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Leveraging Generative AI in Support of Self-Directed Learning: Insights from Student Prompting Practices

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This study explores how undergraduate students engage with generative artificial intelligence (AI) tools in structured prompting tasks and how these interactions relate to self-directed learning (SDL) and AI literacy. A total of 57 students participated in a survey-based study that examined their prior experiences with AI, prompting practices, SDL-related behaviours, perceptions of AI usefulness and ethics, and the pedagogical quality of AI-supported outputs. Findings indicate that nearly all students had prior experience with AI tools and actively engaged in prompt formulation, with most demonstrating specificity and contextual awareness but fewer engaging in iterative refinement. Prompting tasks supported SDL skills such as goal setting, evaluation, and task ownership, though personalization and ethical reflection were less common. Students generally perceived AI as useful and time-saving, yet many expressed uncertainty about ethical boundaries and authorship. The pedagogical quality of outputs was often high, showing structured design, age-appropriate examples, and creative elements. These exploratory results suggest that prompting can serve as both a cognitive and pedagogical practice, supporting learner autonomy and creativity, while highlighting the need for explicit scaffolding in iterative prompting, ethical awareness, and responsible AI use in higher education.

Keywords: artificial intelligence (AI), prompting, generative AI, self-directed learning, digital literacy, AI literacy, higher education

INTRODUCTION

The emergence of generative artificial intelligence (AI) tools such as ChatGPT, Microsoft Copilot, Google Gemini, etc. has introduced new possibilities and challenges for higher education. These tools offer instant access to synthesized information, structured content, and iterative dialogue, allowing students to explore ideas, generate explanations, and receive tailored feedback. As generative models become increasingly included in digital learning environments, it is essential to research how students interact with these technologies, not only as sources of information, but as co-creators of learning materials and experiences.

In parallel with this technological shift, self-directed learning (SDL) has gained renewed relevance. Defined by Knowles (1975) as the learner's ability to take initiative

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in diagnosing learning needs, formulating goals, identifying resources, and evaluating outcomes, SDL is foundational to adult education. Its importance has only grown in digitally mediated learning spaces, where learners must navigate information overload, assess credibility, and make autonomous decisions (Garrison, 1997; Loyens et al., 2008). As AI tools offer personalized feedback and dialogic interaction, they present new opportunities for supporting SDL dimensions such as autonomy, goal-setting, and reflection (Wu et al., 2024). Prompting, the practice of crafting and creating inputs to guide AI responses has emerged as a core literacy in this context. Prompt engineering demands more than content direction users need to communicate context, style, structure, and audience clearly (Karnatak et al., 2025). Prompting thus entails a blend of technical skill and rhetorical awareness, and may be understood as both a cognitive and pedagogical act (Ranade, Saravia & Johri, 2025). Effective prompting requires users to iteratively refine their inputs, critically evaluate outputs, and align AI-generated content with intended learning outcomes. Although generative AI systems offer conversational, personalized interactions, their educational utility hinges on students' ability to strategically engage with them. Prompting mirrors SDL's emphasis on learner initiative, strategy use, and outcome evaluation, positioning prompt literacy as a bridge between self-directed learning and AI tool efficacy. However, not all learners possess equal readiness for this form of engagement. Despite growing interest in AI in education, limited research has examined how students actually engage in prompting within structured learning contexts. There is a particular gap in understanding how these practices relate to the development of SDL competencies and AI literacy (Roe & Perkins, 2024), especially in light of emerging concerns about equitable, critical, and ethical engagement with AI technologies.

Moreover, questions remain about the pedagogical quality, originality, and cognitive depth of AI-supported outputs created by students, as well as how these outputs connect to the development of self-directed learning and AI literacy. To address these gaps, the present study investigates how undergraduate students engage with generative AI tools in a structured assignment that emphasized prompt formulation, content evaluation, and lesson design. A survey combining closed- and open-ended items was employed to capture students' prior experiences, prompting strategies, SDL-related behaviors, and perceptions of AI's pedagogical value.

The research is guided by five questions: (RQ1) What prior experiences do undergraduate students have with generative AI tools, and how do these experiences influence their engagement with AI-supported learning tasks? (RQ2) How do undergraduate students construct and refine prompts when using generative AI tools in educational tasks? (RQ3) To what extent does participation in prompting tasks foster self-directed learning skills such as goal setting, evaluation, reflection, and task ownership? (RQ4) How do students perceive the usefulness, limitations, and ethical implications of generative AI tools in their learning processes? and (RQ5) What is the pedagogical quality of AI-supported outputs produced by students, such as lesson plans and instructional content?

