Fostering Student Agency through a Practice-First AI Agent

Author: Lari Tserenov
University of Twente
P.O. Box 217, 7500AE Enschede
The Netherlands

ABSTRACT

This thesis explores the potential of a practice-first AI agent in enabling agency in digital learning. This design is different from most AI tools that focus on automation, as the intention with this design is to have learners engage in tasks first and then engage in theory, with the goal of triggering inquiry, reflection, and ownership in their own learning. The study looked at two tools used in practice from the Aisystant platform: a task-based simulator and a Telegram AI tutor. Nine users from active study groups were interviewed, and the data was analyzed thematically. Cognitive and educational processes of agency were demonstrated through six mechanisms: learners were given agency through autonomy, cognitive activation through uncertainty and confabulation, reflective writing, intrinsic motivation, meaningful feedback, and agentic engagement. Findings were consistent with constructivist theory, which states that learners form their understanding of theory through experience. Three implications for design principles for AI agents are proposed: support flexible pathways, use uncertainty with a purpose, and provide reflective feedback. The implications position AI not as content that is automating human work, but as a thinking partner in student-driven learning.

AI statement

"During the preparation of this work, the author used Chatgbt, Grammarly, Quilbot in order to support idea development, improve academic writing style, and ensure clarity and coherence of the text.. After using this tools, the author reviewed and edited the content as needed and takes full responsibility for the content of the work."

Graduation Committee members: 1. Dr. Rainer Harms;

2. Dr. Maximilian Goethner

Keywords

AI in education, AI Agent, Telegram Bot, Agency, Learning, CIMO framework

---

1. INTRODUCTION

In terms of student engagement, there is an increasing inability for modern educational systems to move away from student agency (Mameli et al., 2023). Students may navigate a course administratively and do well on their assessments, but will rarely exhibit engagement, autonomy, or reflective thinking. The core issue is typically devoid of agency, with agency defined as the ability to set your own personal learning goals, make informed decisions, be motivated to regulate one's own behaviours and to take full ownership of the learning process and outcomes (Mameli et al., 2023). Agency in the context of education matters, particularly in a digital society where learners are largely expected to do things independently and not be a passive recipient of content. An AI agent can play an important role in supporting agencies, however its design must be undertaken carefully to avoid diminishing the students' autonomy.

At the same time, AI is emerging in education. However, most applications still focus on automating delivery and assessment rather than fostering deeper cognitive engagement or intrinsic motivation. This automation bias limits the potential of AI to promote agency or reflection in learners (Alasadi & Baiz, 2023, p. 2).

This study examines an existing AI agent that implements a task-based, practice-first design intended to promote student agency. The agent was developed prior to this study and is evaluated in its implemented form as a working MVP. The practice-before-theory refers to a pedagogical approach where learners first engage with open-ended tasks before receiving theoretical instruction, aiming to foster curiosity, reflection, and deeper cognitive activation (Haith & Krakauer, 2018). The forefront action provides an opportunity for learners to see relevant problems, reflect on their own thoughts and thinking, and this is exactly the benefit of introducing theory after practice.

This leads to the research question guiding this study:

How can the implementation of practice-first design principles in an AI agent support student agency in digital learning environments?

This logic of engaging students in "initial exploration before explanation" has been discussed in recent literature as a means of enhancing curiosity, promoting cognitive activation, and fostering deeper reflection and conceptual understanding (Alasadi & Baiz, 2023). For instance, a student might first attempt to classify a system based on intuition and only afterward receive the formal definition, helping them compare their own reasoning with the theoretical model. Student agency is viewed here as the ability of the learner to act autonomously, with intention, and responsibility. An educational ecosystem refers to the overall learning context, including the content, peers, tools, and systems that frame such interactions.

To structure the inquiry, this study follows the Explore–Synthesize–Create–Evaluate (ESCE) model, a common structure in design-oriented research (Van Aken, 2004; Denyer et al., 2008). This framework enables iterative development and critical assessment of design principles within a real-world context.

This research does not approach AI as a tool of automation, rather it takes the position of AI as an active design element that can aid students' thinking, agency, and growth. The aim is to contribute both theoretically and practically to the emerging field of AI-supported agencies in education.

This thesis adopts a design-oriented research paradigm that seeks to develop design principles that are actionable in practice and in context. This aligns with the design science paradigm in management which has emphasized the creation of generalizable and principles to solve complex problems in the real world (van Aken, 2004). The intervention discussed in this study is situated in this paradigm, and aims to provide actionable knowledge about the promotion of student agency in AI-supported learning environments.

2. EXPLORE

2.1. Research Goal

The research was stimulated by the occurrence of a real-world issue: although there has been a proliferation of digital learning sites for students, students remain disengaged by passively completing courses and earning digital certificates, while not demonstrating engagement, autonomy, or critical thinking (Stenalt & Lassesen, 2022).

There is evidence from current research to suggest that many automating AI or other types of tools for educational purposes tends to focus on delivery or assessment of learning outcomes, rather than enabling students to take an autonomous reflection about their learning in a mode separate from a formalized learning environment.

Ultimately, this research deconstructs a pressing gap in the design of educational technologies that focus on advanced learning agencies. Specifically, there are few, if any AI-based technological advances that adaptive educational technologies created to support student agency through interaction and personal involvement.

While AI technology holds the potential to support agency, virtually every existing AI-based or other educational technology disregards the potential of activating a student's initiative and intrinsic motivation.

