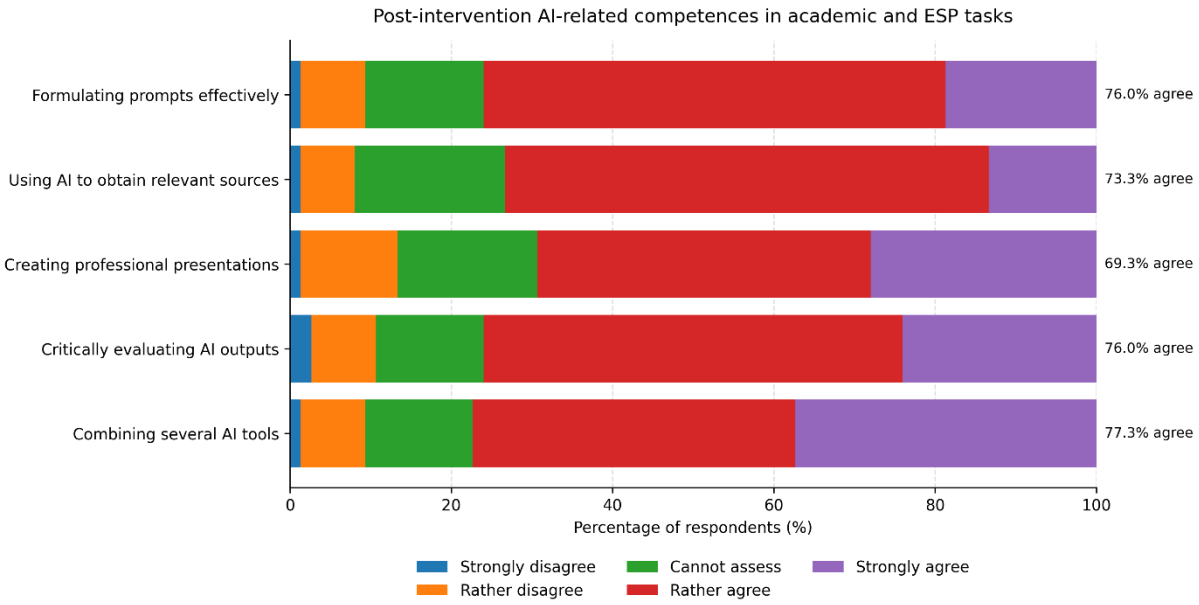



Figure 21: Post-intervention AI-related competences in academic and ESP tasks
*Source: Author's own elaboration based on the obtained data. Visual design prepared with AI assistance; content checked and edited by the author.*

Taken together, the findings above indicate that students perceived themselves as competent in several AI-related academic and ESP tasks after the intervention. The strongest areas were combining multiple AI tools, formulating prompts effectively and critically evaluating AI outputs. These results suggest that the intervention supported not only instrumental tool use, but also more complex AI-related practices that require planning, evaluation and purposeful application. At the same time, source-related work and professional presentation creation, although evaluated positively, may require continued practice in future ESP instruction.

These findings support the relevance of integrating AI literacy into ESP courses at technical universities. They show that AI-enhanced ESP instruction can help students move beyond basic exposure to AI tools towards more structured, academically oriented and critically aware use of AI in study-related tasks.

## 7.4 Ethical Awareness and Responsible AI Use after the ESP Intervention

The following section of the post-intervention questionnaire focused on students' ethical awareness and responsible use of AI after completing the AI-enhanced ESP activities. This subchapter is directly connected with **RO4** and **RQ4**, as it examines whether students demonstrated awareness of ethical boundaries, academic integrity and responsible AI use after the intervention. It is also relevant to **H3**, which assumes that students' ethical awareness improves after the AI-focused ESP instruction. However, the final evaluation of H3 requires comparison with the pre-intervention findings; therefore, this section first presents the post-intervention results separately.

The questionnaire included four statements related to understanding the ethical boundaries of AI use in the academic environment, distinguishing between acceptable and unacceptable AI use in study, transparent acknowledgement of AI use, and perceiving AI as a support tool rather than a replacement for students' own thinking. The findings show a high level of agreement across all four areas, suggesting that students developed or maintained a strong awareness of responsible AI use after the ESP intervention.

The strongest result was recorded in relation to the statement that AI should be perceived as a support tool rather than a replacement for students' own thinking. Altogether, 88% of respondents agreed with this statement, with 38.7% rather agreeing and 49.3% completely agreeing. This result is particularly important because it reflects one of the central ethical principles addressed during the intervention: AI can support learning, writing, searching, presentation preparation or technical problem-solving, but it should not replace students' independent reasoning and academic responsibility.

A similarly strong result was found in relation to students' ability to distinguish acceptable and unacceptable use of AI in their studies. In total, 85.3% of respondents agreed with this statement. More specifically, 57.3% rather agreed and 28% completely agreed. This suggests that most students felt able to recognise the boundary between legitimate AI-supported learning and inappropriate use of AI that could conflict with academic integrity. This competence is essential in higher education, especially when students use AI for assignments, seminar papers, presentations or future bachelor theses.

The need to acknowledge AI use transparently was also recognised by a substantial majority of students. Altogether, 78.7% of respondents agreed that they were aware of the need to state the use of AI transparently. In this category, 45.3% rather agreed and 33.3% completely agreed. Although this result is positive, 14.7% of students selected the neutral option and 6.7% rather disagreed. This indicates that transparent acknowledgement of AI use remains an area where continued guidance may still be necessary, particularly in relation to academic writing and final thesis preparation.

The statement concerning understanding the ethical boundaries of AI use in the academic environment was supported by 76% of respondents. Specifically, 36% rather agreed and 40% completely agreed. At the same time, 16% were unable to assess this statement and 8% disagreed. This suggests that although most students reported understanding ethical boundaries, some uncertainty remained. This is understandable because institutional rules on AI use are still developing and students may need more explicit examples of what is permitted, what must be acknowledged, and what constitutes misuse.

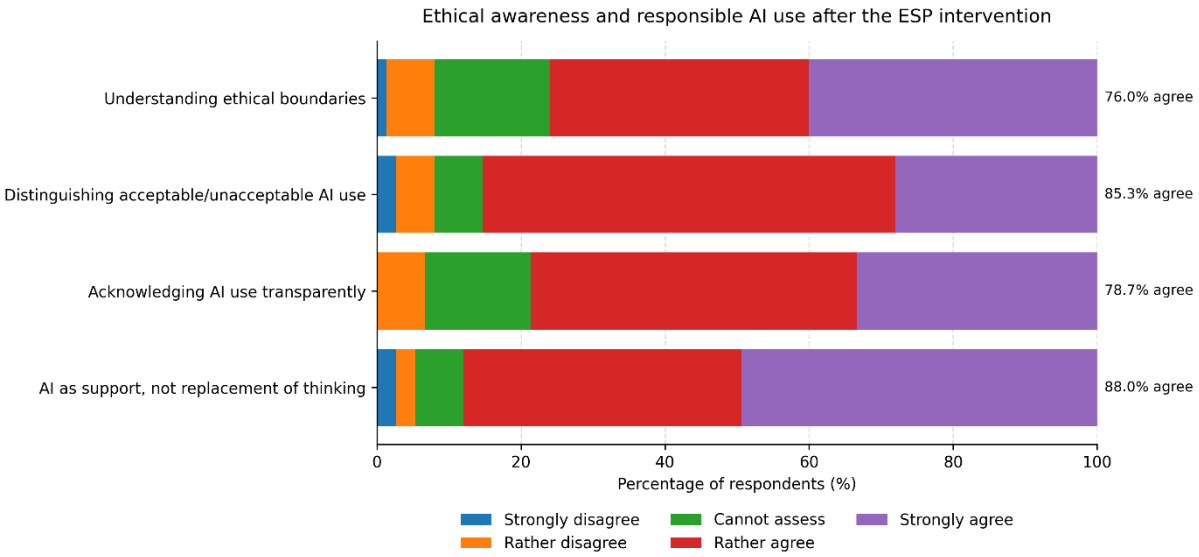



Figure 22: Ethical awareness and responsible AI use after the ESP intervention
*Source: Author's own elaboration based on the obtained data. Visual design prepared with AI assistance; content checked and edited by the author.*

Overall, the findings above indicate that students demonstrated a relatively strong level of ethical awareness after the ESP intervention. Most respondents understood AI as a support tool rather than a replacement for their own thinking, felt able to distinguish acceptable and unacceptable uses of AI, and recognised the need for transparency when AI is used in academic work. These findings suggest that ethical issues should not be treated as an optional addition to AI training, but as a core part of AI literacy in ESP education.

At the same time, the results also show that some uncertainty remained, especially in relation to ethical boundaries and transparent acknowledgement of AI use. This means that future ESP instruction should continue to include practical examples, model situations and clear classroom-level guidance on responsible AI use. The findings presented in this subchapter will be

compared with pre-intervention data in the following comparative chapter in order to evaluate the extent to which they support **H3**.

## 7.5 Students' Attitudes towards AI after the ESP Intervention

The following section analyses students' attitudes towards AI after completing the AI-enhanced ESP intervention. While the previous subchapters focused on frequency of use, skill development, specific competences and ethical awareness, this section examines whether students perceived AI as useful, effective and manageable in their academic work after the training.

This subchapter is directly connected with **RO5** and **RQ5**, as it examines students' attitudes towards AI after the AI-enhanced ESP course. It is also relevant to **H4**, which assumes that students' attitudes towards AI become more positive after the intervention. However, as in the previous sections, the final evaluation of H4 requires comparison with the pre-intervention data. Therefore, the present subchapter first interprets the post-intervention findings separately.

The questionnaire included four statements focused on students' confidence in using AI, their perception of AI as a beneficial study tool, its contribution to more efficient work, and their ability to consider both the benefits and risks of AI. The results show that students' post-intervention attitudes were generally positive, but not uncritical.

The strongest agreement was recorded in relation to AI-supported efficiency. Altogether, 81.3% of respondents agreed that AI helped them work more efficiently, with 40% rather agreeing and 41.3% completely agreeing. Only 6.7% rather disagreed, while 12% were unable to assess the statement. This finding suggests that students perceived AI primarily as a practical tool that can support productivity and reduce time spent on selected academic tasks.

A similarly high level of agreement was found in relation to AI as a beneficial tool for study. In total, 78.7% of respondents agreed with this statement, with 45.3% rather agreeing and 33.3% completely agreeing. This result indicates that most students viewed AI positively after the ESP intervention and recognised its potential value in the academic environment. At the same time, the presence of neutral and rather negative responses shows that students did not respond uniformly and that some uncertainty remained.

Students also expressed a strong ability to consider both the benefits and risks of AI. Altogether, 78.7% of respondents agreed that they could take into account both the positive and negative aspects of AI use. More specifically, 48% rather agreed and 30.7% completely agreed. This result is important because it indicates that students' attitudes were not based only on enthusiasm for AI tools. Instead, many students appeared to recognise that AI use involves both opportunities and limitations.

The lowest level of agreement, although still positive, was recorded in relation to students' confidence when using AI compared with the period before the intervention. In total, 70.7% of respondents agreed that they felt more confident using AI than before, with 53.3% rather agreeing and 17.3% completely agreeing. However, 22.7% were unable to assess this statement,

and 6.7% disagreed. This suggests that the intervention supported students' confidence, but confidence may develop more gradually than practical awareness of usefulness or efficiency.

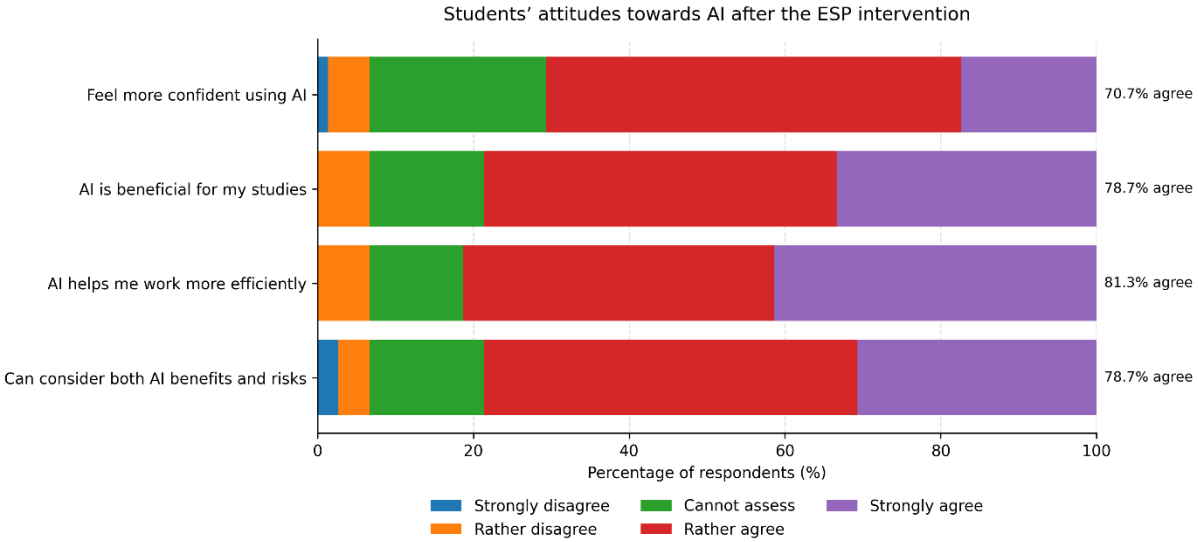



Figure 23: Students' attitudes towards AI after the ESP intervention
*Source: Author's own elaboration based on the obtained data. Visual design prepared with AI assistance; content checked and edited by the author.*

These results in the Figure 23 indicate that the students' attitudes towards AI after the intervention were predominantly positive. Most respondents considered AI beneficial for their studies, perceived it as a tool that helped them work more efficiently, and reported greater confidence in using it. At the same time, the strong agreement with the statement about recognising both benefits and risks indicates that students' attitudes were not purely enthusiastic or uncritical. Rather, the findings suggest a pragmatic and balanced attitude towards AI, in which students recognised its practical value while also being aware of its limitations.

These results support the relevance of AI-enhanced ESP instruction as a way of developing not only technical skills, but also more informed and balanced attitudes towards AI. The extent to which these findings support **H4** will be evaluated in the comparative chapter, where post-intervention attitudes will be compared with students' initial attitudes before the ESP intervention.

## 7.6 Transfer of AI Skills into Academic and ESP-Related Practice

The final closed section of the post-intervention questionnaire focused on students' ability to transfer AI-related skills into academic and ESP-related practice. While the previous subchapters analysed frequency of AI use, perceived skill development, specific AI competences, ethical awareness and attitudes, this section examines whether students felt able to apply AI meaningfully in concrete academic tasks after completing the AI-enhanced ESP intervention.

This subchapter is connected mainly with **RO2** and **RQ2**, as it examines the development of students' self-perceived AI-related competences after the intervention. It is also relevant to **RO3**

and **RQ3**, because it shows how students expected to use AI in study-related and academic contexts after the ESP activities. In addition, the statements concerning responsible use in bachelor theses and adaptation of AI outputs to academic requirements are connected with **RO4** and **RQ4**, as they reflect responsible and academically appropriate use of AI. The findings may also support the later interpretation of **H1** and **H3**, but the final evaluation of these hypotheses requires comparison with the pre-intervention findings.