By addressing these questions, the study provides exploratory, context-bound insights into how generative AI can be meaningfully integrated into higher education. In

particular, it highlights prompting as both a cognitive and pedagogical practice that connects students' prior AI literacy, emerging SDL competencies, and their capacity to critically evaluate and adapt AI outputs for instructional use.

Literature Review

The growing emphasis on learner autonomy and the transformative role of emerging technologies in education makes it essential to revisit three interrelated strands of research, (1) self-directed learning and its impact on academic success, (2) the role of AI in supporting academic success, and (3) the relationship between AI literacy and AI utilization. These strands also frame the theoretical foundation of the present study.

Impact of Self-Directed Learning on Academic Success

Self-directed learning is a foundational concept in adult education, emphasizing learners' capacity to take initiative in diagnosing learning needs, formulating goals, identifying resources, implementing strategies, and evaluating outcomes (Knowles, 1975). Garrison (1997) expanded this understanding through a comprehensive model comprising three interrelated dimensions: self-management, self-monitoring, and motivation. These dimensions have been empirically validated in diverse educational contexts and are strongly associated with learner autonomy and metacognitive awareness (Loyens, Magda, & Rikers, 2008).

A growing body of research demonstrates that SDL positively correlates with academic success, particularly in digitally mediated environments. For example, Pilling-Cormick and Garrison (2007) found that students who actively engaged in metacognitive planning and reflection were more successful in online learning settings. Similarly, Song and Hill (2007) observed that students' ability to regulate their learning strategies significantly impacted their performance in web-based courses.

With the rapid introduction of artificial intelligence technologies, especially generative models like ChatGPT, educational landscapes are evolving in ways that call for a re-examination of autonomy, agency, and learner control. Generative AI tools offer new affordances for iterative and personalized learning experiences, prompting reconsideration of the processes that underpin SDL.

While prior research has established the importance of SDL in online learning, less is known about how prompting with generative AI fosters SDL processes such as goal setting, evaluation, reflection, and task ownership. This gap directly informs RQ3 in the present study.

Impact of AI on Academic Success

AI has been shown to influence student motivation, competence, and achievement in higher education. Recent empirical studies suggest that generative AI tools, especially ChatGPT, can influence learners' motivation, emotional regulation, and affective engagement (e.g., Kohnke et al., 2025; Heung et al., 2025; Bin-Hady, 2024). Daha and Altelwany (2025) found that students with mastery-oriented goals and high academic self-efficacy were less reliant on ChatGPT, suggesting that intrinsic motivation remains a key driver of autonomous learning even in AI-enhanced environments. Alshammari

(2025) reported that students using ChatGPT experienced increased emotional self-regulation, including reduced anxiety and enhanced motivation. Synekop, Ibrahim, and Nordin (2025) demonstrated that ChatGPT-supported instruction improved students' writing and engagement in English as a Foreign Language (EFL) contexts.

However, research also highlights challenges. Susnjak and McIntosh (2024) warned that the ease of generating content with AI tools may encourage cognitive offloading, reducing the development of original thinking and academic writing skills. Selwyn (2019) cautioned against treating AI as a neutral technological advancement, pointing instead to its social, institutional, and epistemological implications. In particular, the integration of generative AI in student work raises complex questions about authorship, agency, and accountability.

Although studies demonstrate both motivational benefits and risks of overreliance on AI, few explore students' perceptions of usefulness, limitations, and ethics when using AI for academic tasks. This gap underpins RQ4, which examines how students perceive the usefulness, challenges, and ethical implications of AI.

Impact of AI and AI Literacy on AI Utilization

The effective use of AI tools depends on foundational competencies in digital and AI literacy. Digital literacy includes not only technical skills but also the capacity for critical and ethical engagement with digital environments (Ng, 2012). Building on this, Long and Magerko (2020) introduced the concept of AI literacy, which encompasses users' abilities to understand, interact with, and critically evaluate AI systems.

Prompting, the practice of crafting inputs for AI tools, has emerged as a key metacognitive skill within AI-supported learning environments (Long & Magerko, 2020; Holmes et al., 2019; Selwyn, 2019). Studies show that students' ability to formulate effective prompts is closely tied to critical thinking and autonomous learning outcomes (Alshammari, 2025; Synekop et al., 2025). Research by Le Thi Tuyet Hanh et al. (2025) also highlights digital inequality, students from rural regions and marginalized groups face greater barriers in acquiring AI literacy.

Ethical frameworks also shape AI literacy. Floridi and Cowls (2019) proposed principles of beneficence, autonomy, and explicability, while Holmes, Bialik, and Fadel (2019) emphasized fairness, learner well-being, and informed consent in AI-mediated education. These concerns underscore the need for pedagogy that builds not only technical competence but also ethical responsibility.