The aim of this study is to investigate how the practice-first design principles of engagement first, and then providing learners with a theoretical purpose of the practice can be incorporated into an AI agent to promote student agency in a digital learning environment.

2.2. Literature Review

This literature review has identified four conceptual foundations that can inform the design of an AI agent to support student agency.

Student agency refers to the learner's ability to act independently, develop personal learning objectives, select approaches, and commit to outcome ownership (Mameli et al., 2023). Agency becomes more critical in situations that require the learner to take responsibility for self-directing their studies, as is often the case in digital spaces where educators may opt to design students' learning around student objectives or through content delivery. There is evidence that students who experience high levels of agency tend to engage at a deep level, require more time and effort for learning, and can sustain long-term motivation (Stenalt & Lassesen, 2022).

Agency should not be conceptualized only as a personal quality but, instead, it seems more productive to consider it as a product of interactive processes between learners and the

contexts in which they operate e.g., institutional, social, and task-based (Ceelen et al., 2025).

Moreover, current progress in learning analytics is indicating that agency can no longer be described solely as a theoretical construct, but can be quantitatively measured. Jääskelä, Heilala, Kärkkäinen, and Häkkinen (2021) have developed a framework to analyze student agency in online learning environments from behavioral indicators in that context (i.e., tool use, engagement trajectories, and task progression). In their work, these researchers were able to show that agency dimensions such as intentionality, autonomy, and self-reflection can be empirically observed from learners' interactions with the learning system, and expand upon design efforts for AI-supported learners in educational contexts.

Yet, in addition to agency, a shift in perspective, design, and practice has to happen from transmitting content, to learning designs that activate learners' decision making and ownership. Supported poorly, students may struggle with an overwhelming choice of options, or just feel the pressure of setting personal objectives, where lack of support can lead to disengagement or demotivation by not setting out to achieve or following through with personal objectives. One possible intervention to counter these hazards is to employ formative assessment practices that provide the students with ongoing feedback and opportunities for regulation, which has been shown to enhance their sense of ownership and agentic engagement (Mohammadi Zenouzagh, Admiraal, & Saab, 2025). Certain instructional designs are more conducive to supporting agency in practice. The practice-before-theory principle is one example of this

Practice-before-theory is a principle of pedagogy that suggests learners benefit from engaging in a task before receiving a formal explanation of theory. Students will elicit intrinsic motivation and curiosity, while stimulating cognitive activation because they can hypothesize and reflect once they have been introduced to structured content (Haith & Krakauer, 2018). Positive outcomes may be students' development of a contextual understanding of concepts, improved retention which could be explained through the structure of desired learning outcomes but, on the other hand, students' misconceptions if the task was not sufficiently scaffolded or was given little clarity. Therefore, task design includes the need for feedback of value to engage with task reflection to aid and align concept and learning. The practice-before-theory principle aligns closely with constructivist learning theory, which focuses on the learner as an active participant in a community of learners building understanding from experience. The order of practical engagement followed by theoretical instruction improved conceptual activation, especially when learners were asked to make and test their own hypotheses in an unfamiliar area (Natarajan et al., 2020).

Constructivist learning theory recognizes the learner as an agent, actively constructing knowledge through experience, in testing hypotheses and reflecting on outcomes. This principle advocates strongly for open-ended tasks, open-ended learner-led experiences for the learner, paragraphs so it fits with the practice first principles. Positive outcomes may include challenging students' critical thinking skills and ability to take skills learned and transfer their application to new contexts. Challenges arise for educator design of tasks and support structures through constructivist learning theory especially when tasks become complex or are conceptual and abstract. Students may struggle with integrating newly learnt knowledge into the rationale outcomes or misconstrue the key concepts if the task is poorly aligned. Educational contexts that use artificial intelligence to build self-regulated learning through meta cognitive strategies, motivational regulation, and adaptive goal-setting are particularly important for promoting student agency in digital environments (Lan & Zhou, 2025).

Lastly, while the practice of using AI in education has mostly focused on automating delivery of content and assessment that was designed through implementation, educational AI is not about automation; it is about an engagement and promoting deep learning and supporting the student taking the lead. A number of studies critique these existing tools in favor of learner autonomy, prioritizing education, or forming meaningful engagement (Alasadi & Baiz, 2023). When designed for its intended purpose, educational AI can have value to scaffold learning, track patterns and promote reflection. Nevertheless, when educational AI is not designed with purpose, the outcomes will always be a passive consumption of content. While generative AI affords meaningful opportunities for personalization and scalable feedback in learning environments, it also introduces considerable and critical risks of undermining critical thinking in their absence or inadequate pedagogical design (Giannakos et al. 2024). This paradox raises an important design issue: AI tools may be efficient, yet may diminish students' cognitive engagement if they substitute for active meaning-making. (Jose et al., 2025).

More recent conversations regarding AI in education indicate an emergence of generative models and learner analytics that may scaffold learner agency in real time (Consoli & Petko, 2025; Reeve et al., 2025). They offer student support and framework and give flexibility not just giving static responses to student questions, but also helping to dynamically adjust the response depending on student uncertainty, hesitation, or conceptual breakthrough. This further reinforces the thinking that AI is a partner in learning rather than just a tool. Building on the theme of agency being scaffolded and detected through digital traces, the new design space for AI in education expands from variable-student-reactive feedback to proactive support of metacognitive engagement.