The questionnaire included four statements focused on students' ability to use AI effectively in seminar papers, use AI responsibly in bachelor theses, structure professional texts with AI support, and adapt AI-generated outputs to academic requirements. The results show that most students felt able to transfer AI-related skills into academic and ESP-related tasks after the intervention.

The strongest agreement was recorded in relation to responsible AI use in future bachelor theses. Altogether, 74.7% of respondents agreed that they would be able to use AI responsibly when preparing their bachelor thesis, with 34.7% rather agreeing and 40% completely agreeing. Only 4% rather disagreed, while 21.3% were unable to assess the statement. This finding is important because it suggests that students associated AI use not only with immediate classroom tasks, but also with more demanding academic writing contexts. At the same time, the relatively high number of neutral responses shows that some students may still need clearer guidance before applying AI in final thesis work.

A similarly strong result was found in relation to AI-supported structuring of professional texts. In total, 77.3% of respondents agreed that AI helps them structure professional texts more effectively, with 37.3% rather agreeing and 40% completely agreeing. This finding is particularly relevant for ESP instruction, where students need to work with specialised language, technical descriptions, professional genres and academic text organisation. AI may therefore serve as a useful support tool for organising ideas, improving coherence and preparing more structured professional communication.

Students also evaluated positively their ability to adapt AI outputs to academic requirements. Altogether, 77.3% of respondents agreed with this statement, with 52% rather agreeing and 25.3% completely agreeing. This result indicates that many students understood that AI-generated content usually requires revision, adaptation and alignment with academic expectations. This competence is crucial because responsible AI use does not consist only of generating content, but also of evaluating, modifying and integrating outputs appropriately into one's own academic work.

The statement concerning effective AI use in seminar papers was supported by 69.3% of respondents. More specifically, 50.7% rather agreed and 18.7% completely agreed. However, 24% of students were unable to assess this statement, and 6.7% disagreed. This suggests that while most respondents felt able to use AI in seminar papers, some uncertainty remained. This may be connected with questions of academic integrity, citation, transparency and the boundary between support and inappropriate replacement of students' own work.

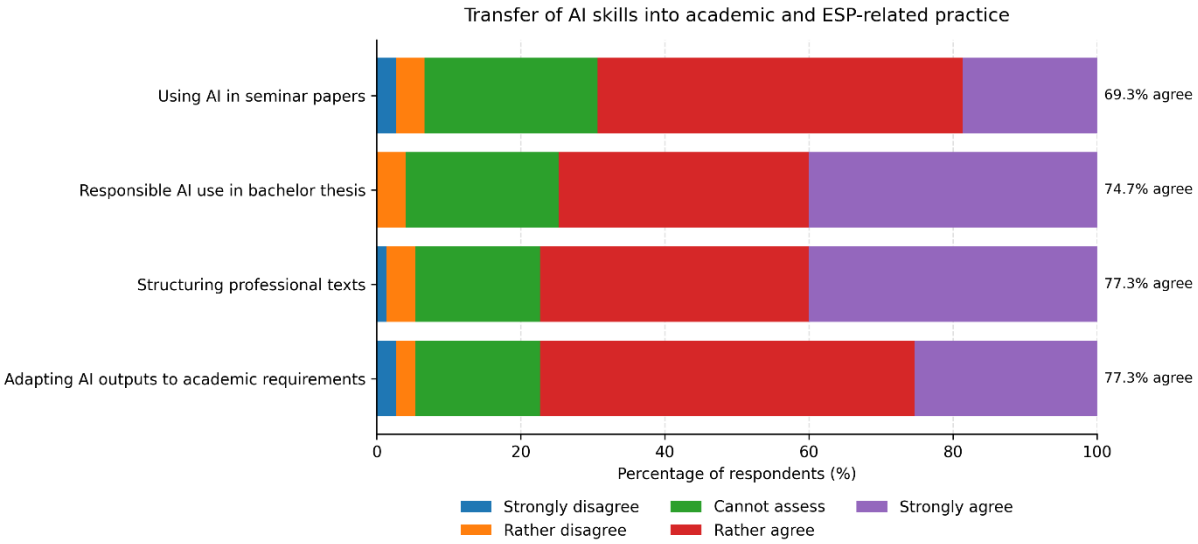



Figure 24: Transfer of AI skills into academic and ESP-related practice
*Source: Author's own elaboration based on the obtained data. Visual design prepared with AI assistance; content checked and edited by the author.*

Overall, the findings in the Figure 24 show that students perceived the AI-enhanced ESP intervention as transferable to academic practice. Most respondents felt able to use AI to structure professional texts, adapt AI outputs to academic requirements, and use AI responsibly in bachelor thesis preparation. These findings are important because they indicate that the intervention did not remain limited to isolated classroom activities, but was perceived as relevant for broader academic work.

At the same time, the results show that some students were still uncertain, especially in relation to seminar papers and bachelor thesis writing. This suggests that future ESP instruction should continue to include explicit examples of acceptable AI-supported writing, transparent acknowledgement of AI use, adaptation of AI-generated outputs, and the difference between support and misconduct. In this sense, AI literacy should be understood not only as the ability to use AI tools, but also as the ability to integrate them responsibly into academic and professional communication.

## 7.7 Supplementary Classroom Reflections after the AI-Enhanced ESP Activities

In addition to the post-intervention questionnaire, brief informal classroom-based group reflections were conducted after the AI-enhanced ESP activities. These reflections were not designed as formal semi-structured interviews and were not recorded or transcribed verbatim. Therefore, they are not treated as a separate interview study or as a source of statistical data. Instead, they serve as supplementary qualitative evidence that helps contextualise the questionnaire findings and provides additional insight into students' immediate reactions to the AI-focused training.

The reflections were guided by several open prompts. Students were invited to comment on which AI activity they found most useful for their studies, which tool or task was new or surprising for them, whether they would like to have more practical AI training in ESP classes,

whether AI could help them with academic work such as presentations, source searching or writing, and what students should be careful about when using AI for university tasks. These prompts were used to encourage students to reflect on the practical value, limitations and responsible use of AI in academic contexts.

This supplementary reflective component is connected mainly with **RO2** and **RQ2**, as it provides additional insight into students' perceived development of AI-related skills after the ESP intervention. It is also relevant to **RO3** and **RQ3**, because students reflected on the ways in which they could use AI tools in their studies. Furthermore, the reflections support the interpretation of **RO4** and **RQ4**, particularly where students commented on responsible use, verification of AI outputs and the need not to replace their own thinking with AI-generated answers. Indirectly, the reflections also help contextualise **RO5** and **RQ5**, as they reveal students' attitudes towards AI after participating in the practical training. However, since these reflections were informal and supplementary, they were not used for direct hypothesis testing.

The classroom reflections suggested that students generally appreciated the practical character of the AI-enhanced ESP activities. A recurring theme was that students found the training useful because it showed them concrete ways of applying AI tools in study-related tasks. They particularly valued activities connected with chatbots, prompt formulation, presentation preparation, text improvement and source searching. This supports the questionnaire findings showing that students perceived improvement in several AI-related competence areas after the intervention.

Students also indicated that some tools or activities were new or surprising for them. While many students had already used chatbots before the intervention, they were less familiar with the more systematic use of prompts, AI-supported presentation tools, source-retrieval tools and video-creation tools. The reflections therefore confirmed that the intervention helped students move beyond spontaneous or intuitive AI use towards more structured and purposeful application of AI in academic and ESP-related contexts.

Another recurring theme was students' interest in further practical AI training. Students expressed that they would welcome more activities of this type in ESP classes, especially if they were directly connected with their study needs. They appeared to prefer hands-on training to purely theoretical explanations. This is important because it suggests that AI literacy can be meaningfully developed when AI tools are integrated into authentic academic and professional communication tasks rather than presented as isolated technological novelties.

The reflections also showed that students recognised the usefulness of AI for academic work. They mentioned its potential support in preparing presentations, improving texts, searching for information, clarifying difficult content and working with academic or professional language. These comments correspond with the post-intervention questionnaire findings, where students reported positive attitudes towards AI and perceived its usefulness in study-related contexts.

At the same time, the reflections did not indicate uncritical enthusiasm. Students also mentioned that AI-generated outputs should be checked, that students should not simply copy AI-generated text, and that AI should not replace their own thinking. These comments are consistent with the

questionnaire findings on ethical awareness and responsible AI use. They suggest that students were aware of the need to use AI critically and transparently in academic work.

Overall, the supplementary classroom reflections support the interpretation of the post-intervention questionnaire results. They indicate that students valued the practical AI-focused activities, perceived them as relevant to their studies and expressed interest in further training. At the same time, they recognised the need for responsible and critical use of AI. Although these reflections are not used as formal interview data, they provide useful contextual evidence showing that AI-enhanced ESP instruction was perceived by students as meaningful, practical and relevant to their academic development.

# 8 Evaluation and Interpretation of Research Findings

The previous chapters presented the findings from the pre-intervention and post-intervention questionnaires separately. While Chapter 6 analysed students' initial experience, knowledge, attitudes, ethical awareness, educational needs and self-assessed AI competence before the AI-enhanced ESP activities, Chapter 7 focused on students' perceptions, practices and self-reported development after the intervention. The purpose of the present chapter is to bring these findings together, interpret them in relation to the research aim, objectives, research questions and hypotheses, and evaluate what they suggest about the role of AI-enhanced ESP instruction in developing AI literacy among technical university students.

Since the research was designed as a small-scale educational intervention, the findings are interpreted primarily as descriptive and context-bound evidence rather than as universally generalisable results. Particular attention is paid to areas where pre- and post-intervention data can be compared directly or indirectly, including frequency of AI use, self-perceived competence, ethical awareness, attitudes towards AI and transfer of AI skills into academic practice. The chapter also discusses the pedagogical implications of the findings for ESP instruction and formulates recommendations for future AI-focused training in technical university contexts.

## 8.1 Comparison of Pre- and Post-Intervention Findings

The comparison of pre- and post-intervention findings provides insight into how students' AI-related practices, competences, attitudes and ethical awareness developed after the AI-enhanced ESP activities. Since the pre- and post-intervention questionnaires were not identical in all items, the comparison is interpreted descriptively and indicatively rather than as a strict item-by-item statistical measurement of change. Where identical or closely corresponding items were available, the findings were compared more directly. In other areas, the post-intervention results were used to interpret students' self-reported development after the instructional intervention.

One of the clearest areas of comparison concerns the frequency of AI use. Before the intervention, 28% of students reported using AI daily and 40% several times a week. After the intervention, the proportion of daily users remained the same at 28%, while the proportion of students using AI several times a week increased to 44%. At the same time, the proportion of students who used AI rarely decreased from 12% before the intervention to 6.7% after the intervention. No student reported never using AI either before or after the intervention. These findings suggest that the intervention did not radically increase daily AI use, but it appears to have supported a modest shift towards more regular use among students who had previously used AI less frequently.

A second important area concerns students' self-perceived AI-related competence. Before the intervention, students reported the highest competence in using chatbots, with a mean score of 4.00, and relatively high competence in technical or programming-related AI tools, with a mean score of 3.45. However, their self-assessed competence was lower in relation to presentation tools, writing and proofreading tools, image and video generators, and especially source-searching tools. After the intervention, students reported perceived improvement in all targeted AI-related skill areas. The strongest improvement was reported in working with chatbots, using

presentation tools and effective prompting. This indicates that the intervention helped broaden students' AI literacy beyond their initial familiarity with general chatbot use.

The comparison also shows that AI-supported academic source work remained an important but more challenging area. Before the intervention, students expressed strong interest in learning how to search for scientific sources using AI, but their self-assessed competence in source-searching tools was the lowest among the evaluated AI tool categories. After the intervention, more than half of the respondents reported improvement in using AI tools for obtaining sources, and most students agreed that they could use AI to obtain relevant academic or professional sources. Nevertheless, post-intervention use of AI for source searching was less frequent than chatbot use. This suggests that while the intervention supported development in this area, academic source work requires continued practice, especially in relation to reliability, relevance and verification.

The findings also suggest development in students' understanding of responsible AI use. Before the intervention, students already demonstrated relatively strong ethical awareness. Most respondents agreed that AI should not replace students' own thinking, that universities should have clear rules on AI use, and that asking AI to write an entire assignment was not appropriate. After the intervention, students continued to show strong ethical awareness. A large majority agreed that AI should be used as support rather than as a replacement for thinking, that they could distinguish acceptable from unacceptable AI use, and that AI use should be acknowledged transparently. This indicates that the intervention did not create ethical awareness from the beginning, but it appears to have strengthened and contextualised students' understanding of responsible AI use in academic practice.

Students' attitudes towards AI also remained generally positive but balanced. Before the intervention, most students considered AI beneficial for their studies, but they also expressed caution, especially in relation to trust in AI-generated results and the possible reduction of critical thinking. After the intervention, students continued to perceive AI positively: most respondents agreed that AI was beneficial for their studies, helped them work more efficiently and increased their confidence in using AI. At the same time, many students also stated that they could consider both the benefits and risks of AI. This suggests that the intervention supported a pragmatic attitude towards AI rather than uncritical enthusiasm.

The comparison of qualitative and reflective data further supports this interpretation. Before the intervention, students most often perceived AI either as a neutral tool or as an opportunity, while a substantial group described it in uncertain or conditional terms. Their responses showed that they recognised both the usefulness and possible risks of AI. After the intervention, supplementary classroom reflections indicated that students appreciated the practical character of the AI-focused activities and would welcome more training of this kind. Students particularly valued activities connected with chatbots, prompting, presentation preparation, source searching and text improvement. At the same time, they continued to emphasise the need to verify AI outputs and not rely on AI uncritically.

The analysis shows that the AI-enhanced ESP intervention contributed to the development of students' AI literacy in several ways. The most visible changes were not in the mere existence

of AI use, because students had already used AI before the intervention, but in the more purposeful, academically oriented and reflective use of AI tools. The intervention appears to have supported students' competence in prompting, presentation preparation, chatbot use, source-related work and critical evaluation of AI outputs. It also helped connect AI use with academic integrity, responsible decision-making and ESP-related tasks. These findings provide the basis for the following sections, where the research objectives, research questions and hypotheses are evaluated more explicitly.