While theory positions AI literacy and prompting as central to meaningful AI use, empirical evidence on how undergraduates construct, refine, and apply prompts in real learning tasks remains limited. This informs RQ1 and RQ2. Furthermore, questions about how students evaluate and adapt AI outputs to meet pedagogical goals (structure, age-appropriateness, creativity) connect directly to RQ5.

Theoretical Framework

The present study is guided by two complementary frameworks self-directed learning and AI literacy. Together, they provide the conceptual lens for interpreting how undergraduate students engage with generative AI in educational tasks.

SDL emphasizes learners' responsibility for setting goals, monitoring progress, and reflecting on outcomes. In this study, SDL is applied to examine whether AI-supported prompting tasks encourage autonomy, goal setting, evaluation, and reflection (RQ3). This framing also informs the analysis of how prior experiences with AI tools shape students' engagement (RQ1).

AI literacy extends digital literacy to include the ability to interact with and critically evaluate AI systems. It encompasses technical skills (e.g., prompt construction), awareness of limitations, and ethical responsibility. In this study, AI literacy underpins the investigation of how students construct and refine prompts (RQ2), how they perceive the usefulness, challenges, and ethical implications of AI (RQ4), and how they evaluate the pedagogical quality of AI-supported outputs (RQ5).

SDL and AI literacy highlight that generative AI does not automatically enhance learning but creates a context where students must exercise both autonomy and critical literacy.

METHOD

Research Design

This study employed a convergent mixed methods design (Creswell & Plano Clark, 2018), embedded within a design-based research (DBR) framework (Collins, Joseph, & Bielaczyc, 2004; Wang & Hannafin, 2005). The mixed methods design was chosen because it enabled the integration of quantitative and qualitative strands, the quantitative strand provided descriptive insights into students' prior AI experiences, prompting practices, and perceptions of usefulness, while the qualitative strand captured students' reflections on prompting strategies, challenges, and ethical considerations. Both strands were collected simultaneously through the same survey instrument, analyzed separately, and then integrated during interpretation. This design ensured that numerical trends could be triangulated with participants' own explanations and reflections.

Participants

Fifty-seven first-year undergraduate students from the Faculty of Education and Rehabilitation Sciences, University of Zagreb, participated in the study. All participants were female (N = 57, 100%). The students were enrolled in the compulsory course Informatics. Their ages ranged from 18 to 22 years (M = 19.4). Participants represented three program tracks: Speech and Language Pathology (n = 38, 66.7%), Social Pedagogy (n = 10, 17.5%), and Educational Rehabilitation (n = 9, 15.8%).

Purposive sampling was employed in this study. All participants were drawn from a single cohort of students enrolled in the compulsory course Informatics. This approach was selected to ensure that participants had a common baseline of exposure to the instructional intervention on generative AI and prompting. By focusing on students who completed the same structured learning activities, the study was able to gather data from individuals directly relevant to the research purpose of examining AI-supported prompting and self-directed learning.

Instruments

Data were collected through an online survey administered at the end of the intervention. The instrument included both closed-ended and open-ended items aligned with the research questions.

Closed-ended items were rated on a 5-point Likert scale (1 = strongly disagree, 5 = strongly agree) and examined digital confidence, perceived usefulness of AI tools, ease of use, ethical awareness, and SDL-related behaviours (e.g., goal setting, evaluation). Example items include: "I feel confident in formulating prompts for AI tools" and "AI tools saved me time in completing the assignment."

Open-ended items invited students to describe their prompting strategies, challenges encountered, and reflections on AI's role in their learning. Example prompts include: "Describe how you adjusted a prompt to improve the AI's response" and "What ethical considerations, if any, did you take into account when using AI?"

The survey was adapted from the Technology Acceptance Model (Davis, 1989) and frameworks of AI literacy (Long & Magerko, 2020), ensuring conceptual alignment with the study's research purposes and questions.

As this was an exploratory study, the survey instrument was not designed as a standardized psychometric scale. Instead, it served as a context-specific tool to capture both numerical trends and qualitative reflections.