2.3. Practice context

Despite the prevalent accessibility of digital learning platforms, there remains a lack of active engagement with learning from many of the students involved: while they may complete courses and assessments, and may earn a passing grade, they do not demonstrate sustained motivation, reflective thinking or the ability to self-direct their own learning. A primary reason is that most EdTech solutions (including those utilizing artificial intelligence), focus on providing information instead of student agency, or the learner's ability to act, make choices, take responsibility, and create their own learning path. This is particularly problematic in online education, where contact with an instructor is limited, and the design of tasks, and interface also play a significant role (Stenalt & Lassesen, 2022).

The context for this study is Aisystant, an educational startup platform designed to promote skills in systems thinking, practical intelligence, and self-development. This program incorporates a systems methodology with domains such as ontology, logic, ethics, aesthetics, mathematics, and theory of concepts, all of which the students engage as they interact

with core ideas and practices meant to build cognitive autonomy. This action model also aligns with constructivist learning theory because students are seen as active constructors of knowledge as they create hypotheses and reflect reason with what they know. This study focuses on two of the digital tools developed within the Aisystant platform, (1) a course-based training simulator, and (2) a Telegram-based AI tutor. The practices outlined in both tools point toward a practice-before-theory, or a learn-by-doing, instruction design. This paradigm captures the general movement in AI development in education to use personalization of learning pathways to support learner agency and goal alignment (Tapalova & Zhiyenbaeva, 2022).

For example, in the first tool, the training simulator, there is a sequence of interactive tasks designed to foster students' active and independent thinking before theory is introduced. The learning activities are systematic in that there is a structured progression of tasks over 18 sessions, where each session contains seven different types of tasks (e.g., identify outliers, complete concept lists, sort items, assess statements, provide examples, explain relationships, or write a concept definition). In each case, theoretical explanation appears explicitly after the student engages with the task as a feasible reflection scaffold and feedback, which also serves to maintain intrinsic motivation, conceptual learning, and transfer of knowledge to their personal projects in an uncertain environment.

In the second tool, the AI tutor in Telegram, this is a structured learning environment that engages students in purposeful interaction and virtually involves them in activities. The AI offers students structured or creative tasks, evaluates responses, and guides learners through the process in a supportive manner. The interaction is dialogic, meaning the bot first offers a task for the person to attempt, then receives the student's answer, encourages them to revise or reflect on their answer, and after that, the bot disengages while the bot presents explanations, analogies, or related concepts. The AI tutor has three modes of training, which includes (1) a predetermined task sequence, (2) a progressive "ladder" activity mode sort, and (3) a random task generator. There is a consultation mode as well, which enables students to ask questions about course concepts. In this way, the AI tutor supports students taking initiative, responsibility, and being reflective, meaning they can work at their own pace, take ownership of their own learning, and thinking. In addition, the experiences and interactions align with the understanding that AI instruments are not automation, rather an element for design which promote student experience, engagement and decision-making (Alasadi & Baiz, 2023). Extensive text-based models like ChatGPT are already making use of them in reading student-generated feedback to promote a process of reflection on their learning by using peer feedback to analyze common themes and summarize performance trends (Katz et al., 2023).

Thus, this context is then very relevant for studying agency for several reasons. First, neither of the tools (i.e., the training simulator and Telegram AI tutor) are prototypes, these are both minimum viable products (MVPs) that have been tested by actual students engaging in actual learning activities in active study groups. Second, the study was not conducted in an artifactual or lab setting: rather, authentic observational data were collected from students actively using the tools in authentic study groups and then nine semi-structured interviews were conducted with learners from the study groups. The interviews revealed processes of agentic behavior (i.e., taking initiative, being reflective, and creating self-defined goals for the task), as well as challenges to adapt to practice-first learning designs. Thus, Aisystant and its tools are a rich, authentic environment in which to observe and test design principles that support agency and active participation in real learning contexts.

2.4. Combined findings

The review of both the literature and early observations of practice offers significant evidence concerning parallels and openings in the development of a salient AI agent that supports student agency. The reflections on early practice observations support the theoretical assertions about the prevalence of the practice-before-theory instructional model working most effectively. Student curiosity and motivation were more prevalent while students were completing assignments before encountering any theoretical component — consistent with constructivist learning theory, where students take an active role in constructing their understanding through experiences. These effects are also representative of the practice-before-theory pedagogy (Haith & Krakauer, 2018), whereby problem solving is revealed prior to explanation, stimulating cognitive activation and meaningful reflection. In summary, students benefit from experiencing challenges and ambiguity first, and the speculation about possible solutions stimulates hypothesis-making, self-motivating curiosity, and reflective reasoning.

The literature and practice also highlighted a few implications for practice that would support student agency while designing the AI agent. Tasks that have students coming up with solutions, a problem-solving activity first, and then in a theoretical context would fit. Tasks should include manageable uncertainty and be able to successfully promote cognitive activation and intrinsic motivation through solving problems. Uncertainty elicits engagement and investment in the activity by facilitating discovery, even when formal explanation is delayed.

Another key implication is including a reflective feedback-loop component in the AI agent. The AI tutor's interaction design demonstrates an important aspect of the agent function of revisions of answers or analogies, and then follow-up theoretical comments. Including a feedback-loop process into the AI agent can further this confirmation. Again, providing wider support to the understanding that educational AI is not just a potential automation tool, but a medium for educational purpose by reflection and student-centered learning processes (Alasadi & Baiz, 2023). Consequently, both the theoretical considerations and the practical observations lead to the recommendation that student agency is fostered in students when learners encounter situations that require taking initiative or exercising judgment or self-correction. This student agency is particularly preserved when using the AI agent, designed to emphasize engagement, ownership, and feedback rather than content delivery.