To make the comparison of the pre- and post-intervention findings more transparent, Table 1 provides a compact overview of selected comparable and thematically corresponding areas. Since the pre- and post-intervention questionnaires were not identical in all items, the table should be interpreted descriptively and indicatively rather than as a strict statistical pre-test/post-test comparison.

| Area of comparison | Pre-intervention findings | Post-intervention findings | Interpretation |
|---|---|---|---|
| **Frequency of AI use** | 28% of respondents used AI daily, 40% several times a week, 20% several times a month and 12% rarely. No respondent selected "never". | 28% of respondents used AI daily, 44% several times a week, 21.3% several times a month and 6.7% rarely. No respondent selected "never". | The intervention did not substantially increase daily AI use, but it supported a modest shift towards more regular use. |
| **Self-perceived AI-related competence** | Students reported the highest competence in chatbot use and technical or programming-related AI tools. Lower competence was reported in presentation tools, writing and proofreading tools, image and video generators and especially source-searching tools. | Students reported perceived improvement in all targeted AI-related skill areas, especially in chatbot use, presentation tools and effective prompting. | The intervention helped broaden students' AI literacy beyond their initial familiarity with general chatbot use. |
| **AI-supported source work** | Students showed strong interest in learning how to search for scientific sources using AI, but source-searching tools represented the lowest self-assessed competence area. | 56% of respondents reported improvement in using AI tools for obtaining sources. However, source-related work remained less frequent than general chatbot use. | Source work developed after the intervention, but it remained a demanding area requiring further practice, verification and academic guidance. |
| **Ethical awareness and** | Students already demonstrated relatively strong ethical awareness, | Students continued to show strong ethical awareness. 88% agreed that AI should | The intervention did not create ethical awareness from the beginning, but it |

| Area of comparison | Pre-intervention findings | Post-intervention findings | Interpretation |
|---|---|---|---|
| **responsible AI use** | especially in relation to the belief that AI should not replace their own thinking, that asking AI to write an entire assignment was inappropriate and that universities should have clear rules on AI use. | be used as support rather than replacement, 85.3% could distinguish acceptable and unacceptable AI use, and 78.7% recognised the need to acknowledge AI use transparently. | strengthened and contextualised students' understanding of responsible AI use in academic practice. |
| **Attitudes towards AI** | Students' attitudes towards AI were generally positive, but also cautious, especially in relation to trust in AI-generated results and the possible reduction of critical thinking. | Students continued to perceive AI positively. 81.3% agreed that AI helped them work more efficiently, 78.7% considered AI beneficial for study, and 70.7% felt more confident using AI than before. | The intervention supported a more informed, practical and balanced attitude towards AI rather than uncritical enthusiasm. |

Table 1: Comparative overview of selected pre- and post-intervention findings
*Source: Author's own elaboration based on the obtained data*

As Table 1 shows, the most visible development did not concern the mere existence of AI use, as students had already used AI tools before the intervention. Rather, the findings indicate a shift in the quality and orientation of AI use. After the AI-enhanced ESP activities, students reported more purposeful use of AI tools, stronger perceived competence in selected AI-related skills, and a clearer connection between AI use, academic integrity and ESP-related tasks. The comparison also confirms that some areas, especially AI-supported source work, require continued pedagogical attention. Overall, the table supports the interpretation that the intervention contributed to the development of AI literacy primarily by making students' AI use more structured, reflective, academically relevant and ethically aware.

## 8.2 Evaluation of Research Objectives and Research Questions

The present section evaluates the research findings in relation to the stated research objectives and research questions. Since the study focused on the development of AI literacy among technical university students in ESP courses, the evaluation considers not only measurable patterns in students' responses, but also their attitudes, ethical awareness, educational needs and perceived ability to apply AI tools in academic and ESP-related contexts.

The first research question focused on students' initial level of AI literacy, frequency of AI use and ethical awareness before the AI-focused ESP activities. The findings showed that all respondents had already used AI tools before the intervention, with ChatGPT being the most frequently mentioned tool. AI use was already common before the training, as 68% of

respondents reported using AI either daily or several times a week. Students most frequently used AI for searching for information and sources, solving technical tasks, writing texts and preparing presentations or graphics. At the same time, the results showed that students' AI literacy was uneven. Although they had relatively strong practical familiarity with AI tools, their conceptual understanding was weaker in some areas, especially in relation to the distinction between generative and analytical AI. Their ethical awareness was already visible before the intervention, particularly in the belief that AI should not replace students' own thinking and that universities should have clear rules for AI use.

The second research question examined the development of students' self-perceived AI competence after completing the AI-enhanced ESP activities. The post-intervention findings indicate that students reported improvement across several AI-related skill areas, especially in working with chatbots, using presentation tools and formulating prompts effectively. Students also reported development in using AI tools for obtaining sources and creating AI-supported video content, although these areas appeared to be more demanding and less frequently used. The intervention therefore supported the development of practical and ESP-relevant AI competence. Its contribution was not in introducing AI tools as completely new technologies, but in helping students use them more purposefully, academically and critically.

The third research question addressed changes in the frequency and purposes of AI use after the ESP-based AI training. The comparison of pre- and post-intervention findings showed that the proportion of daily AI users remained stable at 28%, while the proportion of students using AI several times a week increased from 40% to 44%. The proportion of students who rarely used AI decreased from 12% before the intervention to 6.7% after the intervention. These findings suggest a modest shift towards more regular AI use after the intervention. The post-intervention results also showed that chatbot use remained the most frequent activity, while AI-supported source searching and video creation were used less often. The purposes of AI use became more clearly connected with academic and ESP-related practices, including prompting, text improvement, presentation preparation, source searching and critical evaluation of AI outputs.

The fourth research question focused on the influence of AI-enhanced ESP instruction on students' ethical awareness. The findings showed that ethical awareness was already an important part of students' AI literacy before the intervention. Most students agreed that AI should not replace their own thinking, that it was inappropriate to ask AI to write an entire assignment, and that universities should have clear rules about AI use. After the intervention, students continued to report strong ethical awareness. Most respondents agreed that they understood ethical boundaries, could distinguish acceptable from unacceptable AI use, recognised the need to acknowledge AI use transparently and understood AI as support rather than replacement. The intervention therefore appears to have strengthened and contextualised students' ethical awareness rather than created it from the beginning.

The fifth research question examined students' attitudes towards AI after the AI-enhanced ESP activities. The findings showed that students' attitudes towards AI were generally positive before the intervention, but also cautious. Most students considered AI beneficial for their studies, but many expressed limited trust in AI-generated results and concern that AI may

reduce critical thinking. After the intervention, students continued to perceive AI positively. Most respondents agreed that AI was beneficial for their studies, helped them work more efficiently and increased their confidence in using AI. At the same time, they also reported being able to consider both the benefits and risks of AI. The findings therefore suggest that the intervention supported a balanced and pragmatic attitude towards AI rather than uncritical enthusiasm.

The sixth research question explored the relationship between frequency of AI use and self-perceived AI competence. The findings suggest that students who used AI regularly, especially chatbots and tools connected with technical or programming tasks, tended to report higher confidence and competence in these areas. This pattern was visible in both the pre- and post-intervention data: chatbot use was frequent and self-assessed chatbot competence was high, while more specialised areas such as source-searching tools and video creation were less frequently used and initially associated with lower competence. Since the study was based on self-reported questionnaire data and did not include formal correlation analysis, this relationship should be interpreted cautiously as indicative rather than causal.

Generally, the research objectives were fulfilled and the research questions were answered. The findings show that technical university students had already used AI before the intervention, but their AI literacy was uneven and tool-specific. The AI-enhanced ESP activities supported students' perceived development in several AI-related competences, especially prompting, chatbot use, presentation preparation, text work and critical evaluation of outputs. The intervention also helped connect AI use with academic integrity, responsible decision-making and ESP-related communication tasks. These results confirm the relevance of integrating AI literacy into ESP instruction at technical universities.

For greater clarity, the fulfilment of the research objectives and the answers to the research questions are summarised in Figure 21.

| Objective / Question | Focus | Status | Main conclusion |
|---|---|---|---|
| RO1 / RQ1 | Initial AI literacy | Fulfilled / Answered | Students entered the course with prior AI experience, but uneven AI literacy and a need for guided use. |
| RO2 / RQ2 | Skill development | Fulfilled / Answered | Students reported development mainly in chatbot use, prompting, presentations and source-related work. |
| RO3 / RQ3 | Frequency and purposes of us | Fulfilled / Answered | AI use became slightly more regular and more closely connected with academic and ESP-related tasks. |
| RO4 / RQ4 | Ethical awareness | Fulfilled / Answered | Students showed strong awareness of responsible AI use, transparency and the need for critical thinking. |
| RO5 / RQ5–RQ6 | Attitudes and relationships | Fulfilled / Answered | Attitudes remained positive but balanced; more frequent AI use appeared linked with higher self-perceived competence. |

Figure 25: Compact synthesis of research objectives, research questions and main findings
*Source: Author's own elaboration based on the obtained data. Visual design prepared with AI assistance; content checked and edited by the author.*

## 8.3 Evaluation of Research Hypotheses

The present section evaluates the four research hypotheses formulated in the study. RQ6, which concerns the relationship between frequency of AI use and self-perceived AI competence, is not evaluated as a hypothesis because no formal correlation analysis was conducted. It is addressed descriptively in the previous section. Since the research was designed as a small-scale

educational intervention and the pre- and post-intervention questionnaires were not fully identical in all items, the hypotheses are evaluated primarily on the basis of descriptive and indicative evidence. Where comparable data were available, the interpretation is based on pre- and post-intervention comparison. In other cases, the evaluation draws on students' self-reported development and post-intervention responses.

**H1 assumed that students would report higher self-perceived AI-related skills after AI-focused ESP activities.** The findings provide support for this hypothesis. Before the intervention, students reported the highest competence in using chatbots and technical or programming-related AI tools, while their competence was lower in presentation tools, writing and proofreading tools, image and video generators, and especially AI tools for searching and processing sources. After the intervention, students reported improvement in all targeted AI-related skill areas. The strongest perceived development was found in chatbot use, presentation tools and effective prompting. Students also reported improvement in source-retrieval tools and AI-supported video creation. Therefore, **H1 can be considered supported on the basis of students' self-reported development**, although the evidence should be interpreted as descriptive rather than as a strict statistical pre-test/post-test comparison.

**H2 assumed that the frequency of AI usage would increase after AI-enhanced ESP instruction.** The findings provide partial support for this hypothesis. Before the intervention, 28% of respondents used AI daily and 40% used it several times a week. After the intervention, the proportion of daily users remained unchanged at 28%, while the proportion of students using AI several times a week increased to 44%. At the same time, rare use decreased from 12% before the intervention to 6.7% after the intervention. These findings indicate a modest shift towards more regular AI use, although not a dramatic increase in daily use. Therefore, **H2 can be considered partially supported**.

**H3 assumed that students' ethical awareness would improve after the AI-focused ESP intervention.** The findings provide indicative support for this hypothesis. Before the intervention, students already demonstrated relatively strong ethical awareness. Most respondents agreed that AI should not replace students' own thinking, that asking AI to write an entire assignment was inappropriate, and that universities should have clear rules on AI use. After the intervention, students continued to show strong ethical awareness, especially in relation to distinguishing acceptable and unacceptable AI use, acknowledging AI use transparently, and understanding AI as a support tool rather than a replacement for independent thinking. Since ethical awareness was already high before the intervention, the results do not show a simple linear increase. Rather, they suggest that the intervention helped strengthen and contextualise students' ethical understanding in relation to academic practice. Therefore, **H3 can be considered partially and indicatively supported**.

**H4 assumed that students' attitudes towards AI would become more positive after the intervention.** The findings provide partial support for this hypothesis. Before the intervention, students' attitudes towards AI were already generally positive. Most respondents considered AI beneficial for their studies, although they also expressed caution, especially regarding trust in AI-generated results and the possible reduction of critical thinking. After the intervention,

students continued to perceive AI positively: most agreed that AI was beneficial for their studies, helped them work more efficiently, and made them feel more confident in using AI. However, the post-intervention findings also show that students remained aware of both the benefits and risks of AI. Thus, the intervention did not simply make students more enthusiastic about AI. Rather, it supported a more informed, practical and balanced attitude. Therefore, **H4 can be considered partially supported**.

Overall, the evaluation of hypotheses shows that the findings generally support the expected direction of the research. The strongest support was found for the development of self-perceived AI-related skills, especially in practical areas addressed during the ESP intervention. More moderate support was found for increased frequency of AI use and more positive attitudes, mainly because students had already used AI frequently and viewed it positively before the intervention. Ethical awareness was also already relatively strong before the training, but the intervention appears to have helped students connect ethical principles more clearly with academic practice. RQ6 was interpreted descriptively rather than as a hypothesis, and the findings suggest a possible association between more frequent AI use and higher perceived competence. The results therefore suggest that AI-enhanced ESP instruction contributed to the development of students' AI literacy, especially by making their AI use more purposeful, reflective, academically relevant and ethically aware.

## 8.4 Summary of the Main Findings

The findings of the research show that AI literacy among technical university students should be understood as a multidimensional and gradually developing competence. The students who participated in the research had already used AI tools before the AI-enhanced ESP intervention. All respondents reported previous experience with AI, and the majority used AI regularly even before the training. This means that the intervention did not introduce students to AI as a completely new phenomenon. Rather, its role was to help students move from spontaneous and intuitive AI use towards more purposeful, academically relevant, critical and ethically aware use.

The pre-intervention findings showed that students were most familiar with chatbots, especially ChatGPT, and that they most frequently used AI for information searching, technical tasks, writing and presentation preparation. However, their AI literacy was uneven. They demonstrated strong practical familiarity with AI tools, but weaker conceptual understanding in some areas, especially in relation to the distinction between generative and analytical AI. Their self-assessed competence was also uneven: students felt most competent in chatbot use and technical or programming-related AI tasks, while they reported lower competence in academic source-searching tools, presentation tools, writing-support tools and multimodal AI applications.

The post-intervention findings suggest that students perceived development in several AI-related skill areas after completing the AI-focused ESP activities. The strongest perceived improvement was reported in chatbot use, presentation tools and effective prompting. Students also reported development in source-retrieval tools, video-creation tools and the ability to combine several AI tools in one task. These findings indicate that the intervention broadened

students' AI-related competence beyond their initial tool use and helped them apply AI more systematically in academic and ESP-related tasks.

The findings also show that AI-supported academic source work remained one of the most important but also more demanding areas. Before the intervention, students expressed strong interest in learning how to search for scientific sources using AI, but their self-assessed competence in this area was relatively low. After the intervention, students reported improvement in using AI for source-related work; however, this activity was still used less frequently than general chatbot work. This suggests that AI-supported source retrieval requires continued practice, especially in connection with reliability, relevance, verification and academic quality.

Ethical awareness was another important finding. Students already demonstrated a relatively strong awareness of responsible AI use before the intervention. Most respondents understood that AI should not replace their own thinking and that using AI to write an entire assignment instead of the student was not appropriate. After the intervention, students continued to show strong ethical awareness, especially in relation to distinguishing acceptable and unacceptable AI use, acknowledging AI use transparently and understanding AI as support rather than replacement. The intervention therefore appears to have strengthened and contextualised students' ethical awareness rather than created it from the beginning.

Students' attitudes towards AI were generally positive before the intervention and remained positive afterwards. However, the findings do not suggest uncritical enthusiasm. Students recognised the usefulness of AI for study-related tasks, but they also remained aware of risks such as over-reliance, reduced critical thinking and unreliable outputs. After the intervention, students reported that AI helped them work more efficiently and that they felt more confident using AI. At the same time, they also indicated that they could consider both the benefits and risks of AI. This suggests a balanced and pragmatic attitude towards AI.

The partial support of several hypotheses should not be interpreted as a weakness of the research. It reflects the specific starting point of the research sample. The students already used AI frequently and perceived it relatively positively before the intervention. Therefore, the intervention could not be expected to produce a dramatic shift from non-use to use or from negative attitudes to positive attitudes. Its contribution was more subtle but pedagogically important: it helped students use AI more purposefully, more critically and more responsibly in academic and ESP-related contexts.

In general terms, the findings point to that AI-enhanced ESP instruction can support the development of AI literacy among technical university students. Its value lies not only in teaching students how to use selected AI tools, but also in helping them understand when, why and how to use these tools in academic work. The results indicate that ESP courses can provide a meaningful space for developing AI literacy because they connect language learning, academic communication, professional terminology, presentation skills, source work and ethical reflection.

## 8.5 Pedagogical Implications and Recommendations for ESP Practice

The findings of the research have several implications for ESP instruction at technical universities. They show that students already use AI tools frequently, but their use is often practical, intuitive and uneven. Therefore, the role of ESP instruction should not be limited to introducing students to AI tools. Instead, ESP courses should help students develop AI literacy as an academic and professional competence that includes effective tool use, prompt formulation, critical evaluation, ethical awareness and responsible integration of AI outputs into their own work.