Procedure

The intervention was integrated into a regular lecture and assignment within the course. Students first attended a lecture titled Generative Artificial Intelligence: Prompting and Text Manipulation, designed to introduce foundational concepts of generative AI, prompt engineering, and ethical implications of AI use in education. The lecture covered techniques such as zero-shot, few-shot, instruction-based, role-based, and refinement prompting (Brown et al., 2020; Holmes, Bialik, & Fadel, 2019), as well as best practices for writing effective prompts. This phase provided the necessary theoretical and technical scaffolding to ensure informed engagement with AI tools. Following the lecture, students completed a hands-on assignment titled Practicing Prompting. This structured activity consisted of five interrelated tasks aligned with real-world themes such as digital safety, identity theft, and social media literacy. The exercises included, comparative analysis of prompt effectiveness, information validation through cross-referencing AI outputs with official sources, creation of age-appropriate educational content using AI, role-based writing (e.g., acting as a school psychologist) and development of a complete lesson plan using generative AI. These tasks reflect prompt engineering as a critical AI literacy skill and were informed by principles of experiential and inquiry-based learning. Students were encouraged to test, revise, and evaluate AI-generated outputs. This approach also aligns with SDL theory (Knowles, 1975), as students assumed responsibility for selecting appropriate strategies, defining learning goals (e.g., creating lesson outcomes), and evaluating the usefulness of AI-generated materials. The ability to assess, adapt, and refine prompts further fostered metacognitive awareness and agency in the learning process. Upon completion of the assignment, students were invited to complete an anonymous online survey.

Specifically, it included questions on students' prior experiences with AI tools and patterns of use (RQ1), their strategies for constructing, refining, and applying prompts (RQ2), and their reflections on learning processes and self-directed learning skills such as goal setting, evaluation, and reflection (RQ3). Additional items explored students' perceptions of the usefulness, challenges, and ethical implications of AI integration (RQ4), as well as their attitudes toward the broader role of AI in higher education and evaluations of the pedagogical quality of AI-supported outputs (RQ5).

To clarify the structure of the intervention, Table 1 summarizes the phases, activities, and data collection procedures. The design followed a single DBR cycle, beginning with a lecture, followed by a structured assignment, and concluding with a survey. Each phase served a distinct purpose introducing prompting concepts, enabling authentic practice, and capturing student experiences through both quantitative and qualitative data.

Table 1
Phases of the intervention and data collection within the design-based research (DBR) framework

Phase	Activity	Purpose	Data collected
Phase 1: Lecture	Students attended lecture on Generative AI: Prompting and Text Manipulation	Introduce AI literacy concepts, prompting strategies, and ethics	–
Phase 2: Assignment	Students completed structured tasks (prompt creation, evaluation, lesson design)	Apply prompting in authentic tasks, connect AI use to SDL	Student outputs (lesson plans, AI interactions)
Phase 3: Survey	Online questionnaire with closed- and open-ended items	Capture experiences, perceptions, SDL behaviours	Quantitative (Likert-scale items) + Qualitative (open responses)
Phase 4: Analysis & Integration	Descriptive stats + thematic analysis	Examine prompting practices and SDL support	Integrated findings aligned with RQs

Data Analysis

Closed-ended survey responses were analyzed using descriptive statistics to summarize prior AI usage, prompting practices, perceived usefulness, and SDL-related behaviors. Frequencies and percentages were calculated for categorical items.

To assess the internal consistency of the full set of Likert-scale items, a reliability analysis was conducted across 43 items representing students' perceptions of AI-supported learning, self-directed learning behaviours, prompting competence, and ethical awareness. Cronbach's alpha was computed using the responses of 57 participants, yielding a coefficient of $\alpha = .96$, which indicates excellent internal consistency (George & Mallery, 2019). This suggests that the items reliably measure a coherent underlying construct related to students' experiences with generative AI in learning. Although the sample size is relatively small, reporting this coefficient provides

an estimate of measurement reliability and supports cautious interpretation of the findings. Given that the data were ordinal, Cronbach's alpha was used as an approximate indicator, while acknowledging that ordinal alpha based on polychoric correlations would be preferable in future research with larger samples (Zumbo, Gadermann, & Zeisser, 2007).

Open-ended responses were analyzed thematically following Braun and Clarke's (2006) six-step approach. The author independently conducted the coding, beginning with inductive descriptive codes generated directly from the data. These initial codes were iteratively refined into broader categories, including prompting strategies, self-directed learning behaviors, and ethical awareness. Categories were derived through constant comparison of coded data, ensuring they captured recurring patterns relevant to the research questions. Representative quotations were selected to illustrate each theme.

FINDINGS

This section presents findings across several domains, including prior AI usage, engagement with prompting tasks, perceived learning outcomes, and educational attitudes toward AI. Reflections from open-ended responses are also analysed to highlight students' prompting strategies, self-directed learning behaviours, and the pedagogical quality of AI-supported outputs. Together, these results offer insight into how students interacted with generative AI tools and how such interactions influenced their learning processes and skill development.