3. SYNTHESIZE

3.1. Goal

This study aims to synthesize insights from the literature and practice and to create principles of design for AI-based

educational tools that promote student agency within a practice-before-theory framework. The project is not designed to create a general-purpose AI tutor, but instead to examine the ways specific design choices (i.e., sequencing tasks prior to theory, introducing safely manageable uncertainty, and including reflection loops) can serve to organize the student's initiative, engagement and ownership in digital learning environments.

Rather than a tool for the automation of instruction, this study conceptualizes AI as an interactive and adaptive design element that can engage students in cognitive effort, generate hypotheses, and promote self-directed learning. As students engage with two tools in the Aisystant platform (a course-based simulated training task and a Telegram-based AI tutor), analysis of the students' engagement will aim to provide practical suggestions for designers as to how to design AI in ways that allows for learner agency within authentic and real-world contexts.

This perspective aligns with current thinking in design-based educational research which emphasizes that testing design principles should not only occur in a laboratory simulation, but should occur in ecosystems with real learners. This study locates the inquiry firmly in lived learner experiences, using ongoing feedback, at the same time acknowledging the complexity of educational reality, and framing design, as discussion between theory, context and practice.

3.2. CIMO Logic

This section applies the CIMO logic (Denyer et al., 2008) by articulating the context of design, the interventions, the mechanisms, and expected outcomes to inform the design of the AI agent.

In the context of digital learning environments, often characterized by students engaging with content in an autonomous mode, with few or limited feedback from the instructor, students' agency is usually significantly underdeveloped. This is especially relevant with a platform such as Aisystant that is premised on educational design built on independent learning, and in which the organization and sequencing of the tasks utilized has become a primary driver of the student experience in the learning process. While digital learning tools provide access and flexibility, they are often wholly lacking in the embedded design elements which are often necessary for agency, critical reflection, and intentional learning.

The **intervention** described in this paper consists of two educational tools, which are based on practice-before-theory logic, that this study examines – a training simulator that is based on a course structure, and a Telegram-based AI tutor. Both interventions introduce tasks first, and without any theoretical instruction, thus creating a structure in which the students engage in making sense of the challenges, and afterward can explain their actions. The design options also introduce manageable levels of uncertainty within the complexity of tasks, but additionally provide opportunities for feedback in terms of either considering responses to expert answers, or revising responses based on AI generated feedback.

These characteristics of the design elements were intended to activate specific psychological and cognitive mechanisms (Haith & Krakauer, 2018), including curiosity, cognitive dissonance, hypothesis generation, and reflective reasoning. All students engage with open-ended or ambiguous tasks and will quickly create a sense of ownership and mental investment in the context. The design features also support student engagement in the reflective aspects of the task, and engage students in metacognitive processes that allow learners to think through how to refine their thinking and internalize feedback as part of their learning pathway.

Consequently, the anticipated **outcomes** involve students exhibiting higher levels of agency, as evidenced through visible behaviors (e.g. self-governing taking initiative, intentionally setting goals, and intentionally engaging in the learning of course material). The tools do not provide knowledge passively, or simply based on previous learning, rather create conditions that require the student to make decisions, justify reasoning, and revise understanding in working with content knowledge. Using the tools, the AI agent does not act simply as a mechanism for the delivery of the material, but instead an interactive support mechanism for agency activated learners.

4. CREATE

4.1. Design Principles

The intervention is based on three main design principles that emerged from theoretical knowledge and practical implementation: (1) students do tasks before receiving theoretical instruction (practice-before-theory), (2) create manageable uncertainty to provoke cognitive effort and interest, and (3) establish reflective feedback loops to foster self-regulation and agency.

The first principle practice-before-theory is consistent with research in the constructivist learning literature that showed students benefit if they have engaged in a task prior to formal instruction (Haith & Krakauer, 2018). This practice stimulates curiosity, hypothesis generation, and deeper thinking about the theory. In the example of AI design, it means agents prompt students to attempt tasks and only after encourage clarification or provide conceptual framing ultimately making the theory an assessment tool rather than a prescription.

The second principle is based on the manageable uncertainty that builds from tasks being entirely structured or guided, the tools introduce open ended challenges that require interpreting and decision-making themselves. This originates from evidence that cognitive activation is enhanced when students are faced with ambiguity at an acceptable level, that is, ambiguity that is complex enough to promote cognitive activation but not so overwhelming that it leads to confusion. With respect to the AI system, this entails increasing levels of challenge and complexity that energize learners to act and make decisions before validation.

The third principle is the feedback loop that highlights reflection and evaluation. If we do not send an increasing degree of correction, but formulate responses to students in structured ways through the tool or the follow-up from the AI tutor prompts students to compare, rethink, and re-formulate their thinking. This type of feedback cultivates their metacognitive awareness and allows for agency because they now have a chance to be evaluating students with a self-regulation focus, rather than immediate correction. This way they are not being judged by AI, but instead engage in practice where an AI is a partner for thinking that prompts iteration, articulation and internalizing of concepts (Alasadi & Baiz, 2023).

Together, these design principles provide a framework for designing AI powered tools that regard learners as active agents continuously, rather than passive recipients, and place responsibility, curiosity, and reflection as a central element of digital education.

Moreover, these principles align with larger changes in digital pedagogy, which are looking for not just efficiency or engagement but for the building of learner identity. When learners have a chance to express their thinking prior to observing content, they begin to connect to a sense of personal authorship and ownership of learning. This authorship is an essential precursor for agency, as learners begin to see themselves as more than knowledge receptors, they begin to see themselves as co-constructors of meaning.