One of the most important implications is that AI literacy should be integrated into ESP courses in a practical and task-based way. The students in the present research responded positively to hands-on activities connected with chatbots, presentation tools, source searching, text improvement and video creation. This suggests that AI training is most meaningful when it is connected with authentic academic and ESP-related tasks. In technical university contexts, these tasks may include explaining technical terminology, preparing professional presentations, working with academic sources, improving abstracts or reports, describing processes, interpreting data and preparing visual or multimodal outputs.

The findings also suggest that prompt formulation should be treated as a core ESP skill. Prompting is not only a technical skill; it is also a form of academic and professional communication. When students formulate prompts, they need to define purpose, context, audience, register, expected output and constraints. These are also important elements of ESP communication. Therefore, prompt formulation can help students practise clarity, specificity, genre awareness and audience awareness in English. ESP teachers can use prompting activities to develop both language competence and AI-related competence at the same time.

Another important recommendation concerns academic source work. The research showed that students were highly interested in using AI for source searching, but this area remained more demanding than general chatbot use. For this reason, ESP courses should include systematic activities focused on AI-supported academic source retrieval, verification and evaluation. Students should learn how to distinguish between reliable and unreliable information, how to check whether AI-generated references are real, how to compare AI-generated summaries with original sources and how to avoid using AI as a substitute for proper academic reading. This is especially important for students who will later write seminar papers, bachelor theses or professional reports.

The results also confirm the need to teach AI-supported writing carefully. Students may use AI to generate ideas, improve grammar, reformulate sentences, structure texts or translate specialised terminology. These uses can be pedagogically valuable if students remain active authors of their work. However, AI-supported writing also creates risks connected with plagiarism, loss of authorship and superficial task completion. ESP teachers should therefore provide clear examples of acceptable and unacceptable AI use. Students should understand the difference between using AI for support and allowing AI to replace their own thinking, writing and responsibility.

Ethical awareness should be an explicit and repeated part of AI-enhanced ESP instruction. The findings showed that students were already aware of several ethical risks before the intervention, but they benefited from connecting these issues with concrete academic tasks. Ethical AI use should therefore not be taught only as a theoretical topic. It should be integrated into practical activities, for example when students use AI to prepare a presentation, improve a text, search for sources or generate visual content. Each task can include a short reflective component asking students what they used AI for, how they checked the output and what part of the final product remained their own contribution.

The research also indicates that students benefit from multimodal AI activities, although tools for presentation and video creation may require more guidance than chatbots. In ESP courses, multimodal AI tools can support presentation skills, visual communication, poster preparation and explanation of technical processes. However, students should also be trained to evaluate visual clarity, accuracy, source credibility and appropriateness of AI-generated content. AI-generated presentations or videos should not be accepted automatically as good outputs; they should be assessed critically in terms of language, content, structure, design and academic relevance.

A further implication concerns teacher training. ESP teachers do not need to become AI specialists or programmers, but they need sufficient AI literacy to guide students responsibly. This includes basic understanding of selected AI tools, awareness of their limitations, ability to design meaningful AI-supported tasks and knowledge of ethical issues related to academic integrity. Universities should therefore support ESP teachers through practical workshops focused on AI tools, prompting, academic source work, AI-supported writing, assessment and classroom policies for responsible AI use.

The findings also suggest that institutional clarity is necessary. Students should not be left to guess what is acceptable and unacceptable when using AI in academic work. Universities and departments should formulate clear guidelines on AI use in assignments, seminar papers, presentations and final theses. These guidelines should explain when AI use is permitted, how it should be acknowledged, what forms of AI assistance are acceptable and what constitutes academic misconduct. Clear institutional guidance would support both students and teachers and would reduce uncertainty in AI-related academic practices.

For ESP practice, the research supports a gradual model of AI literacy development. In the first stage, students can learn basic orientation in AI tools and their limitations. In the second stage, they can practise prompt formulation and AI-supported language work. In the third stage, they can use AI for academic source searching, presentation preparation and professional communication tasks. In the fourth stage, they can reflect on ethical issues, transparency and academic responsibility. Such a gradual model would allow AI literacy to develop naturally together with students' ESP competence.

From this perspective this section has shown that the pedagogical implication of the research is clear: AI literacy should become a purposeful part of ESP instruction at technical universities. Since students already use AI tools, the task of ESP teachers is not to decide whether AI should enter the classroom, but to teach students how to use it responsibly, critically and effectively.

AI-enhanced ESP instruction can help students connect English language learning with academic communication, technical terminology, digital competence and ethical decision-making. In this sense, ESP courses can become an important space for preparing students not only for university study, but also for future professional environments in which AI-supported communication and problem-solving will be increasingly common.

## 8.6 Limitations of the Research

Although the present research provides useful insight into the development of AI literacy among technical university students in ESP courses, several limitations need to be acknowledged. These limitations are connected mainly with the research sample, the research design, the nature of the collected data and the scope of the instructional intervention.

The first limitation concerns the research sample. The study was conducted with 75 second-year full-time bachelor's students at the Faculty of Materials Science and Technology of the Slovak University of Technology in Trnava. The participants represented a clearly defined and relevant group of technical university students enrolled in ESP courses. However, the sample was limited to one faculty, one university, one academic semester and one specific educational context. For this reason, the findings should be interpreted as context-bound evidence rather than as results that can be automatically generalised to all university students, all technical universities or all ESP learning environments.

A second limitation is connected with the composition of the sample. The research group was predominantly male, which reflects the usual demographic structure of many technical study programmes, but it also means that the findings cannot provide a balanced gender-based comparison of AI literacy development. Similarly, the sample consisted mainly of students from selected technical study programmes, especially Applied Informatics and Automation in Industry and Computer-Aided Manufacturing Technologies. Students from humanities, social sciences, teacher training or other non-technical fields might demonstrate different patterns of AI use, attitudes, ethical awareness and educational needs.

Another limitation concerns the research design. The study was designed as a small-scale educational intervention, not as a controlled experiment. There was no control group of students who completed the ESP course without AI-focused activities. Therefore, the findings cannot prove with full certainty that all observed changes were caused exclusively by the intervention. Students may also have developed their AI-related skills through their own independent use of AI tools outside the classroom. Nevertheless, the pre- and post-intervention design made it possible to compare students' initial position with their self-reported perceptions after the AI-enhanced ESP activities.

The use of self-reported questionnaire data also represents a limitation. The findings are based on students' own perceptions of their AI use, competence, attitudes and ethical awareness. Self-reported data are valuable because they show how students understand and evaluate their own development, but they do not necessarily measure actual performance. For example, a student may report being able to formulate effective prompts or evaluate AI outputs critically, but this does not automatically prove that the student can do so consistently in authentic academic tasks.

Future research could therefore combine questionnaires with performance-based tasks, analysis of student outputs or teacher assessment.

A further limitation is that the pre- and post-intervention questionnaires were not fully identical in all items. This means that not all areas could be compared through direct item-by-item measurement. Where identical or closely corresponding items were available, comparison was more direct. In other areas, the post-intervention questionnaire provided descriptive evidence of students' perceived development after the intervention. For this reason, the findings were interpreted mainly descriptively and indicatively. This methodological limitation was taken into account when evaluating the research objectives, research questions and hypotheses.

The formulation and evaluation of the hypotheses should also be understood in this context. Several hypotheses were only partially supported, but this does not weaken the research. Rather, it reflects the specific starting point of the sample. Students already used AI relatively frequently and had generally positive attitudes towards AI before the intervention. Therefore, the intervention could not be expected to produce a dramatic shift from non-use to use or from negative attitudes to positive attitudes. Its contribution was more specific: it supported more purposeful, academically aware, critical and ethically oriented AI use.

The scope of the intervention was also limited. The AI-focused training consisted of five 50-minute sessions integrated into regular ESP instruction. Although this was sufficient to introduce selected AI tools and support practical activities related to chatbots, prompting, source searching, presentation preparation and video creation, it was not long enough to develop advanced AI literacy in all areas. More complex competences, such as systematic academic source evaluation, advanced AI-supported writing, ethical decision-making in thesis preparation or multimodal content creation, would require longer and more repeated training.

Another limitation concerns the rapidly changing nature of AI tools. The tools used or discussed during the intervention, such as ChatGPT, Canva, Gamma and Vidnoz, represent only selected examples of AI-supported applications available at the time of the research. Since AI technologies develop quickly, specific tools, functions and user practices may change. Therefore, the findings should not be interpreted as tool-specific conclusions, but rather as evidence of how structured AI-enhanced ESP instruction can support students' broader AI literacy.

The supplementary classroom reflections also have limitations. They provided useful contextual insight into students' reactions to the AI-enhanced ESP activities, but they were informal, classroom-based and not recorded or transcribed verbatim. They were therefore not treated as formal interview data or as a separate qualitative study. Their role was to support the interpretation of questionnaire findings and to provide additional context for students' perceived usefulness of the intervention.

Taken together, these limitations show that the research should be interpreted as a focused educational study situated in a specific ESP context. These limitations do not diminish the value of the research; rather, they define the scope within which the findings should be interpreted.

The study provides context-bound evidence that AI-enhanced ESP instruction can support more purposeful, critical and ethically aware use of AI tools among technical university students.

## 8.7 Suggestions for Further Research

The findings of the present research open several possibilities for further investigation. Since this study was conducted as a small-scale educational intervention in one technical university context, future research could extend the scope of inquiry and examine the development of AI literacy in a broader range of higher education settings. Comparative studies involving students from different faculties, universities, study programmes and academic disciplines would make it possible to identify whether technical students differ from students in humanities, social sciences, teacher training or other professional fields in their AI use, attitudes, ethical awareness and educational needs.

Further research could also work with larger and more diverse research samples. The present study focused on second-year full-time bachelor's students enrolled in ESP courses at STU MTF. Future studies could include students from different years of study, master's students, doctoral students or part-time students. Such research could show whether AI literacy develops differently depending on students' academic maturity, study experience, discipline or professional orientation. It would also be useful to examine whether students who are preparing bachelor's or diploma theses have different needs in relation to AI-supported source work, academic writing and ethical use of AI.

Another important direction for future research concerns the use of control groups. Since the present research did not include a control group, future studies could compare students who complete AI-enhanced ESP instruction with students who follow a similar ESP course without explicit AI-focused training. This would make it possible to evaluate the effect of the intervention more precisely and to distinguish more clearly between development caused by classroom instruction and development resulting from students' independent use of AI tools outside the course.

Future research could also include more systematic statistical analysis. In the present study, the relationship between frequency of AI use and self-perceived AI competence was interpreted descriptively through RQ6. Future studies could examine this relationship through correlation analysis, for example by using Spearman's rho for ordinal questionnaire data. This would allow researchers to determine whether students who use AI tools more frequently also report significantly higher perceived competence. More advanced analysis could also examine whether confidence, attitudes, ethical awareness or type of AI use predict students' self-perceived AI literacy.

A further suggestion concerns the use of performance-based assessment. The present study relied mainly on self-reported questionnaire data, which provided valuable insight into students' perceptions, attitudes and perceived development. However, future research could combine questionnaires with practical tasks in which students demonstrate their AI-related competences. For example, students could be asked to formulate prompts, evaluate AI-generated outputs, verify AI-generated references, revise an AI-supported text or prepare an AI-assisted

presentation. Such tasks would make it possible to compare students' perceived competence with their actual performance.

Future studies could also examine the long-term impact of AI-enhanced ESP instruction. The present research measured students' perceptions shortly after the intervention. It would be useful to investigate whether students continue to use AI tools responsibly and effectively later in their studies, for example when preparing seminar papers, presentations, bachelor's theses or professional projects. Longitudinal research could show whether AI literacy developed through ESP instruction has a lasting effect or whether repeated training is necessary.

Another promising area for further research is academic integrity and AI use in final theses. Since students increasingly use AI tools for source searching, text improvement, translation, summarisation and structuring of academic work, future research should examine how students understand the boundary between acceptable support and inappropriate dependence on AI-generated content. This is particularly important in relation to bachelor's and master's theses, where authorship, transparency, citation practice and independent thinking are central academic requirements.

Further research could also focus on teachers. ESP teachers play an important role in guiding students towards responsible and academically meaningful AI use. Future studies could examine ESP teachers' AI literacy, their attitudes towards AI tools, their confidence in designing AI-enhanced tasks and their need for professional development. This would be especially relevant in technical university contexts, where ESP teachers are expected to support students' academic language, professional communication and digital competences at the same time.

It would also be useful to investigate specific types of AI-supported ESP tasks in greater detail. For example, separate studies could focus on AI-supported vocabulary learning, technical terminology explanation, academic source retrieval, presentation preparation, poster design, multimodal communication, abstract writing or feedback on student texts. Such focused research could help identify which AI-supported activities are most effective for ESP learning and which require stronger teacher guidance.

Future research should also pay attention to the changing nature of AI technologies. Since AI tools develop rapidly, the focus should not be limited to individual applications such as ChatGPT, Canva, Gamma or Vidnoz. Instead, future studies should examine broader competences that remain relevant across tools, such as prompt formulation, critical evaluation, source verification, ethical decision-making, transparency and responsible integration of AI outputs into academic work. This would make research findings more durable despite technological change.

The findings of the present study suggest that AI literacy can be meaningfully developed within ESP instruction, especially when AI tools are connected with authentic academic and professional communication tasks. Further research should therefore continue to explore how ESP courses can support students not only in learning English, but also in becoming competent, critical and ethically responsible users of AI in academic and future professional contexts.

## CONCLUSION

The present monograph examined the development of artificial intelligence literacy in English for Specific Purposes instruction at a technical university. Its focus was not on artificial intelligence as a purely technological phenomenon, but on its educational, linguistic and academic implications. The central concern of the monograph was how university students can be guided to use AI tools not only efficiently, but also critically, ethically and meaningfully in relation to their studies and future professional communication.

The theoretical part of the monograph established the conceptual framework for this investigation. It first discussed the growing presence of artificial intelligence and generative AI in higher education and pointed to the fact that AI tools are becoming part of ordinary academic practices, including information searching, writing support, translation, language revision, presentation preparation and independent learning. At the same time, the discussion emphasised that the educational use of AI cannot be evaluated only through its advantages. Questions of reliability, authorship, academic integrity, transparency, privacy, over-reliance and critical thinking remain central to any responsible integration of AI into university learning.

AI literacy was therefore understood as a multidimensional competence. It involves more than the ability to operate AI tools. It includes understanding how AI works at a basic conceptual level, using AI tools purposefully, evaluating AI-generated outputs, recognising ethical boundaries and transferring AI-supported competences into academic and professional contexts. Such an understanding is particularly relevant in higher education, where students are expected not only to complete tasks, but also to develop independent judgement, academic responsibility and discipline-related communication skills.

The monograph also considered the position of Generation Z university students. Although these students are often described as digitally immersed learners, the theoretical discussion showed that digital familiarity should not be confused with AI literacy. Frequent use of digital technologies does not automatically guarantee responsible academic use of AI. Students may be confident users of online tools and still need explicit guidance in source verification, ethical decision-making, transparent acknowledgement of AI assistance and critical evaluation of machine-generated content.

Within this framework, English for Specific Purposes was presented as a meaningful educational space for developing AI literacy. ESP instruction at technical universities is already oriented towards students' real academic and professional needs. It connects language learning with technical terminology, academic reading, source work, presentation skills, written communication, professional genres and transferable competences. For this reason, the integration of AI literacy into ESP does not represent an artificial addition to the course. Rather, it responds to the changing nature of academic and professional communication in which students increasingly encounter AI-supported tools.