The results are presented in alignment with the five research questions. As the data are based primarily on self-reports from a single cohort, the findings are descriptive and exploratory in nature. They provide an initial insight into how undergraduate students engaged with prompting activities and perceived the role of generative AI in supporting SDL, but they should not be generalized beyond the present context.

RQ 1: What prior experiences do undergraduate students have with generative AI tools, and how do these experiences influence their engagement with AI-supported learning tasks?

To address RQ1, the findings examine students' prior experiences with generative AI tools and how these shaped their engagement with the assignment. Table 2 summarizes prior AI usage, while Table 3 presents students' in-task engagement through prompt iteration practices.

Prior Exposure to AI Tools

As shown in Table 2, most students reported occasional or frequent prior use of AI tools.

Nearly all participants (98.2%) had prior experience using AI tools such as ChatGPT, Microsoft Copilot, or Google Gemini. Among these, 56.1% reported using AI occasionally, while 36.8% used it regularly in academic or everyday contexts. Only one respondent (1.8%) indicated no prior use. Common past uses included content generation for academic work, idea exploration, and clarification of academic material, suggesting moderate AI literacy among students.

Table 2
Prior use of AI tools (N = 57)

Response	n	%
Occasionally use AI tools	32	56.1
Frequently use AI in academic or everyday work	21	36.8
Tried once or twice	3	5.3
Never used AI tools	1	1.8

Engagement with the AI-Supported Task

Student engagement with the AI-supported learning activity was high. Overall, 84.2% of respondents reported adjusting at least one prompt to improve output quality, indicating an active, iterative engagement with the tool (see Table 3 in RQ2 for details on iteration practices). Most students (66.7%) described the AI as "very useful" for the task, and another 28.1% considered it "useful in parts." Regarding output integration, 49.1% combined AI-generated content with their own text, while 38.6% used AI content with only minor modifications. The frequency of prompt revision and the combination of AI and self-generated content illustrate a nuanced use of AI, where students exercised discretion and editorial control. Details of how students iterated and refined their prompts are presented in RQ2. One student reflected, "AI tools can primarily assist in creating various materials for therapy or class preparation, especially when we are short on time," underscoring the role of AI in easing instructional design burdens.

RQ 2: How do undergraduate students construct and refine prompts when using generative AI tools in educational tasks?

To address RQ2, the findings focus on how students constructed, refined, and applied prompts during the tasks. Patterns of prompt specificity, iteration, and role- or instruction-based strategies illustrate varying levels of prompting competence.

Prompting Practices and Strategies

Most students demonstrated a foundational understanding of how to formulate prompts that include specific instructions and context. Building on the engagement patterns reported in RQ1, this section focuses specifically on how students constructed, refined, and applied prompts. While most students reported adjusting prompts at least once (see Table 3), the depth and style of their prompting practices varied. Overall, 86% of submissions showed evidence of prompt specificity. Students often included role and audience indicators such as: "Write a message from a school psychologist to parents about safe use of social media." and "Generate a lesson plan for 15-year-olds on fake news detection."

Table 3 summarizes prompt iteration practices. Prompt refinement was less common (38%), though several students experimented with iteration suggesting that while students understood how to write clear and purposeful prompts, they were less practiced in the recursive process of prompt improvement. One wrote: "I had to rewrite my prompt three times before it stopped giving me general facts and started suggesting specific activities." Use of prompting styles such as role-based and instruction-based prompting appeared in 72% of cases. One student employed stepwise prompting: "First

I asked for a basic explanation, then I specified the tone and format. This gave me a more age-appropriate version."

Table 3
Prompt iteration practices (N = 57)

RESPONSE	n	%
Adjusted prompts once or twice	39	68.4
Adjusted prompts multiple times	9	15.8
Used the first result without changes	9	15.8

Table 3 illustrates these in-task behaviours, showing that while most students revised prompts at least once, a smaller group relied on the first response without modification.

RQ 3: To what extent does participation in prompting tasks foster self-directed learning (SDL) skills, such as goal setting, evaluation, reflection, and task ownership?

To address RQ3, the findings explore whether prompting activities supported the development of self-directed learning skills, including goal setting, evaluation, reflection, and task ownership. Drawing on Likert-scale survey items and qualitative responses, students reported varying levels of competence and reflection, with many demonstrating critical engagement and autonomy in their learning processes.