4.2. Functional Design

The intervention involves two digital resources situated on the Aisystant digital platform: a course-based training simulator and an AI tutor on Telegram. Both resources are premised on "practice-before-theory" sequencing, but they differ significantly in their platform, the degree to which they adapt to individual learners, and the protocol employed during their use.

The training simulator has a predetermined structure over 18 different sessions (and one bonus assignment) covering various tasks in the oil industry. Each session or task consists of a series of tasks taking seven forms, that require students to engage in active manipulation or application of the core concepts that will ultimately be followed by theoretical content. The tasks consist of (1) determining the outlier, (2) compiling a conceptual list, (3) classifying items into types, (4) identifying which items are correct, (5) generating examples, (6) articulating relationships between concepts, and (7) drafting explanations using "thinking through writing." Engagement with each "task type," invites students to analyze, compare, and document ideas independent of disciplinary frameworks, followed by a comparison of their responses to expert responses. The interface permits students to analyze their responses, as it includes, "example of thinking through writing" for students to compare and contrast other ideas, yet it does not score or grade students' responses automatically, which encourages individual students to self-reflect and take responsibility for their learning. Examples of the user interface and task prompts are found in Figures 1 - 8 in the appendix.

The AI tutor on Telegram is a conversational agent, creating a more dynamic, adaptive environment. Students can engage the tutor in four formats (1) a pre-set internship plan that outlines task templates, (2) a "ladder" that permits students to work through concept sections from the core manual, (3) random task mode, and, (4) the final iteration permitting students to consult the AI tutor. Each of the modes involves an open or closed task a) either or not involving templates. With each task, the tutor provides a response for students to engage in corrective procedures, or through explanation, offer analogies and scaffold thinking patterns with tasks, especially where creative tasks are utilized and "thinking through writing," is involved. Unlike the simulator, this tool affords opportunity for iterative feedback and feedback, and mostly follows a dialogic structure: task → answer → AI clarification→ next task. The framework allows for reflection-in-action, and provides students with guidance to grow in their growing mastery by illuminating misconceptions and explanatory prompts from the task. Variations can be seen in the user colored interactive interface across a range of tasks, from Figures 9 - 13.

Both tools embed uncertainty in terms of the "correct" predetermined explanation, and invite learners to problem solve, and reason independently. Simultaneously, both tools provide a degree of scaffolding, whether through modeling phrase and wording, and "example thinking through writing" (simulator) as an expert sample, or, through AI supporting learners through comments and posing questions (AI tutor), or if there is reasoning developed thinking through writing (AI tutor). Together, the two tools clearly operationalize the three principles, established above: practice-first task design, constructed ambiguities, and reflective feedback loops.

4.3. Intervention Summary

The intervention consists of two digital learning tools developed on the Aisystant platform: a structured training simulator and a conversational AI tutor provided through Telegram. Both tools aim to put the practice-before-theory principle into action, thus supporting student agency through design task experience first, structured ambiguity, and self-generated opportunities for reflection.

Rather than traditional Ed Tech tools that are focused on content delivery or automating assessment, these two interventions are based on three purposeful design principles from theory, namely (1) student interaction with tasks prior to theoretical instruction, (2) tasks contained manageable uncertainty to induce cognitive activation, and (3) reflective loops were deliberately designed into the tasks for the purpose of regulating metacognition. The training simulator guides students through 18 structured sessions with each session having seven types of concept-driven tasks. The AI tutor provides a dialogic engagement for students in an adaptive way with iterative feedback and consulting possibilities.

In combination, the tools establish a context-controlled but open environment that students are invited to initiate, deliberate, reflect on their rationale, and develop more reasoning through feedback. As a result, this intervention is a rich and theory-guided context in which to observe and assess the activation of student agency in a digital learning environment. The next section of this manuscript will outline how the intervention was administered and evaluated in active study groups using qualitative data.

5. EVALUATE

5.1. Goal

The evaluation purpose is to explore the extent to which the practice-before-theory AI agent in two digital forms: a course-based practice simulator and a Telegram AI tutor develops student agency in digital learning experiences. It explores the particular design mechanisms of these tools: (1) learning by doing before abstracting to theory, (2) introducing manageable uncertainty for cognitive engagement, and (3) the potential for feedback loops for sense-making and self-regulation.

The evaluation returns to the core assumptions of the CIMO logic presented earlier in this study. In this case:

- Context: Independent learners working in peer-supported digital study groups on Aisystant.

- Intervention: Two tools that embody practice-before-theory instruction.
- Mechanisms: Activation of cognitive effort, reflective thinking and self-regulation.
- Outcomes: Visible behaviors of student agency such as initiative, intentional learning and ownership.

By focusing on learner experiences, this section explores whether and how these mechanisms were activated in practice with the intention of providing insights into how design decisions shape learner agency and engagement, and in turn, to produce design implications for subsequent iterations of the AI agent.

5.2. Method

To assess the effect of the AI agent on student agency, this research utilized a qualitative methodology consisting of a thematic analysis of nine semi-structured interviews. The participants were purposely recruited from currently active study groups that used the Aisystant platform and had experienced at least one of the two digital tools examined in this thesis: the course-based training simulator, and the AI tutor in Telegram.