The empirical part of the monograph explored this theoretical assumption in a specific institutional context. The research was conducted with second-year students enrolled in ESP courses at the Faculty of Materials Science and Technology of the Slovak University of Technology in Trnava. The AI-enhanced ESP intervention was designed as a structured

instructional sequence in which students worked with chatbots, prompting, AI-supported source orientation, presentation tools and multimodal AI-supported applications. The purpose of the intervention was not to promote uncritical use of AI, but to help students understand how AI can support language learning, academic communication and professional preparation when used responsibly.

The findings indicate that students had already entered the course with considerable experience of AI tools. This confirms that higher education is no longer dealing with the question of whether students will use AI, but rather with the question of how they will use it. Here, the imperative drawn from Margaret Atwood at the outset of this work – *"not to censure, but to understand"* – finds its full practical justification. The role of university instruction is not to react through institutional censure or prohibitive measures, but to create conditions in which students can develop a reflective understanding of these tools and use them in an academically appropriate manner. The empirical findings suggest that even a limited ESP-based intervention can contribute to students' awareness of AI-related skills, ethical boundaries, source verification, and the practical value of AI tools for academic and professionally oriented tasks.

One of the important contributions of the monograph is the emphasis on purposeful AI use. The results did not suggest that the main value of instruction lies in making students use AI more frequently. Many students were already regular users before the intervention. The more important contribution lies in helping students move from intuitive or spontaneous use towards more conscious, selective and responsible use. This distinction is essential. In the context of AI literacy, progress should not be measured only by frequency of use, but by the quality of judgement, the ability to evaluate outputs, the awareness of limitations and the student's responsibility for the final academic product.

The monograph also highlights the continuing importance of the teacher. AI tools may provide immediate explanations, language suggestions or visual outputs, but they cannot replace pedagogical judgement, academic standards or human responsibility. In ESP instruction, the teacher remains central in designing meaningful tasks, explaining ethical boundaries, guiding reflection, supporting language development and helping students evaluate the quality of AI-generated outputs. The integration of AI into ESP therefore does not reduce the role of the teacher; it makes this role more complex and more necessary.

From a pedagogical perspective, the study suggests that AI literacy can be integrated into ESP through practical and carefully structured activities. Prompt formulation, comparison of AI-generated and human-produced texts, source verification, terminology checking, translation post-editing, presentation preparation and ethical reflection are all suitable ways of connecting AI literacy with language learning. Such activities allow students to experience AI not as an independent authority, but as a tool whose outputs must be questioned, revised and adapted to the academic or professional purpose.

The research also points to the importance of transparency and academic integrity. AI-supported learning can be productive when students understand the difference between assistance and substitution. Using AI to brainstorm, revise language, compare formulations or support presentation preparation may contribute to learning. Submitting AI-generated content as one's

own work, using unverified sources or avoiding one's own intellectual effort undermines the educational process. For this reason, AI literacy should include repeated discussion of acceptable and unacceptable uses of AI in concrete academic tasks.

Naturally, the monograph has its limitations. The empirical research was conducted in one institutional setting and with a specific group of technical university students. The findings are therefore context-bound and cannot be generalised to all ESP courses or all technical universities. The research also relied primarily on self-reported data, which reflects students' perceptions of their development rather than direct measurement of performance. These limitations, however, do not weaken the value of the study. They define its scope and indicate directions for further research.

Future research could extend the present study by involving larger samples, different faculties, various study programmes or comparative institutional contexts. It would also be useful to include performance-based tasks, analysis of student outputs, interviews or longitudinal research in order to examine how AI literacy develops over time and how students transfer AI-related competences into other academic and professional situations. Further attention should also be paid to ESP teachers' preparedness, since teachers themselves need support in designing AI-enhanced materials, setting clear rules and guiding students towards responsible AI use.

In conclusion, the monograph argues that AI literacy is becoming an important component of contemporary ESP competence. Technical university students need English for academic and professional communication, and this communication is increasingly shaped by digital and AI-supported tools. ESP courses can therefore play a key role in helping students develop not only linguistic competence, but also the critical, ethical, and reflective abilities needed for responsible participation in AI-mediated academic environments. Ultimately, moving beyond the initial impulse to censure AI enables higher education to truly understand and shape its potential. The aim is not to replace human learning with artificial intelligence, but to prepare students to use artificial intelligence in ways that strengthen their learning, communication, and future professional agency.

# RESUMÉ

Predkladaná monografia mapuje rozvoj gramotnosti v oblasti umelej inteligencie (AI) v kurzoch angličtiny pre špecifické účely (ESP) na technickej univerzite. Jej ústrednou témou je otázka, ako viesť študentov technických odborov k tomu, aby AI nástroje nevyužívali iba intuitívne či účelovo, ale najmä premyslene, kriticky, eticky a v súlade s akademickými štandardmi. Práca vychádza z predpokladu, že umelá inteligencia sa stáva bežnou súčasťou vysokoškolského štúdia a akademickej komunikácie. Študenti po nej siahajú pri vyhľadávaní informácií, preklade, písaní textov, jazykových korektúrach, ale aj pri príprave prezentácií, tvorbe vizuálov či osvojovaní si odbornej terminológie. Vysoké školy preto už nemôžu o AI uvažovať iba ako o vonkajšom technologickom fenoméne; musia ju prijať ako pevnú súčasť akademického prostredia, ktorá si vyžaduje koncepčné pedagogické usmernenie.

Cieľom monografie bolo preskúmať, ako sa rozvíja AI gramotnosť u študentov druhého ročníka technickej univerzity v rámci kurzov ESP. Výskum sa konkrétne zameral na to, ako štruktúrované aktivity s integráciou AI ovplyvnili sebahodnotenie kompetencií študentov, frekvenciu a účely využívania týchto nástrojov, ich postoje k umelej inteligencii a v neposlednom rade ich etické povedomie v akademickom prostredí. Výskum sme koncipovali ako mikro-pedagogickú intervenciu s predintervenčným a pointervenčným zberom dát. V počiatočnej fáze sme zisťovali doterajšie skúsenosti študentov s AI, ich zaužívané spôsoby práce, úroveň porozumenia tejto technológii a očakávania spojené s jej využitím v štúdiu. Pointervenčná fáza následne overovala vnímaný posun študentov po absolvovaní cieľových aktivít, ktoré boli zamerané na prácu s chatbotmi, efektívne promptovanie, akademické vyhľadávanie zdrojov, prípravu prezentácií a tvorbu videoobsahu.

Teoretickú časť monografie sme rozdelili do troch hlavných kapitol. Prvá kapitola analyzuje postavenie umelej inteligencie a AI gramotnosti vo vysokoškolskom vzdelávaní. Poukazuje na to, že AI už dávno nie je výsadou informatiky či pokročilého spracovania dát, ale preniká do každodenných akademických činností – od písania prác, cez jazykové vzdelávanie až po samostatné štúdium. Celospoločenská dostupnosť generatívnych nástrojov tento trend ešte urýchlila, keďže umožňuje priamu komunikáciu so systémami v prirodzenom jazyku.

Zároveň zdôrazňujeme, že AI gramotnosť nemožno zužovať len na technickú obsluhu daného nástroja. V monografii ju chápeme ako komplexnú, viacrozmernú kompetenciu. Tá zahŕňa porozumenie princípom a limitom AI, schopnosť prakticky ju aplikovať pri plnení akademických úloh, kriticky hodnotiť vygenerované výstupy, konať eticky a prenášať tieto zručnosti do akademickej i budúcej profesijnej praxe. Takýto prístup reflektuje skutočné potreby vysokoškolského vzdelávania, kde cieľom nie je len mechanické dokončenie úlohy, ale rozvoj samostatného myslenia a akademickej zodpovednosti.

V tejto kapitole sa venujeme aj príležitostiam a rizikám, ktoré so sebou AI prináša. Na jednej strane dokáže výrazne podporiť efektivitu učenia, jazykový rozvoj či personalizované vzdelávanie. Na druhej strane však otvára vážne hrozby v podobe faktických nepresností (tzv. halucinácií), vymyslených citácií, plagiátorstva, straty kritického myslenia a oslabenia vlastného intelektuálneho vkladu študentov. Monografia preto obhajuje vyvážený postoj: AI

netreba nekriticky prijímať ani paušálne odmietať, kľúčom je pedagogicky riadené, etické a reflexívne používanie.

Druhá kapitola sa orientuje na generáciu Z ako na špecifickú skupinu študentov, ktorí vyrastali v digitálne saturovanom svete. Hoci sú títo mladí ľudia zvyknutí na neustálu prítomnosť smartfónov a sociálnych sietí, v práci jasne upozorňujeme, že ich digitálna obratnosť automaticky neznamená rozvinutú akademickú digitálnu kompetenciu či AI gramotnosť. Študenti síce s nástrojmi pracujú sebavedomo, no často potrebujú usmerniť pri overovaní zdrojov, hodnotení kvality informácií, rozlišovaní medzi legitímnou pomocou a neprípustným nahradením vlastnej práce, ako aj pri transparentnom priznávaní podielu AI na ich úlohách.

Odmietame preto zjednodušenú predstavu, že generácia Z prirodzene ovláda digitálne technológie na akademickej úrovni. Ich technologická intuícia je síce výhodou, no bez pedagogickej podpory, jasných pravidiel a priestoru na reflexiu nestačí. V akademickom prostredí musíme toto neformálne a spontánne používanie pretvoriť na zodpovednú akademickú prax. Študenti musia presne vedieť, kedy je AI vhodnou oporou, kedy je jej použitie problematické a ako si zachovať vlastnú intelektuálnu integritu za výsledný text či projekt.

Tretia kapitola prepája AI gramotnosť priamo s výučbou ESP na technických univerzitách. Tento typ jazykovej výučby chápeme ako prístup, ktorý striktne vychádza zo špecifických akademických a profesijných potrieb študentov. V technickom prostredí nejde o všeobecnú angličtinu; študenti potrebujú jazyk na prácu s odbornou terminológiou, čítanie technických štúdií, opis procesov, prezentovanie projektov a komunikáciu v medzinárodnom expertnom prostredí.

Práve preto sú ESP kurzy ideálnym priestorom na rozvoj AI gramotnosti. Činnosti, na ktoré študenti AI najčastejšie využívajú (preklad, reformulácia textu, práca s terminológiou, tvorba prezentácií či videí), sa priamo prekrývajú s cieľmi ESP výučby. Monografia preto zdôrazňuje, že AI gramotnosť by sa nemala vyučovať ako izolovaná technologická téma, ale mala by byť organicky integrovaná do autentických jazykových úloh prepojených s budúcim povolaním študentov.

Vo výskumnej časti monografie, sme si stanovili päť hlavných výskumných cieľov:

1. Identifikovať počiatočnú úroveň AI gramotnosti, frekvenciu používania AI nástrojov a etické povedomie študentov druhého ročníka ESP pred ich účasťou na vyučovacích aktivitách zameraných na AI.
2. Preskúmať rozvoj sebahodnotených zručností študentov v oblasti AI po absolvovaní štruktúrovanej ESP výučby podporenej AI, ktorá bola zameraná na chatboty, stratégie promptovania, vyhľadávanie akademických zdrojov a tvorbu obsahu s podporou AI.
3. Analyzovať zmeny vo frekvencii a účeloch používania AI nástrojov po ukončení AI tréningu integrovaného do ESP kurzov.
4. Preskúmať rozvoj etického povedomia a zodpovedných postojov študentov k používaniu umelej inteligencie v akademickom prostredí po pedagogickej intervencii.

5. Preskúmať postoje študentov k AI po absolvovaní ESP kurzu podporeného AI a opísať vzťah medzi frekvenciou používania AI a sebahodnotenou kompetenciou študentov v oblasti AI.

Týmto cieľom zodpovedalo šesť výskumných otázok, označených ako RQ1 až RQ6. Keďže prvá otázka mala deskriptívny charakter a šiesta bola koncipovaná ako exploračná, nakoľko sme predpokladaný vzťah netestovali formálnou korelačnou analýzou, neformulovali sme k nim hypotézy. Hypotézy sme stanovili len pre otázky overujúce pointervenčné zmeny, teda pre hypotézy H1 až H4. Predpokladali sme v nich, že po absolvovaní aktivít vzrastie úroveň sebahodnotených zručností, zvýši sa frekvencia používania AI, posilní sa etické povedomie a postoje študentov k AI budú pozitívnejšie.

**Výskumná otázka – VO1:** Aká je počiatočná úroveň AI gramotnosti, frekvencia používania AI a etické povedomie študentov ESP pred ich účasťou na vyučovacích aktivitách zameraných na AI?

**Výskumná otázka – VO2:** Do akej miery sa zmení sebahodnotená kompetencia študentov v oblasti AI vo vzťahu k vybraným AI aplikáciám po absolvovaní ESP výučby podporenej AI?

**Výskumná otázka – VO3:** Ako sa mení frekvencia a účel používania AI nástrojov po ukončení AI tréningu integrovaného do ESP kurzov?

**Výskumná otázka – VO4:** Ako ovplyvňuje účasť na ESP výučbe zameranej na AI etické povedomie študentov v oblasti zodpovedného akademického používania umelej inteligencie?

**Výskumná otázka – VO5:** Ako sa menia postoje študentov k umelej inteligencii po absolvovaní ESP aktivít podporených AI?

**Výskumná otázka – VO6:** Existuje vzťah medzi frekvenciou používania AI a sebahodnotenou kompetenciou študentov v oblasti AI po absolvovaní ESP kurzu?

Na základe stanovených cieľov a výskumných otázok, sme naformulovali štyri hypotézy:

**H1:** Študenti po absolvovaní vyučovacích aktivít v rámci ESP zameraných na AI uvádzajú významne vyššiu úroveň sebahodnotených zručností v oblasti AI v porovnaní s predintervenčnou fázou.

**H2:** Frekvencia používania AI nástrojov u študentov ESP sa po absolvovaní výučby ESP podporenej AI zvyšuje.

**H3:** Študenti po pedagogickej intervencii preukazujú vyššiu úroveň etického povedomia týkajúceho sa akademického používania AI.

**H4:** Postoje študentov k umelej inteligencii sú po účasti na výučbe ESP s integráciou AI pozitívnejšie.

Vo výskume sme použili dizajn zmiešaného výskumu, ktorý kombinoval kvantitatívne údaje z dotazníkov, kvalitatívne odpovede na otvorené dotazníkové otázky a doplnkové neformálne reflexie z vyučovacích hodín. Kvantitatívna zložka výskumu sa opierala o uzavreté dotazníkové položky, ktoré boli súčasťou predintervenčného a pointervenčného dotazníka. Tieto položky pozostávali z otázok s nadväzným výberom odpovedí, otázok zisťujúcich frekvenciu a zo škálových tvrdení (Likertova škála). Umožnili nám identifikovať všeobecné vzorce v používaní AI študentmi, preskúmať vybrané aspekty ich odpovedí pred pedagogickou intervenciou a po nej, ako aj analyzovať sebahodnotený rozvoj študentov vo vybraných oblastiach AI gramotnosti. Uzavreté otázky sú v prieskumnom výskume vhodné preto, lebo generujú štruktúrované a porovnateľné dáta, ktoré sa dajú číselne spracovať a použiť na identifikáciu tendencií v rámci celej výskumnej skupiny. V tejto štúdii slúžili uzavreté dotazníkové položky na preskúmanie kognitívnej, afektívnej a konatívnej dimenzie AI gramotnosti v štruktúrovanej podobe. Kvalitatívna zložka výskumu bola založená predovšetkým na otvorených otázkach charakteru rozhovoru, ktoré boli zaradené do predintervenčného dotazníka. Tieto otázky umožnili študentom vyjadriť vlastné názory na umelú inteligenciu ich vlastnými slovami, vrátane toho, ako AI vnímajú, aké príležitosti či riziká s ňou spájajú a ako by chceli AI konkrétne využívať vo svojom štúdiu.