Perceived Learning Outcomes

Students attributed several learning benefits to AI integration. Based on Likert-scale survey items, 61.4% reported feeling competent using AI tools, though about a quarter remained neutral, indicating varying degrees of confidence. Prompting was widely seen as cognitively demanding while 43.9% found it simple, a much larger proportion (91.2%) agreed that effective prompting required clear thinking and linguistic precision. The tools also promoted reflection and critical engagement. About 78.9% of participants revised their prompts to improve quality, and 75.4% stated that AI responses stimulated their critical thinking. As one participant put it, "AI tools help in designing creative tasks or stories tailored to children's developmental levels", highlighting the potential for AI to enhance both cognitive complexity and developmental appropriateness. Students generally found the AI outputs useful for organizing their work (91.2% said AI helped them structure content, and 86% felt responses were well adapted to the intended audience). These findings are complemented by reflections such as, "I believe AI can be useful in adjusting or generating materials, especially for children with special needs".

Self-Directed Learning Behaviours

A significant number of students engaged in self-directed learning through goal-setting and output evaluation, 82% stated clear goals such as desired learning outcomes, educational level, or target audience. For example: "The aim is for students to be able to explain the risks of online identity theft and know how to prevent them." Evaluation of AI outputs was evident in 75% of the files. Students often critiqued content as being too vague or factually incomplete, e.g. "The AI said phishing always leads to identity theft, which isn't entirely true. I added clarification." Only 35% of submissions included

strong signs of personalization or stylistic edits. One example: "I rewrote the conclusion to match my voice and added a call-to-action for students." These practices align with SDL models (e.g., Garrison, 1997; Zimmerman, 2002) by highlighting learners' ability to manage learning goals, monitor performance, and regulate strategies. However, task ownership was prevalent in over 90% of submissions, with students reflecting on choices they made in selecting tone, audience, and output formats.

Digital and Cognitive Skill Development

Students also reported substantial development of digital and cognitive competencies. A total of 80.7% said they improved their ability to formulate precise prompts, and 82.5% felt more confident in using AI tools. Additionally, 86% indicated that the activity enhanced their digital skills, and 84.2% reported better understanding of how form and function interact in digital content. The capacity to critically evaluate AI outputs was also affirmed, 91.2% of respondents believed they could independently use AI for educational material creation, and 89.5% claimed to have developed the ability to distinguish between useful and unhelpful outputs. Ethical concerns were also salient. 93% of students agreed that educational AI use demands responsibility and ethical awareness, and 87.7% stated that they verify AI-generated content. One participant noted, "AI should not be copied without understanding, but used as support in idea development," aligning with current discourse on responsible AI integration.

RQ4: How do students perceive the usefulness, limitations, and ethical implications of generative AI tools in their learning processes?

To address RQ4, the findings examine students' perceptions of AI tools, focusing on usefulness, reported challenges, and ethical awareness. Table 4 presents ratings of perceived usefulness, while Table 5 summarizes the main challenges encountered, ranging from ethical uncertainty to technical barriers.

A large majority perceived clear benefits from AI use, 96.5% reported that AI saved time, and 86% agreed that it improved their understanding of the assignment. Students also noted motivational and cognitive benefits (see Attitudes Toward AI in Higher Education below). As shown in Table 4, nearly two-thirds (63.2%) found AI tools very useful, while just over one-third (35.1%) judged them useful only in parts, and only a single student (1.8%) considered the tools to have limited usefulness.

Table 4
Perceived usefulness of AI tools (N = 57)

Response	n	%
Very useful – helped a lot	36	63.2
Useful in some parts	20	35.1
Limited usefulness – required extensive editing	1	1.8

AI Literacy and Critical Awareness

Explicit recognition of AI limitations (e.g., inaccuracy or oversimplification) appeared in 42% of responses, students acknowledged issues such as outdated information or oversimplification. Students noted: "The AI suggested outdated statistics, so I checked

CERT.hr and corrected them." or "Some of the definitions were too abstract for primary school students."

Ethical use of AI was implied but rarely articulated directly. For instance, one student wrote, "AI should not be copied without understanding, but used as support in idea development," reflecting an awareness of ethical boundaries but highlighting the need for more robust ethical scaffolding in future instruction. While many avoided copying content verbatim, only 22% discussed the ethical dimension explicitly. One commendable example was: "Although the AI's response was well-written, I changed the wording to ensure it's my own expression and understanding."

As shown in Table 5, the most frequently reported challenge was ethical uncertainty about distinguishing one's own work from AI-generated contributions (66.7%). Beyond ethics, 42.1% of students struggled with formulating clear and specific prompts, while 31.6% had difficulty evaluating AI responses for accuracy or relevance. A smaller group (21.1%) noted challenges in adapting AI content to the intended target audience. Interestingly, some students reported that they faced no significant challenges at all (8.8%), whereas a few pointed to technical issues (5.3%) or limitations of free AI versions (1.8%). These findings highlight that while ethical boundaries were the most salient concern, a substantial proportion of students also encountered practical and technical barriers when working with generative AI.