The selection of participants required purposeful sampling to ensure diverse perspective and relevance to the emergent agency intervention. The specific criteria were: (1) prior use of the simulator or AI tutor, (2) involvement in one (or more) of the Aisystant study groups, and (3) ability to think and represent potential learning experiences in Russian or English. Out of the nine participants, eight interviews were conducted in Russian, and one in English, based on personal experience and fluency. With the consent of participants, all interviews were conducted online, recorded, and then anonymized to protect participant identity. In the results section when referring to the interviewees, they are denoted as Interviewee 1, Interviewee 2, etc.

The interview protocol included prompts that were designed to probe how learners experienced the mechanisms outlined in the learning supported by a conjectured theory of action (CIMO) framework that would impact agency and especially autonomy, reflective thinking, intrinsic motivation, and cognitive activation. Participants were asked to discuss instances they engaged in learning with the tools as well as reflect on how those experiences impacted their learning and learning behaviours.

The analysis drew on Braun and Clarke's thematic analysis approach (Braun & Clarke, 2006). The interview transcripts were read multiple times, and initial codes were produced manually. Subsequent iterations grouped those codes into initial subthemes and relevant themes that fit with the research aim of assessing how the AI partners supported student agency. The analysis respected reoccurrence across interviews, while also illuminating single instances of contrast or differences to expand understandings of the diversity present in learner experience. All coding was done manually and organized using a spreadsheet-based tracking and comparative method without the use of qualitative software analysis.

A variety of procedures were undertaken to enhance the trustworthiness of the qualitative findings. First, the interviews were reviewed multiple times over several days to increase immersion and obtain a consistent interpretation. Additionally, quotes were sought not only for repetition across participants but also for their illustrative function in highlighting particular mechanisms. Although formal member-checking was not done, many of the themes were cross-validated against both notes and informal feedback from the same groups involved in the study. While software-assisted coding was not used, rigorously following a thorough, manual method of tracking and comparing themes using a structured spreadsheet countered any lack of software. This process was grounded in the principle of transparency, while still providing for depth of interpretation and thematic concern.

This approach to thematic analysis provided rich, situated understandings for how students experienced the intervention and learned about the hypothesized structural learning mechanisms in real-life learning contexts.

5.3. Results

Autonomy and Ownership. Across the interviews, the theme of control and freedom was stated numerous times. Participants spoke about the tools and the ability to choose when and how to engage with tasks, particularly the Telegram tutor. One learner remarked, "It felt under my control." Another noted, "I liked that there wasn't a strict path - you could go back, redo stuff, skip something and come back later." These accounts show a learning context that preserved the learner's autonomy and provided opportunity for pacing and re-engagement. This sense of ownership is a key aspect of agency, as it reinforces self-direction and internal accountability for one's own learning path. These patterns would be consistent with the notion of agentic engagement, which has been demonstrated to lead to greater motivation and deeper learning outcomes when students actively engage in the process of shaping their own learning experience (Reeve et al., 2022).

Cognitive activation through uncertainty. Several learners explained that when they failed at a task or were initially confused or uncertain, it resulted in deeper engagement with the material. One participant explained, "Well, one time I failed a task and I wanted to go back and understand the theory." Another explained, "I guessed the answer, and then it was wrong, and that made me curious." These accounts demonstrate ways in which learners did not view uncertainty as a problem, but rather, as a place to make hypotheses, reflect, or inquire. When considering the intervention design, initial experiences with an ill-defined or ambiguous problem appeared to elicit intrinsic motivation to understand the underlying theory.

Reflective thinking through writing. Many participants described writing tasks as making a distinctive difference in their learning process.Writing functioned as a mechanism to slow down, justify thinking, and articulate ideas more methodically. One participant stated: "Writing made me stop and think." Another said: "Now I read and then I immediately write down my thoughts … then I think about it, group it, and write a full text." These examples illustrate an example of how writing was not simply a mechanism for students to express thoughts, it was a way to internalize content, creating metacognition, and in turn more active processing of information and making meaning of their own experiences.

Intrinsic motivation and curiosity. Across interview sessions, students articulated motivation came from their desire to understand, not from external motivation. "When I tried to

answer something myself, I was more motivated to know the explanation." Yet another said, "It created a spark of enthusiasm; I wanted to see more." When motivation came from the attempt to solve the problem, not knowing the theory was of particular importance. Therefore, the practice-first structure appeared to support agency by presenting theory as something that was earned, rather than an imposed accepted theory from the get-go.

Feedback as a driver of learning . Participants described the value of on-time, valuable feedback after interactions with AI tutors. Feedback simultaneously served, not as a means of correction, but also a means of clarification, and learning. One participant said, "I could ask the AI tutor and get a pointed explanation of what those mistakes were ." An additional learner said, "I wanted more information on whether I got this right or wrong." The dialogic nature of the AI interaction allowed learners to revisit the thinking and remediate it through recursive loops. Feedback that requested the learner to respond to the thinking in written form, for example, - was particularly formative in maintaining agency.

Agentic engagement and initiation. A few participants said they went above the required minimum. For example, they would prompt additional task prompts, assist others in documenting their learning, or set up their own learning timetables. One learner said, "I started to make sure I set time aside every week for the learning sessions." An additional learner said, "I took my team through the course trainer and helped create extra tasks." These examples seem to indicate the design provided a space for learners to not only develop ownership of their learning, but other learning, and a shift from passive learners to active participation.

Collectively, these six themes suggest not only did the intervention provide the intended mechanisms of agency, but also, autonomy, cognitive activation, reflection and intrinsic motivation . While not every learner indicated the mechanisms of agency equally, the tools provided opportunities for and meaningful student-engaged learning. The lessons learned will feed into the next iteration with the AI agent by reiteration of the importance of learner agency, learning flexibility, open-ended task design, reflective writing, and inclusion of dialogic feedback as a way to augment agency.