Výskum prebiehal na Materiálovotechnologickej fakulte STU v Trnave počas zimného semestra akademického roka 2025/2026. Výskumnú vzorku tvorilo 75 študentov dennej formy bakalárskeho štúdia v druhom ročníku, ktorí boli rozdelení do piatich ESP skupín. Všetky skupiny absolvovali počas 13-týždňového semestra porovnateľný vyučovací obsah. Vzorku sme vybrali zámerne, keďže išlo o jasne definovanú skupinu zapojenú do rovnakej pedagogickej intervencie.

Z hľadiska demografie išlo o vzorku typickú pre technické študijné programy, kde muži tvorili 88 % a ženy 12 %. Vekovo bola vzorka relatívne homogénna, pričom 69,3 % študentov malo 18 až 20 rokov, 28 % sa nachádzalo vo vekovom rozpätí 21 až 23 rokov a len 2,7 % malo 24 a viac rokov. Z hľadiska odborov výrazne prevládali študenti programu Aplikovaná informatika a automatizácia v priemysle, ktorí predstavovali 62,7 % vzorky. Nasledovali programy Počítačom podporované výrobné technológie s 24 % a Integrovaná bezpečnosť s 12 %. Ostatné programy, ako napríklad materiálové inžinierstvo, manažment či mechatronika, boli zastúpené len okrajovo a spolu tvorili zostávajúcich 1,3 %. Dáta sme zbierali pomocou dvoch dotazníkov – predintervenčného, zameraného na doterajšie skúsenosti, vzdelávacie potreby a počiatočné postoje, a pointervenčného, ktorý overoval vnímaný rozvoj, etické hranice a prenos zručností do akademickej praxe.

**Výsledky predintervenčnej fázy**

Vstupný dotazník potvrdil, že umelá inteligenca nebola pre študentov novinkou. Všetkých 75 respondentov uviedlo, že pred začiatkom výučby už s AI nástrojmi pracovalo. Intervencia teda nepredstavovala zoznamovanie sa s neznámou technológiou, ale skôr snahu transformovať spontánnu prax na informované a akademicky zodvedné používanie.

Z hľadiska pravidelnosti používania pred začiatkom intervencie uviedlo 28 % respondentov, že AI využíva denne, a presne 40 % po nej siahalo niekoľkokrát týždenne. Ďalších 20 % študentov

deklarovalo používanie niekoľkokrát mesačne a 12 % ju využívalo zriedkavo. Možnosť, že by AI nepoužili nikdy, nevybral žiaden respondent, z čoho vyplýva, že celkovo až 68 % študentov pracovalo s týmito nástrojmi pravidelne, teda denne alebo viackrát do týždňa. Pokiaľ ide o účel, jednoznačne dominovalo vyhľadávanie informácií a zdrojov, ktoré označilo 84 % opýtaných. S výrazným odstupom nasledovalo riešenie technických či programátorských úloh so 49,3 %, písanie textov a seminárnych prác so 46,7 % a tvorba prezentácií či grafiky, ktorú uviedlo rovných 40 % študentov.

V oblasti teoretického porozumenia AI až 86,6 % študentov deklarovalo, že dokáže vysvetliť pojem umelá inteligencia, a 77,4 % poznalo aspoň tri konkrétne aplikácie. Schopnosť rozpoznať AI generovaný text alebo obraz pozitívne ohodnotilo 70,7 % respondentov. Najsilnejším zistením bolo vysoké povedomie o chybovosti systémov, keďže až 94,7 % študentov súhlasilo s tvrdením, že výstupy je potrebné overovať. Naopak, najslabším miestom bolo rozlišovanie medzi generatívnou a analytickou AI, kde správne porozumenie deklarovalo len 46,6 % vzorky, zatiaľ čo zvyšok tvorili študenti, ktorí s týmto rozlíšením nesúhlasili alebo ho nevedeli posúdiť.

Počiatočné postoje boli vo všeobecnosti pozitívne, no racionálne. Hoci 81,3 % študentov vnímalo AI ako prínos pre štúdium, len 29,3 % jej výsledkom skôr dôverovalo, pričom úplnú dôveru nevyjadril nikto. Významná časť, konkrétne 77,3 %, navyše vyjadrila obavu, že nadmerné spoliehanie sa na AI môže oslabiť kritické myslenie. S tým, aby bola AI pevnou súčasťou univerzitnej výučby, súhlasilo 60 % opýtaných.

Vstupná analýza etického vnímania ukázala, že študenti mali etické hranice nastavené správne už pred výskumom. Prevažná väčšina, presnejšie 89,3 %, považovala AI za prijateľnú, ak funguje len ako pomocník, no 81,3 % jasne odmietlo možnosť nechať si vygenerovať celé zadanie namiesto vlastnej práce. Potrebu transparentne priznať použitie AI v akademickom texte si uvedomovalo 72 % študentov a až 93,3 % zdôraznilo, že AI nesmie nahradiť vlastné myslenie. Po jasných pravidlách zo strany univerzity volalo 76 % opýtaných.

Čo sa týka vzdelávacích potrieb, študenti mali záujem najmä o praktické zručnosti. Najviac ich lákalo vyhľadávanie vedeckých zdrojov s podporou AI, čo uviedlo 80 % respondentov, a efektívna práca s chatbotmi, o ktorú prejavilo záujem 77,3 % študentov. O tvorbu prezentácií v nástrojoch ako Canva či Gamma malo záujem 54,7 % opýtaných. O samostatný blok venovaný čisto etike malo záujem len 50,7 % študentov, čo naznačuje, že etické otázky je lepšie integrovať priamo do praktických cvičení než ich prednášať izolovane.

Vstupná sebahodnotená kompetencia bola veľmi nevyrovnaná. Študenti sa cítili najistejšie pri práci s chatbotmi, kde priemerné skóre dosiahlo hodnotu 4,00 z piatich a až 78,6 % hodnotilo svoje zručnosti ako vysoké či veľmi vysoké. Relatívne vysoko skončili aj programátorské nástroje s priemerným skóre 3,45 a s 58,6 % pozitívnych hodnotení. Ostatné kategórie však dopadli podstatne horšie. Pri prezentačných nástrojoch a rovnako pri nástrojoch na písanie a korektúru textu dosiahlo priemerné skóre zhodnú hodnotu 2,36, pričom vysokú kompetenciu uviedlo len 14,7 %, respektíve 21,3 % študentov. Ešte nižšie hodnoty vykazovali obrazové a video generátory s priemerom 2,20 a iba trinásťpercentným podielom vysokej kompetencie. Úplne najslabšou oblasťou boli akademické vyhľadávače s priemerným skóre 2,12, kde vysokú úroveň vlastných zručností vnímalo len 12 % opýtaných.

V otvorených odpovediach študenti preukázali pragmatizmus. Najväčšia časť, reprezentujúca 37,3 %, vnímala AI ako neutrálny nástroj, 34,7 % ju videlo ako príležitosť a 22,7 % vyjadrilo ambivalentný postoj, kedy síce uznávali užitočnosť technológie, no zároveň menovali riziká závislosti či straty kritického myslenia. Len minimálny podiel, konkrétne 4 %, vnímal AI striktne ako hrozbu. Pri otázke na konkrétne plány využitia v štúdiu najčastejšie uvádzali vyhľadávanie informácií s podielom 33,3 %, podporu pri učení a vysvetľovaní látky s 25,3 %, zhodne písanie a preklad s 25,3 % a programovanie s 24 %.

**Výsledky pointervenčnej fázy a diskusia**

Po absolvovaní intervencie zostala AI stabilnou súčasťou študijného života respondentov. Podiel denných používateľov sa síce nezmenil a zostal na úrovni 28 %, no skupina študentov využívajúcich AI niekoľkokrát týždenne vzrástla zo 40 % na 44 %, zatiaľ čo zriedkavé používanie kleslo z 12 % na 6,7 %. Tento posun indikuje mierny nárast pravidelnosti, nie však nekontrolovanú explóziu používania. Najčastejšou pointervenčnou aktivitou zostala práca s chatbotmi, ktorú 66,7 % študentov využívalo často alebo veľmi často. Nasledovala úprava textov s podielom 33,3 % a príprava prezentácií s 28 %. Práca s akademickými zdrojmi, ktorú často využívalo 12 % študentov, a tvorba videa so štyrmi percentami boli podstatne menej frekventované.

V oblasti sebahodnoteného rozvoja študenti deklarovali zlepšenie vo všetkých sledovaných dimenziách. Najvýraznejší posun pocítili pri prezentačných nástrojoch, kde 64 % uviedlo zlepšenie alebo výrazné zlepšenie. Pri práci s chatbotmi zaznamenalo posun vpred 68 % študentov, pri efektívnom promptovaní 61,3 %, pri práci s akademickými zdrojmi 56 % a pri tvorbe videa 50,7 % opýtaných.

Hodnotenie konkrétnych akademických kompetencií po intervencii dopadlo taktiež pozitívne. Schopnosť kombinovať viacero AI nástrojov pri riešení jednej úlohy deklarovalo 77,3 % študentov. To, že dokážu promptovať účelne a efektívne, potvrdilo 76 % opýtaných, pričom zhodný podiel 76 % uviedol, že vie kriticky posúdiť kvalitu vygenerovaného výstupu. Používanie AI na vyhľadávanie relevantných odborných zdrojov úspešne zvládlo 73,3 % respondentov a schopnosť pripraviť s podporou AI profesionálnu prezentáciu potvrdilo 69,3 % študentov.

Pointervenčné etické povedomie potvrdilo, že študenti vnímajú AI správne, keďže až 88 % z nich ju chápe výlučne ako podporu, nie ako náhradu vlastného intelektu. Rozlišovať medzi akceptovateľným a neakceptovateľným využitím AI v štúdiu dokázalo 85,3 % respondentov a 78,7 % si plne uvedomovalo povinnosť transparentne priznať zapojenie AI do tvorby textov. Jasné etické hranice v akademickom prostredí deklarovalo 76 % opýtaných, hoci 16 % nevedelo túto otázku posúdiť, čo signalizuje potrebu kontinuálneho pedagogického vedenia.

Postoje študentov zostali aj po intervencii pragmatické, pričom 81,3 % súhlasilo, že AI im pomáha pracovať efektívnejšie, a 70,7 % uviedlo, že ich sebadôvera pri práci s týmito technológiami vzrástla. Schopnosť vnímať pozitívne aj negatívne stránky AI deklarovalo 78,7 % opýtaných. Pokiaľ ide o prenos zručností do širšej akademickej praxe, 77,3 % študentov uviedlo, že dokáže s pomocou AI štruktúrovať odborné texty a prispôsobiť ich výstupy

akademickým požiadavkám. To, že budú AI zodpovedne využívať pri písaní bakalárskej práce, potvrdilo 74,7 % respondentov. Určitú neistotu s podielom 24 % odpovedí „neviem posúdiť“ sme však zaznamenali pri seminárnych prácach, čo pravdepodobne pramení z pretrvávajúcich obáv ohľadom akademickej integrity a nejasných hraníc plagiátorstva.

Kvalitatívne dáta z triednych reflexií tieto závery potvrdili. Študenti vysoko ocenili praktické zameranie cvičení a opakovane zdôrazňovali, že preferujú reálny tréning pred suchou teóriou. Hoci chatboty poznali, systematická práca s promptmi, akademické vyhľadávače či pokročilé funkcie Canvy pre nich boli nové a prekvapujúce. Zároveň v diskusiách nezaznievalo nekritické nadšenie; sami študenti zdôrazňovali, že výstupy z AI sa musia dôsledne kontrolovať a texty nemožno iba slepo kopírovať.

**Vyhodnotenie výskumných otázok a hypotéz**

Analýza potvrdila, že ciele výskumu sme splnili a všetky výskumné otázky boli zodpovedané. Pri RQ1 sa ukázalo, že hoci mali študenti vysokú vstupnú prax s AI, ich gramotnosť bola nesúrodá a obmedzená na úzky okruh nástrojov. Výsledky k RQ2 až RQ5 preukázali pozitívny vplyv intervencie na rozvoj kompetencií, mierne ustálenie frekvencie používania, ukotvenie etického vnímania v reálnych situáciách a sformovanie vyvážených postojov. Pri RQ6 dáta naznačili, že študenti s vyššou frekvenciou používania AI, najmä v oblasti programovania a chatbotov, vykazovali vyššiu mieru sebadôvery a vnímanej kompetencie.

Vyhodnotenie stanovených hypotéz prinieslo nasledujúce závery. Hypotéza H1, predpokladajúca rozvoj sebahodnotených zručností, bola podporená. Študenti po intervencii deklarovali preukázateľné zlepšenie vo všetkých sledovaných oblastiach, najmä v promptovaní a tvorbe prezentácií, kde bola vstupná úroveň nízka. Kvôli povahe dát má však toto zistenie deskriptívny, nie prísne inferenčný charakter. Hypotéza H2, overujúca zvýšenie frekvencie používania, bola podporená iba čiastočne. Podiel denných používateľov sa nepohol z miesta a zostal na 28 %, pričom sme zaznamenali len mierny presun z kategórie zriedkavého používania do kategórie používania niekoľkokrát týždenne. Intervencia teda neviedla k masívnemu nárastu kvantity používania, ale skôr k zmene kvality.

Hypotéza H3, zameraná na posilnenie etického povedomia, bola podporená čiastočne a indikatívne. Študenti vykazovali vysoké etické štandardy už pred začiatkom výskumu, takže namiesto lineárneho nárastu môžeme hovoriť skôr o úspešnej stabilizácii a prepojení teoretických zásad s konkrétnymi akademickými úlohami. Podobne aj hypotéza H4, predpokladajúca sformovanie pozitívnejších postojov, bola podporená len čiastočne. Postoje boli priaznivé už na vstupe a intervencia nespôsobila radikálny obrat v ich vnímaní, ale prispela k tomu, že ich pozitívny vzťah k AI sa stal zrelším, kritickejším a opieral sa o reálnu praktickú skúsenosť.

**Záver, implikácie a limity výskumu**

Hlavné zistenia monografie ukazujú, že AI gramotnosť budúcich inžinierov netreba vnímať ako jednorazovú technickú zručnosť, ale ako viacrozmernú, postupne sa rozvíjajúcu kompetenciu. Keďže študenti s týmito nástrojmi už bežne pracujú, hlavnou úlohou pedagógov ESP nie je

rozhodovať o tom, či AI do triedy pustia, ale naučiť študentov narábať s ňou kriticky a akademicky vhodným spôsobom.

Pre pedagogickú prax navrhujeme štvorfázový model integrácie AI do ESP kurzov. V prvej, orientačnej fáze, dochádza k zoznámeniu sa s limitmi a fungovaním AI. V druhej, procesuálnej fáze, nasleduje nácvik efektívneho promptovania a jazykových úprav. Tretia, aplikačná fáza, zahŕňa využitie AI pri reálnom akademickom vyhľadávaní, tvorbe prezentácií a odborných výstupov. Celý proces uzatvára štvrtá, reflexívna fáza, postavená na kritickej diskusii o etike, autorstve a transparentnosti. Tento postupný model zaručuje, že rozvoj AI gramotnosti prebieha prirodzene a súbežne s rozvojom jazykových a komunikačných kompetencií.