Table 5
Reported challenges in using AI (multiple responses allowed)

Challenges	n	%
Ethical uncertainty about boundaries of own work vs. AI	38	66.7
Formulating clear and specific prompts	24	42.1
Understanding and evaluating AI responses	18	31.6
Adapting content to target audience	12	21.1
Nothing challenging	5	8.8
Technical issues	3	5.3
Limitations of free AI versions	1	1.8

Attitudes Toward AI in Higher Education

Students showed strong support for integrating AI more systematically into academic curricula. When asked whether they would like to use AI in other courses, 38.6% responded "definitely yes," and another 38.6% expressed conditional interest ("if the task requires it"). An additional 15.8% favoured use with instructor support. Regarding future professional application, 56.1% stated they would use AI tools depending on context, while 42.1% planned to integrate them regularly or occasionally. Many students noted the motivational value of AI, 87.7% found the task more engaging due to AI integration, and 78.9% felt more interested in completing it. One student remarked, "AI could be better used in class if students are guided to ask the right questions and adjust the answers", hinting at the need for pedagogical scaffolding in AI use.

RQ5: What is the pedagogical quality of AI-supported outputs produced by students, such as lesson plans and instructional content?

To address RQ5, the findings evaluate the pedagogical quality of AI-supported outputs, drawing on qualitative coding of lesson plans and instructional tasks to highlight patterns in structure, age appropriateness, cognitive challenge, and creativity.

Pedagogical Quality of Final Product

Most students created pedagogically sound outputs. 89% structured their tasks with an introduction, explanation, and multiple-tiered exercises. For example: "The lesson includes a warm-up question, a short explanation of phishing, and three tasks ranging from recognition to prevention strategies." Age appropriateness was achieved in 76% of submissions. Language, tone, and examples were adapted for elementary or secondary school learners. One student used an analogy: "Imagine you get a shiny candy from a stranger—it looks nice, but it might be dangerous. That's how phishing works online."

Cognitive challenge was present in 65% of the work, with tasks moving beyond recall to include analysis or application: "Compare two emails and identify which one is a phishing attempt. Explain why." Creativity appeared in 58% of assignments. Students used storytelling, dialogues, or visual metaphors to enhance engagement. One designed a mini-role play: "Act out a conversation where one student tries to convince another not to share their password." This coding shows that students developed foundational skills in AI prompting and self-regulated learning. Most were able to set goals, evaluate outputs, and construct structured, pedagogically meaningful content. However, fewer demonstrated deep ethical awareness or advanced prompt iteration, suggesting areas for targeted instruction.

These figures suggest that students not only utilized AI to generate content but also exercised pedagogical judgment in adapting it for instructional purposes. A representative example includes a task that asked students to compare phishing emails and explain why one was fraudulent, showcasing analytical depth.

DISCUSSION

The findings from this study provide insights into how undergraduate students engage with generative AI tools and how such interactions relate to SDL and AI literacy. By linking prior experiences, prompting practices, reflective behaviours, ethical awareness, and pedagogical outcomes, the study extends earlier research that highlighted both the opportunities and risks of AI in higher education (Dwivedi et al., 2023; Selwyn, 2019).

Prior experience and engagement (RQ1)

Nearly all participants had already used generative AI, most on an occasional or regular basis. This mirrors broader reports of rapid uptake of tools such as ChatGPT in academic settings (Zhai, 2022). However, while prior use gave students confidence to engage, the structured task shifted their orientation from consumption to purposeful application. Over 84% of students adjusted at least one prompt, and nearly half blended AI outputs with their own text. This finding resonates with research positioning prompting as a new literacy practice, where learners must engage in audience-aware

communication and exercise editorial judgment (Ranade et al., 2025). At the same time, the relatively modest proportion of students who iterated prompts multiple times (38%) suggests that recursive engagement with AI is not yet fully internalized, echoing earlier concerns that learners may treat AI outputs as fixed products rather than drafts to refine (Dehouche, 2021; Jakesch et al., 2022; Fu et al., 2023).

Prompting and SDL development (RQ2 and RQ3)

The results also demonstrate how prompting tasks supported SDL skills. Students frequently set clear goals (82%), monitored AI outputs, and reflected on accuracy and appropriateness. These behaviours align with Garrison's (1997) SDL dimensions of self-management and self-monitoring, and Zimmerman's (2002) model of cyclical self-regulation. Importantly, over 90% acknowledged that effective prompting required clarity and precision, suggesting that AI engagement can act as a scaffold for metacognitive development. This echoes findings from Pilling-Cormick and Garrison (2007) and Song and Hill (2007), who showed that reflection and planning enhance academic success in online contexts. However, personalization and stylistic adaptation were less frequent (35%), indicating that while task ownership was high, many students did not integrate their individual voice. This points to a developmental trajectory, AI may help learners externalize thinking, but further pedagogical scaffolding is needed to strengthen deeper reflection and originality.