6. DISCUSSION

6.1. Theoretical Contributions

The research presented here makes a contribution to the new field of AI-supported learning design, showing evidence that certain design mechanisms such as practice-before-theory sequencing, uncertainty in tasks, and reflective feedback loops, can potentially activate learner agency in authentic digital contexts. In contrast to most of the current literature examining AI tools in non-authentic or lab-controlled environments (e.g., education focused studies), this study took place on the authentic platform, Aisystant, where actual learners engaged in study groups with each group member volunteering to be there. This provides ecological validity to our findings, emphasizing that what happened was not a theoretical rationale but lived learning experiences.

The evaluation results indicate that agency can be developed when a learner is engaged in doing something before the learner has an explanation. The act of attempting to do a task means that a learner is now positioned to critically reflect on and make sense of their responses, and then pursue a new created understanding to revise or deepen their meaning making of the task. This supports preceding work on constructivist learning and knowledge activation through manageable uncertainty (Haith & Krakauer, 2018), and also extends this previous work by demonstrating how an AI literacy agent can function as a scaffolding partner, rather than merely an automated evaluator. When students work with AI-based tools that support their reflection and agency, they may begin to reshape their identity from passive consumers to active designers of their learning experiences, a manifestation of transformative agency (Yang & Markauskaite, 2025).

This all challenges the current practice of automation as the main logic in AI-supported education and instead presents a design logic - one in which AI agents can be designed to purposeful dialogic, metacognitively supports that activate curiosity, ownership, and reflective - three core components of agency.

6.2. Implications for AI-based Educational Design

In practical terms, these findings support the construction of a list of design principles that can help to inform next iterations of AI tools intended to foster learner agency:

Support autonomy through flexible task design. Learners appreciated being able to decide how quickly, where (in what order), and what ways they would engage with tasks. A next iteration should incorporate flexibility for task paths, the ability to modify the difficulty, and the option to return to previous tasks.

Design for cognitive engagement, not only correctness. Learners expressed that when they struggled or failed initially, they tended to engage more deeply into the task. Thus as opposed to trying to eliminate uncertainty with the AI, agents can strategically utilize tasks that are open-ended or ambiguous to support learners' creation of and experimentation with hypotheses.

Integrate reflection as a mechanism of learning. Writing and dialogic feedback were identified as effective prompts of deeper engagement with learning content. Future designs should build on the writing to think features, and continue to include AI prompted follow up questions that ask learners to justify, compare or iterate upon their learning.

Facilitate self-regulation and leadership. Several students went beyond expected uses of the AI tools, for example, engaging in peer learning, building new tasks, or creating schedules. These types of behaviors are indicative of a potential shift in AI use from a guide to inspiring participants to lead learning. For example, future iterations could support opportunities for participants to set individual goals, track progress, and lead co-created learning opportunities.

Students' confidence and responsibility in engaging with AI tools is shaped by the pedagogical approach taken with students, and in particular how the learning environments support autonomy and through intentional decision-making (Consoli & Petko, 2025).

Overall, the findings indicate a need to begin moving toward learner-centered designs characterized by flexible and co-created opportunities, with AI playing a facilitative rather than prescriptive role. This does not imply only the addition of new features, but rather shift in the primary role of AI within the learners' use of the tools from one of automation to augmentation of learner thinking.

Additionally, these findings encourage a rethinking of what it means for AI to play a facilitative role in education. While most AI applications strive for efficiency through the process of automation – dispensing content, checking answers, and so forth the tools that we describe here represent a different pathway: augmentation of thought. A case in point is between the AI tutor who did not just give the student the right answer, but often prompted the student to write more about topics, elaborate, and reflect. This represents a definitive shift from transactional to dialogic AI. In a next iteration, designers might consider how agents can be designed not to optimize efficiency but to provide scaffolding for intellectual engagement for instance, prompting criticism of material, encouraging synthesis of ideas, or knowing when a learner shows independent insight.

6.3. Limitations of the Study

Despite providing pragmatic implications, there are several limitations of this study. First, the sample size of only nine gives limited scope for generalizability. Although the study came close to reaching thematic saturation, this will have to await a second study comprising larger and more diverse populations, to confirm and refine findings.

Second, all coding was done manually without the use of qualitative software, which can introduce a degree of subjective bias. Nonetheless, individual patterns were corroborated across multiple readings, and illustrative quotes were selected to ensure transparency of interpretations.

Third, the evaluation only interrogated learner perceptions and self-reported reflections. While the reflections were rich and in-depth, there was no consideration of data around direct behaviors such as clickstreams or progression logs that could have added additional dimensions to understanding possible learning behaviors.

Lastly, the Telegram-based AI tutor was used by a smaller subset of the participants than the simulator, meaning that there could be some bias towards insights into design of the simulator. Future evaluations may prioritize a more balanced exposure to both or embedded analytics.

6.4. Suggestions for Future Work

Future studies could also examine how AI agents can be developed to adjust continuously to a learner's developing state of agency—potentially something like noticing times of hesitation, times of being uncertain, or times of a breakthrough, and then offer contextually relevant prompts. One potential line of inquiry is using multimodal data (e.g., typing speed, revision patterns, hesitation signals) to infer a learner's state and dynamically adjust tasks or feedback.

In addition, future work may involve trialing various reflection scaffolds (e.g., peer explanations, voice recordings, decision trees), and comparing their effectiveness at eliciting deeper agency in context. More broadly than the current work, the expansion of the model to offer social pathways for interaction (e.g., group-based AI facilitation) would also be a promising direction for research.