Každý výskum má však svoje limity. Prvým je rozsah a zloženie vzorky – 75 študentov druhého ročníka na jednej fakulte STU predstavuje špecifický kontext, preto výsledky nemožno automaticky zovšeobecňovať na celé vysoké školstvo. Druhým limitom je rodová nevyváženosť, kde osemdesiatosempercentný podiel mužov znemožňuje hlbšiu komparáciu na základe pohlavia. Tretím limitom je samotný dizajn mikro-intervencie bez prítomnosti kontrolnej skupiny, kvôli čomu nemožno s absolútnou istotou izolovať vplyv intervencie od iných vonkajších faktorov. V neposlednom rade sme pracovali so sebahodnotiacimi dotazníkmi, ktoré vyjadrujú subjektívne vnímanie študentov a nemusia presne odrážať ich reálny technický výkon.

Budúci výskum by mal tieto bariéry prekonať. Odporúčame realizovať rozsiahlejšie štúdie na viacerých univerzitách, porovnať technické odbory s humanitnými či prírodovednými a sledovať rozdiely naprieč stupňami štúdia, napríklad medzi bakalárskym a doktorandským stupňom. Taktiež by bolo prínosné doplniť dotazníky o výkonnostné testy, analýzu reálnych študentských prác alebo longitudinálne sledovanie. Pozornosť si zaslúžia aj samotní vyučujúci, ich pripravenosť a metodologické potreby pri integrácii AI do výučby.

Z celkového pohľadu monografia potvrdzuje, že AI gramotnosť sa stáva neoddeliteľnou súčasťou moderného vysokoškolského vzdelávania. ESP kurzy na technických univerzitách majú jedinečnú príležitosť stať sa lídrami v tejto transformácii. Systematické pedagogické vedenie dokáže zabezpečiť, že umelá inteligencia nebude pre štúdium hrozbou, ale efektívnym partnerom, ktorý študentov pripraví na reálne požiadavky súčasného trhu práce a akademickej komunikácie.

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# APPENDIX A

**Structured Description of the AI-Enhanced ESP Instructional Intervention**

The following appendix provides a structured overview of the AI-enhanced ESP instructional intervention implemented during the winter semester of the academic year 2025/2026. The intervention was designed for second-year students enrolled in English for Specific Purposes courses at the Faculty of Materials Science and Technology of the Slovak University of Technology in Trnava. The aim was to connect AI literacy with academic, technical and professional English rather than to teach artificial intelligence as an isolated technological topic.

The intervention consisted of five AI-focused sessions integrated into regular ESP instruction. The sessions focused on ethical and responsible AI use, chatbot interaction, prompt formulation, AI-supported source searching and verification, presentation preparation in Canva and Gamma, and avatar-based multimodal communication using Vidnoz. The activities were designed as guided hands-on tasks and were linked to ESP needs such as technical terminology, academic source work, presentation skills, professional communication and responsible use of AI-generated content.

The five sessions were also connected through a final pair-work ESP presentation task. Students prepared a presentation about a fictional company, which produces some products and applied the skills developed during the intervention. They used AI tools for brainstorming, prompt formulation, source orientation, verification of information, presentation design, script development and multimodal communication. The final presentation included an AI-generated avatar created in Vidnoz, either as a CEO or company representative, or as a presenter of the selected product.

From a didactic perspective, the intervention followed the principles of active, student-centred ESP instruction and was connected with Bloom's taxonomy of educational objectives. Students were gradually guided from understanding and applying selected AI tools towards analysing, evaluating and creating AI-supported outputs. The appendix does not reproduce the complete teaching materials, worksheets or presentation files. Instead, it presents a condensed methodological overview of the intervention design.

Table A1: Overview of the AI-Enhanced ESP Instructional Intervention

| Sessions | Focus of the intervention | ESP-related objective | AI tools / platforms used | Main classroom activity | Student output | Bloom's taxonomy focus | AI literacy dimension |
|---|---|---|---|---|---|---|---|
| **S 1** | Ethical introduction to AI and algorithmic decision-making | To introduce AI as a support tool in academic and technical university contexts and to develop initial ethical awareness of AI use | Moral Machine, selected chatbot tools | Students explored ethical dilemmas connected with algorithmic decision-making and discussed the limits of automated decisions. The activity was followed by a | Short reflection on responsible AI use in academic and ESP contexts | Understand, analyse, evaluate | Understanding AI; ethical and responsible use |

| Sessions | Focus of the intervention | ESP-related objective | AI tools / platforms used | Main classroom activity | Student output | Bloom's taxonomy focus | AI literacy dimension |
|---|---|---|---|---|---|---|---|
| | | | | discussion of responsible AI use in academic work, especially the difference between AI as support and AI as replacement. | | | |
| **S 2** | Practical chatbot use, critical thinking and prompt formulation | To develop students' ability to use chatbot tools purposefully, formulate effective prompts, verify AI-generated information and distinguish between ethical support and inappropriate academic use | ChatGPT, Copilot, Gemini, Claude, Perplexity AI or similar chatbot tools | Students were introduced to chatbots as "super-autocomplete" systems that generate plausible language but may still produce errors. They practised six elements of effective prompting: clarity, context, role/style, format, limitations and iteration. They also completed the "Socrates Challenge" and "Reverse Socrates" activities focused on questioning, testing and verifying chatbot outputs. | Improved prompt, comparison of weak and strong prompts, verified chatbot statements and short reflection / exit ticket on ethical chatbot use | Understand, apply, analyse, evaluate | Understanding AI; using and applying AI; evaluating AI outputs; ethical and responsible use |
| **S 3** | AI-supported academic source searching and verification | To support students in using AI for academic and professional source orientation while developing critical evaluation of information | AI-supported search tools, selected chatbots, academic databases or library sources | Students learned how AI can support the generation of keywords, research questions and search strategies. They compared AI-suggested sources with reliable academic or professional sources and discussed fabricated or unreliable references. | List of verified sources with comments on relevance and reliability | Analyse, evaluate | Evaluating AI outputs; academic source work; responsible use |
| **S 4** | Practical training in Canva and Gamma for | To develop students' ability to prepare, adapt and critically | Canva, Gamma, selected | Students were introduced to the practical workflow of creating | Draft presentation outline or short AI- | Apply, analyse, evaluate, create | Academic and professional transfer; |

| Sessions | Focus of the intervention | ESP-related objective | AI tools / platforms used | Main classroom activity | Student output | Bloom's taxonomy focus | AI literacy dimension |
|---|---|---|---|---|---|---|---|
| | ESP presentation preparation | evaluate AI-supported presentations for academic, technical and professional communication in English | chatbot tools | presentations in Canva and Gamma. They worked with templates, AI-generated outlines, slide structure, visual design, text adaptation, presentation mode, export options and interactive presentation features. The emphasis was placed on adapting AI-generated or template-based outputs to ESP requirements, technical content and academic appropriateness. | supported presentation on a technical/ professional topic | | multimodal communicatio n; using and applying AI; evaluating AI outputs |
| **S 5** | Practical training in Vidnoz and AI-supported avatar presentation | To introduce students to AI-supported avatar creation and multimodal ESP communication as part of a final pair-work presentation task | Vidnoz, Canva, Gamma, selected chatbot tools | Students were practically introduced to Vidnoz and shown how to create an AI avatar for academic and professional presentation purposes. They prepared or adapted a short presentation script for an avatar representing either a fictional company, for example as a CEO, or a product designed by the students. The activity was connected with the final ESP presentation in which students applied skills from all previous sessions. | AI-supported avatar script, avatar concept or avatar-integrated presentation segment | Apply, analyse, evaluate, create | Multimodal communicatio n; academic and professional transfer; using and applying AI; ethical and responsible use |

*Source: Author's own elaboration based on the design of the AI-enhanced ESP instructional intervention.*

**Session 1: Ethical Introduction to AI and Algorithmic Decision-Making**

The first session introduced students to artificial intelligence not only as a useful academic tool, but also as a technology connected with ethical decision-making, responsibility and social consequences. The session started with the online Moral Machine activity, which was used as an introductory stimulus for discussing algorithmic decision-making. Students were asked to reflect on situations in which automated systems may be required to make or support decisions with ethical consequences.

The aim of the activity was not to discuss autonomous vehicles in technical detail, but to open a broader ethical discussion about the limits of automated decision-making and the role of human responsibility. This was then connected with the academic use of AI tools. Students discussed whether AI should be treated as a neutral tool, a decision-making assistant or a system whose outputs always require human judgement.

The second part of the session focused on responsible AI use in academic and ESP contexts. Students analysed examples of acceptable and unacceptable uses of AI in university work. Acceptable uses included using AI to clarify technical terminology, improve grammar in a text written by the student, generate possible search keywords or support the structure of a presentation. Problematic uses included asking AI to write an entire assignment, submitting AI-generated text without personal engagement, using fabricated sources or failing to acknowledge AI assistance where required.

The activity was connected with higher-order thinking skills because students were not only asked to understand AI-related ethical issues, but also to analyse concrete situations, evaluate the appropriateness of AI use and formulate their own position on responsible academic behaviour.

**Illustrative classroom task:**

Students were given several scenarios and asked to decide whether the use of AI was acceptable, questionable or unacceptable.

Examples of scenarios:

1. A student asks AI to explain the difference between tensile strength and hardness in simpler English before reading a technical text.
2. A student asks AI to write the whole seminar paper and submits it without changes.
3. A student uses AI to improve the grammar and clarity of a paragraph that they wrote themselves.
4. A student asks AI to generate references and uses them without checking whether the sources exist.
5. A student uses AI to prepare a presentation outline and then verifies, edits and adapts the content.

The expected output was a short reflection on responsible AI use in academic work. Students were encouraged to formulate one rule that they considered important for their own AI-supported learning.

**Session 2: Practical Chatbot Use, Critical Thinking and Prompt Formulation**

The second session focused on chatbot use, prompt formulation, critical thinking and ethical engagement with AI-generated outputs. Students were introduced to chatbot tools such as ChatGPT, Copilot, Gemini, Claude and Perplexity AI and discussed the idea that chatbots generate plausible language but do not understand meaning in the same way as humans.

Students practised six elements of effective prompting: clarity, context, role or style, format, limitations and iteration. They compared weak and improved prompts and observed how prompt quality influenced the relevance, clarity and academic usefulness of chatbot responses.

**Example of a weak prompt:**

Explain automation.

**Improved prompt:**

Explain the concept of industrial automation in English for second-year technical university students. Use clear academic language, include three key terms, provide one example from manufacturing and organise the answer into three short paragraphs.

The session also included the activities **"Socrates Challenge"** and **"Reverse Socrates"**. In the first activity, students chose a topic they knew well and tried to identify mistakes, vague statements or gaps in chatbot answers. In the second activity, they selected an unfamiliar topic, wrote down several plausible chatbot statements and verified them using reliable sources. These activities showed why fluent AI-generated language must not be confused with verified knowledge.

The expected outputs were an improved prompt, a comparison of weak and strong chatbot responses, selected verified statements and a short reflection on ethical chatbot use.

**Session 3: AI-Supported Source Searching and Verification**

The third session focused on AI-supported academic source searching and verification. This session was particularly important for technical university students because they need to work with professional and academic sources when preparing presentations, seminar papers, reports and later bachelor theses. At the same time, AI-generated references and summaries may be incomplete, inaccurate or fabricated.

Students were first shown how AI can support the early stages of source work. AI tools were used to generate keywords, search phrases, possible research questions and thematic directions. However, the teacher emphasised that AI-generated suggestions cannot replace academic source verification.

Students worked with topics relevant to the Faculty of Materials Science and Technology, for example:

- sustainable materials in engineering,
- automation in manufacturing,
- occupational safety in industrial environments,
- computer-aided manufacturing,
- recycling and circular economy in materials technology,
- robotics in production,
- additive manufacturing,
- environmental impact of industrial production.

**Illustrative prompt:**

Suggest English keywords and search phrases for finding academic sources on the use of recycled materials in industrial production. Organise the keywords into three groups: general topic, technical terminology and environmental context.

Students then checked selected AI-generated suggestions against reliable academic or professional sources. The aim was to show that AI may help with orientation, but the student must remain responsible for the reliability, relevance and academic quality of the final source selection.

The session explicitly developed higher-order thinking skills. Students analysed AI-suggested sources, evaluated whether they were relevant and reliable, and justified their decisions. The expected output was a short list of verified sources or search terms with comments on relevance and reliability.

**Session 4: Practical Training in Canva and Gamma for ESP Presentation Preparation**

The fourth session focused on practical training in AI-supported presentation preparation using Canva and Gamma. This session was directly connected with ESP learning because technical university students often need to present technical concepts, professional topics, processes, materials, production methods or safety issues in English. The aim was to help students use AI-supported presentation tools not only as design aids, but also as tools for structuring, adapting and improving academic and professional communication.

The session included guided practical work with Canva. Students were introduced to the basic presentation workflow in Canva, including selecting or adapting templates, working with slides, editing text and images, adjusting visual style and preparing the final presentation for classroom delivery. Attention was paid to the fact that template-based design can save time, but the final presentation must still be adapted to the topic, audience and academic purpose. Students were therefore encouraged to evaluate whether the chosen template supported the technical content or distracted from it.

The Canva part also demonstrated selected presentation functions that can increase classroom interaction and presentation control. These included presentation mode, interactive features

such as student questions through a link or QR code, the use of a timer for classroom tasks and options for controlling the presentation remotely. These functions were discussed not only as technical features, but also as ways of supporting student engagement and clearer classroom communication.

The second part of the session focused on Gamma as an AI-supported tool for generating structured presentations from prompts, notes, uploaded files or existing text. Students were shown how to create a new presentation, choose between generating content from a short prompt, pasting existing text, importing a file or using a template. They also discussed how to adjust generation settings, such as the amount of text, target audience, tone, style and additional instructions. Particular attention was paid to the need to review and customise the generated content before using it.

Students prepared a short presentation outline or draft on a technical or professional topic related to their studies. Possible topics included:

- the role of automation in modern manufacturing,
- occupational safety in production,
- additive manufacturing,
- smart materials,
- computer-aided design and manufacturing,
- sustainable materials,
- quality control in industrial production,
- environmental responsibility in industrial companies.

**Illustrative prompt for Gamma or chatbot-supported presentation planning:** Create a clear 5-slide presentation outline in English for second-year technical university students on the topic "The role of automation in modern manufacturing". Include an introduction, three main points and a conclusion. Use formal but understandable ESP language, suggest concise slide titles and avoid excessive text on slides.

Students then used Canva or Gamma to create or improve a draft presentation. They evaluated the AI-generated structure, checked whether the content matched the topic, revised language where necessary and considered whether the visual form supported or distracted from the academic message. The teacher emphasised that AI-generated presentations, images and slide structures should be treated as drafts that require review, verification and adaptation.

The ethical and academic dimension of AI-supported presentation preparation was also addressed. Students discussed why AI-generated content should not replace their own subject knowledge, why technical information must be checked, and why copyright, personal data and appropriate use of images should be considered when preparing academic or professional materials. They were also reminded that the final presentation remains the responsibility of the student, even when AI-supported tools are used.