Perceptions of usefulness, limitations, and ethics (RQ4)

Most students found AI beneficial, with 96.5% agreeing it saved time and 86% reporting it improved understanding. These perceptions are consistent with studies showing that ChatGPT supports motivation, emotional regulation, and engagement (Daha & Altelwany, 2025; Alshammari, 2025; Synekop et al., 2025). Yet the findings also highlight challenges. Ethical uncertainty was the most common difficulty reported (66.7%), with students unsure how to balance AI contributions against their own authorship. This aligns with Selwyn's (2019) critique of uncritical AI adoption and Floridi and Cowls' (2019) call for ethical principles such as autonomy and explicability. Although most students verified AI-generated information, fewer than a quarter explicitly reflected on originality or attribution, underscoring a gap between technical competence and ethical responsibility. Embedding explicit ethical literacy into AI-integrated assignments is essential to ensure responsible use, as recent work on educational AI governance also stresses (Dabis & Csáki, 2024).

Pedagogical quality of AI-supported outputs (RQ5)

Most submissions demonstrated sound instructional design, including scaffolded tasks (89%) and age-appropriate examples (76%). Many also incorporated creativity through storytelling or analogies, suggesting that AI can act as a catalyst for innovative pedagogy when embedded in structured activities. These findings extend earlier claims that AI enhances efficiency (Dwivedi et al., 2023) by showing its potential to support higher-order learning design. At the same time, variability in cognitive challenge, some tasks focused on recall, while others required analysis or synthesis suggests that students need guidance to align AI outputs with established frameworks such as

Bloom's taxonomy. This echoes Susnjak and McIntosh (2024) warning that uncritical reliance on AI risks cognitive offloading unless paired with intentional design, while also supporting arguments that AI can stimulate creativity and learner motivation when used with pedagogical scaffolding (Doshi & Hauser, 2024).

Results show that generative AI can support SDL by fostering goal setting, reflection, and evaluation, while also enabling the development of AI literacy through prompting and critical appraisal. Yet gaps in iteration depth and ethical awareness indicate that these literacies do not develop automatically. As Abraham et al. (2025) argue, human–AI collaboration is best understood as dialogic and recursive, requiring explicit scaffolding. The present study contributes to this conversation by showing how students both leveraged and struggled with AI tools, offering practical implications for educators who wish to integrate generative AI in ways that strengthen rather than weaken learner autonomy.

CONCLUSION

This exploratory study investigated how undergraduate students engage with generative AI tools through prompting practices and how these interactions relate to the development of SDL and AI literacy. Guided by SDL and AI literacy frameworks, the intervention provided initial insights into how prompting functions not only as a technical skill but also as a reflective and pedagogical practice.

The findings, interpreted across five research questions, suggest that students brought varying degrees of prior AI experience (RQ1), constructed and refined prompts with moderate specificity and iteration (RQ2), and demonstrated self-directed learning behaviours such as goal setting, evaluation, and task ownership (RQ3). Students generally perceived AI tools as useful and time-saving but expressed limited ethical awareness, highlighting the need for stronger curricular support in this area (RQ4). Finally, student-created outputs were often pedagogically sound, showing structured design, age-appropriate adaptation, and some creativity, though not all demonstrated higher-order cognitive challenge (RQ5).

These results indicate that prompting tasks with generative AI can provide opportunities to foster both technical fluency and reflective engagement. However, given the exploratory nature of the study, these findings should be interpreted as provisional rather than conclusive. The sample was limited to a single cohort, data relied primarily on self-reports, and the intervention spanned only one course assignment. These factors restrict generalizability and call for caution in extrapolating beyond this context.

The study nonetheless highlights areas where pedagogical scaffolding could enhance learning. Students may benefit from explicit instruction in iterative prompting strategies, verification of AI outputs, and ethical dimensions of AI use. Teacher education programs and higher education curricula more broadly could also consider integrating "prompt literacy" as part of AI literacy education, framing it not as a tool-specific technique but as a form of digital rhetoric and pedagogical reasoning.

Future research should extend this work by examining longitudinal effects of prompting tasks, disciplinary differences in prompting practices, and the potential of collaborative

co-prompting models between students and educators. Such studies could clarify how generative AI might best be integrated into higher education to support critical, ethical, and autonomous engagement with technology.

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