From the perspective of Bloom's taxonomy, the session moved from applying tool functions to analysing, evaluating and creating. Students did not only use Canva or Gamma mechanically. They had to decide what to keep, what to remove, what to rewrite, how to adapt the output to an ESP context and how to make the presentation clear, accurate, visually appropriate and academically responsible.

The expected output of this session was a draft presentation outline or a short AI-supported presentation segment related to the final "Digital Product Design Challenge". This activity prepared students for the final pair-work presentation, in which they presented a fictional company or product and applied AI-supported presentation design, ESP communication and responsible content adaptation.

**Session 5: Practical Training in Vidnoz and AI-Supported Avatar Presentation**

The fifth session focused on practical training in AI-supported avatar creation and multimodal communication using Vidnoz. This session was directly connected with the final ESP presentation task, in which students worked in pairs and prepared a presentation about a fictional company or product. The aim was to show students how AI-supported avatar tools can be used as part of academic and professional communication, while also encouraging them to evaluate the appropriateness, credibility and ethical implications of such tools.

The session was introduced as a continuation of the previous activities. In earlier sessions, students had worked with chatbots, prompt formulation, source searching and verification, and AI-supported presentation tools such as Canva and Gamma. In Session 5, these skills were brought together in a multimodal task. Students were shown how an AI-generated avatar could be used to present a company, introduce a product, support a marketing-style presentation, or create a short professional message in English.

The teacher provided practical guidance on how to use Vidnoz. Students were introduced to the basic workflow of the tool, including choosing or creating an avatar, preparing a script, selecting a voice or speaking style, checking pronunciation and clarity, and generating a short avatar-based presentation segment. The emphasis was placed on the fact that the avatar should not be used merely as a visual effect, but should have a meaningful communicative function within the presentation.

The activity was linked to the course topic in which students worked with company and product presentation. In pairs, students designed or represented a fictional company and prepared a final ESP presentation. As part of this presentation, they were required to include an AI-generated avatar. The avatar could have one of two main roles. First, it could represent the fictional company, for example as a CEO or company representative introducing the company's mission, values, product or service. Second, it could be used to introduce or present the product itself, for example by explaining its purpose, main features, target users or advantages.

Students were encouraged to prepare the avatar script carefully. They could use chatbot tools to brainstorm ideas, improve the structure of the script, check grammar or adapt the language to a more professional style. However, they were reminded that the content had to remain their own responsibility. The teacher emphasised that AI-generated scripts should be treated as drafts and

should be checked, edited and adapted to the purpose of the presentation, the fictional company profile and the expected ESP level.

**Illustrative prompt for avatar script preparation:**

Prepare a short 45-second script in English for an AI avatar who acts as the CEO of a fictional technology company. The company develops smart safety solutions for manufacturing environments. Use professional but clear language suitable for a university ESP presentation. Include the company's mission, one product benefit and a short closing statement.

**Alternative illustrative prompt:**

Prepare a short script for an AI avatar introducing a new eco-friendly material designed for industrial production. The avatar should explain what the product is, who it is intended for and why it is useful. Use clear technical English suitable for second-year technical university students.

After generating or drafting the script, students evaluated whether the language was appropriate, whether the message was clear, and whether the avatar's role made sense within the presentation. They also considered whether the avatar helped the presentation or whether it risked making the output appear superficial, artificial or less academically serious. This discussion was important because multimodal AI tools can make presentations more visually attractive, but they do not automatically improve the quality of the content.

The ethical dimension of avatar use was also discussed. Students reflected on issues such as artificial representation, authenticity, the possible overuse of AI-generated speakers, the importance of transparency and the need to preserve their own responsibility for the final presentation. They were reminded that an avatar can support communication, but it should not replace students' own understanding, preparation or ability to explain their topic.

The final presentation task required students to apply skills from all previous sessions. They used prompt formulation when preparing their scripts and presentation content. They used source-searching and verification strategies when gathering information. They used Canva or Gamma, or another selected tool, to design the presentation. They used Vidnoz to create the avatar-based part of the presentation. At the end of the presentation, students were expected to include information about how they worked with sources and information during the preparation process. This final reflection connected the practical output with responsible AI use, academic transparency and critical evaluation of information.

From the perspective of Bloom's taxonomy, the session moved strongly towards higher-order cognitive processes. Students applied AI tools, analysed the suitability of generated scripts and avatar outputs, evaluated the credibility and appropriateness of multimodal AI-supported communication, and created their own final ESP presentation output. The activity therefore connected AI literacy with project-based learning, ESP presentation skills, professional communication and responsible use of AI tools.

The expected output of the session was an avatar script, avatar concept or avatar-integrated presentation segment. In the broader intervention, this session contributed to the final pair-work

presentation in which students presented a fictional company or product and explained how they had worked with information, sources and AI tools during the preparation process.

**Summary of the Pedagogical Logic of the Intervention**

The five intervention sessions followed a gradual didactic progression. Students first discussed ethical and responsible AI use, then developed chatbot interaction and prompt formulation, practised AI-supported source searching and verification, created AI-supported presentations in Canva or Gamma, and finally integrated an AI-generated avatar into a multimodal ESP presentation.

The intervention was not designed as a set of isolated tool demonstrations. The individual sessions were connected through a final pair-work presentation about a fictional company , which produces some products. This final task required students to apply prompt formulation, critical evaluation of AI outputs, source verification, presentation design, script development and avatar-based communication.

The pedagogical purpose of the intervention was to help technical university students use AI tools critically, purposefully and responsibly in English-medium academic and professional contexts. The intervention therefore connected AI literacy with ESP presentation skills, technical communication, multimodal digital competence and academic integrity.

# APPENDIX B

## Pre-intervention questionnaire: Skúsenosti, postoje a potreby študentov MTF STU v oblasti umelej inteligencie

*The questionnaire was administered electronically via Google Forms. For reasons of space, this appendix presents the wording of the questionnaire items in a condensed format.*

*Introductory information: The questionnaire was part of research conducted by PaedDr. Jana Luprichová, PhD. at the Faculty of Materials Science and Technology of the Slovak University of Technology in Trnava. It aimed to identify students' knowledge, experience, attitudes and needs in the field of artificial intelligence before the beginning of instruction, including ethical AI use in the academic environment. Participation was voluntary, anonymous and the data were processed only in aggregate form for scientific and pedagogical purposes. Approximate completion time: 10 minutes.*

| Section | No. | Question / item wording | Response format / options |
|---|---|---|---|
| A | Consent | Vyplnením tohto dotazníka potvrdzujete, že ste boli oboznámení s jeho účelom a dobrovoľne súhlasíte s účasťou na výskume. | Súhlasím s účasťou na výskume. / Nesúhlasím (v tom prípade dotazník nemusíte ďalej vypĺňať). |
| B | 1 | Uveďte svoje pohlavie. | Žena / Muž / Iné |
| B | 2 | Uveďte svoj vek. | 18–20 / 21–23 / 24 a viac |
| B | 3 | Vyberte svoj študijný program. | Aplikovaná informatika a automatizácia v priemysle; Integrovaná bezpečnosť; Materiálové inžinierstvo; Mechatronika v technologických zariadeniach; Počítačová podpora výrobných technológií; Priemyselné manažérstvo; Výrobné technológie; Výrobné zariadenia a systémy; Other |
| C | 4 | Použil/a som už niekedy nástroje umelej inteligencie (napr. ChatGPT, Copilot, Canva Magic Write, Gamma, DALL·E a pod.). | Áno / Nie |
| C | 5 | Ak áno, ktoré nástroje ste používali? | Open answer |
| C | 6 | Ako často používate nástroje umelej inteligencie? | denne / niekoľkokrát týždenne / niekoľkokrát mesačne / zriedkavo / nikdy |
| C | 7 | Na aké účely AI najčastejšie používate? | Tick all that apply: písanie textov (seminárky, preklady, e-maily); tvorba prezentácií alebo grafických materiálov; vyhľadávanie informácií / podkladov; riešenie technických úloh alebo kódu; Other |
| D | 8 | Vyjadrite mieru súhlasu s tvrdeniami: Viem vysvetliť, čo znamená pojem umelá inteligencia. Poznám aspoň tri nástroje založené na umelej inteligencii. Rozumiem rozdielu medzi generatívnou a analytickou AI. Dokážem odhaliť, kedy je text alebo obrázok vytvorený AI. Viem, že AI môže robiť chyby a overujem si jej výstupy. | Scale: 1 = vôbec nesúhlasím; 2 = skôr nesúhlasím; 3 = neviem posúdiť; 4 = skôr súhlasím; 5 = úplne súhlasím |
| E | 9 | Vyjadrite mieru súhlasu s tvrdeniami: Používanie AI považujem za prínosné pre moje štúdium. Cítim sa sebaisto pri práci s nástrojmi AI. Dôverujem výsledkom, ktoré mi AI poskytne. Obávam sa, že AI môže znižovať potrebu kritického myslenia. Myslím si, že AI by mala byť súčasťou univerzitného vzdelávania. | Scale: 1–5 as above |
| F | 10 | Vyjadrite mieru súhlasu s tvrdeniami: Použitie AI pri tvorbe školských úloh je v poriadku, ak ju používam len ako pomocníka. Nie je správne, ak študent požiada AI, aby napísala celú prácu namiesto neho. Viem, že ak využijem AI pri písaní textu, musím to v práci uviesť. AI by nemala nahrádzať vlastné premýšľanie študenta. Myslím si, že univerzity by mali mať jasné pravidlá o používaní AI. | Scale: 1–5 as above |
| G | 11 | Vyjadrite mieru súhlasu s tvrdeniami: Chcel/a by som sa naučiť efektívne používať chatboty (napr. ChatGPT, Gemini). Zaujíma ma tvorba prezentácií a vizuálov pomocou AI (Canva, Gamma). Chcel/a by som vedieť vyhľadávať vedecké zdroje pomocou AI. Mám záujem o krátky tréning o etickom používaní AI počas semestra. | Scale: 1–5 as above |
| H | 12 | Ohodnoťte svoju aktuálnu zdatnosť v práci s nasledujúcimi typmi AI nástrojov: Chatboty (napr. ChatGPT, Gemini, Copilot); Prezentačné nástroje (napr. Canva Magic Write, Gamma); Generátory obrázkov a videí (napr. DALL·E, Ideogram, Runway, Pika Labs); AI pre písanie a korekciu textov (napr. Grammarly, Quillbot, WordTune); AI na vyhľadávanie a spracovanie zdrojov (napr. Perplexity, Elicit, Consensus); AI v technických alebo programovacích úlohách (napr. ChatGPT pre kód, GitHub Copilot). | Rating: 1 = vôbec nezdatný/á; 5 = veľmi zdatný/á |
| I | 13 | Ako vnímate umelú inteligenciu – skôr ako príležitosť, hrozbu alebo neutrálny nástroj? Prečo? | Open answer |
| I | 14 | Ak by ste mohli využiť AI vo svojom štúdiu, na čo konkrétne by ste ju chceli použiť? | Open answer |

# APPENDIX C

## Post-intervention questionnaire: Zručnosti, využívanie a postoje študentov MTF STU v oblasti umelej inteligencie po absolvovaní vzdelávacích aktivít k umelej inteligencii

*The questionnaire was administered electronically via Google Forms after the AI-enhanced ESP activities. Introductory information: The questionnaire followed the previous survey and aimed to identify how students' skills, frequency of use, attitudes and ethical awareness in the field of artificial intelligence changed after a series of educational activities within the ESP course. The questionnaire was anonymous and the data were used exclusively for pedagogical and research purposes. Approximate completion time: less than 10 minutes.*

| Section | No. | Question / item wording | Response format / options |
|---|---|---|---|
| A | Consent | Súhlas s účasťou na výskume. | Súhlasím s účasťou na výskume a so spracovaním mojich anonymných odpovedí. / Nesúhlasím (dotazník ďalej nevyplňujem). |
| B | 1 | Uveďte svoje pohlavie. | Žena / Muž / Iné |
| B | 2 | Uveďte svoj vek. | 18–20 / 21–23 / 24 a viac |
| B | 3 | Vyberte svoj študijný program. | Aplikovaná informatika a automatizácia v priemysle; Integrovaná bezpečnosť; Materiálové inžinierstvo; Mechatronika v technologických zariadeniach; Počítačová podpora výrobných technológií; Priemyselné manažérstvo; Výrobné technológie; Výrobné zariadenia a systémy; Iné |
| C | 4 | Ako často v súčasnosti používate nástroje umelej inteligencie pri štúdiu? | denne / niekoľkokrát do týždňa / niekoľkokrát do mesiaca / zriedkavo / vôbec |
| C | 5 | Frekvencia používania AI podľa typu činnosti: Práca s chatbotmi (vysvetľovanie, návrhy textov); Vyhľadávanie odborných zdrojov (napr. SciSpace); Tvorba prezentácií (Canva, Gamma); Tvorba videí pomocou AI (napr. Vidnoz); Úprava a optimalizácia textov pomocou AI. | Scale: nikdy / zriedkavo / občas / často / veľmi často |
| D | 6 | Ohodnoťte, do akej miery sa vaše zručnosti zmenili po absolvovaní ESP vzdelávacích aktivít pomocou AI: Chatboty (ChatGPT, Gemini a pod.); AI nástroje na získavanie zdrojov; Prezentačné nástroje (napr. Canva, Gamma); AI nástroje na tvorbu videa (napr. Vidnoz); Schopnosť efektívne promptovať. | Scale: výrazne sa nezlepšili / skôr sa nezlepšili / nezmenili sa / zlepšili sa / výrazne sa zlepšili |
| E | 7 | Vyjadrite mieru súhlasu s tvrdeniami: Dokážem cielene a efektívne formulovať prompty. Viem využiť AI na získanie relevantných odborných zdrojov. Dokážem vytvoriť profesionálnu prezentáciu s podporou AI. Viem kriticky posúdiť kvalitu AI výstupov. Dokážem kombinovať viac AI nástrojov v jednej úlohe. | Scale: 1 = vôbec nesúhlasím; 2 = skôr nesúhlasím; 3 = neviem posúdiť; 4 = skôr súhlasím; 5 = úplne súhlasím |
| F | 8 | Vyjadrite mieru súhlasu s tvrdeniami: Rozumiem etickým hraniciam používania AI v akademickom prostredí. Viem rozlíšiť prípustné a neprípustné použitie AI pri štúdiu. Uvedomujem si potrebu transparentne uvádzať použitie AI. AI vnímam ako pomocný nástroj, nie náhradu vlastného myslenia. | Scale: 1–5 as above |
| G | 9 | Vyjadrite mieru súhlasu s tvrdeniami: Cítim sa istejšie pri používaní AI než predtým. AI považujem za prínosný nástroj pre moje štúdium. AI mi pomáha pracovať efektívnejšie. Pri práci s umelou inteligenciou dokážem zohľadňovať jej prínosy aj riziká. | Scale: 1–5 as above |
| H | 10 | Vyjadrite mieru súhlasu s tvrdeniami: Viem efektívne využiť AI pri seminárnych prácach. Budem vedieť zodpovedne využiť AI pri bakalárskej práci. AI mi pomáha lepšie štruktúrovať odborný text. Dokážem AI výstupy prispôsobiť akademickým požiadavkám. | Scale: 1–5 as above |

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**FROM CURIOSITY TO COMPETENCE: DEVELOPING AI LITERACY THROUGH ESP INSTRUCTION AT A TECHNICAL UNIVERSITY**

scientific monograph

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