Finally, further iteration of the AI tutor interface could include a focus on which types of interactions (e.g., dialogic scaffolding, analogy prompts, response meta-questions) had the best success at evoking metacognitive reflection and ownership. As with the study undertaken here, design-based research is a valuable methodology for this kind of iterative and situative experimentation.

7. CONCLUSION

This thesis examined how AI agents developed with practice-before-theory principles can support student agency within digital learning environments. This descriptive study stemmed from a practice-based recognition: while digital tools and AI are common in education, they are often built merely to deliver content or automate tasks and not to position students as active participants in their own learning.

This study did not develop a new prototype, but rather produced a "case study" based on an existing minimum viable product as used on the Aisystant platform — not a lab, but a real environment. The students engaged with two tools: a prescriptive training simulator and a conversational AI tutor in Telegram. These tools were predicated on three key design principles; 1) practice before theory, 2) manageably uncertain, 3) reflective feedback loops. All three of these principles together were to catalyze autonomy, curiosity and ownership for their learning.

The findings indicated that these constructs were present within students' experiences. Across interviews, students explained that open-ended tasks fostered extended engagement, that writing jettisoned them as thinkers, and that their ability to reflect, backtrack and re-engage fostered a sense of control in their engagement. Several students even took initiative on their tasks in a manner that exceeded basic expectations – i.e. helping others, developing their own work routines – which suggested a movement beyond engagement and toward involvement.

On a theoretical level, this study relates with constructivist learning models, supporting that agency can emerge when students first attempt to make sense of something, and then place a theoretical frame around it. This study also contributes to the emerging literature on design-based AI in education by illustrating how feedback, task sequences and interaction structures can be designed to support their reflection, ownership – not correctness.

In practical terms, this thesis illustrates design recommendations for future AI tools; provide flexible pathways, build in ambiguity and space for discovery, support writing and dialogic feedback, and allow learners to self-organize. Again, AI is not intended to be a "perfect" AI tutor, but rather a design consideration – one that opens space for learning, rather than closes it.

This study does not claim to solve the issue of student agency within digital learning contexts. However, it does offer an alternative approach to how AI can be utilized to support student agency – not as a process shortcut, but a progression to participation. Future work may involve examining how AI agents can actively adapt to learners, in real time, or whether these ideas can scale to more diverse educational environments. But at this juncture, the take-away is simple: agency can be designed for - and AI might be a way to do it, if done with intent.

References

Alasadi, A., & Baiz, T. (2023). Generative AI in education and research: Opportunities, concerns, and solutions. *Education Sciences, 13*(6), 615. https://doi.org/10.1021/acs.jchemed.3c00323

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. Qualitative Research in Psychology, 3(2), 77–101. https://doi.org/10.1191/1478088706qp063oa

Ceelen, L., Khaled, A., Nieuwenhuis, L., & de Bruijn, E. (2025). Agency in workplace learning: Supervisors' and students' interacting strategies in a physiotherapy placement. Vocations and Learning, 18, Article 10. https://doi.org/10.1007/s12186-025-09364-7

Consoli, T., & Petko, D. (2025). Which educational approaches predict students' generative AI confidence and responsibility? Computers and Education: Artificial Intelligence, 9, 100431. https://doi.org/10.1016/j.caeai.2025.100431

Denyer, D., Tranfield, D., & van Aken, J. E. (2008). Developing design propositions through research synthesis. Organization Studies, 29(3), 393–413. https://doi.org/10.1177/0170840607088020

Giannakos, M., Azevedo, R., Brusilovsky, P., Cukurova, M., Dimitriadis, Y., Hernandez-Leo, D., Järvelä, S., Mavrikis, M., & Rienties, B. (2024). The promise and challenges of generative AI in education. Behaviour & Information Technology, 1–27. https://doi.org/10.1080/0144929X.2024.2394886

Haith, A. M., & Krakauer, J. W. (2018). The multiple effects of practice: Skill, habit and reduced cognitive load. Current Opinion in Behavioral Sciences, 20, 196–201. https://doi.org/10.1016/j.cobeha.2018.01.015

Jääskelä, P., Heilala, V., Kärkkäinen, T., & Häkkinen, P. (2021). Student agency analytics: Learning analytics as a tool for analysing student agency in higher education. Behaviour & Information Technology, 40(8), 790–808. https://doi.org/10.1080/0144929X.2020.1725130

Jose, B., Cherian, J., Verghis, A. M., Varghise, S. M., Mumthas, S., & Joseph, S. (2025). The cognitive paradox of AI in education: Between enhancement and erosion. Frontiers in Psychology, 16, 1550621. https://doi.org/10.3389/fpsyg.2025.1550621

Katz, A., Wei, S., Nanda, G., Brinton, C. G., & Ohland, M. (2023). Exploring the efficacy of ChatGPT in analyzing student teamwork feedback with an existing taxonomy. arXiv (Cornell University). https://doi.org/10.48550/arxiv.2305.11882

Lan, M., & Zhou, X. (2025). A qualitative systematic review on AI empowered self-regulated learning in higher education. NPJ Science of Learning, 10, Article 21. https://doi.org/10.1038/s41539-025-00319-0

Mameli, C., Grazia, V., & Molinari, L. (2023). Student agency: Theoretical elaborations and implications for research and practice. Teaching and Teacher Education, 121, 103939. https://doi.org/10.1016/j.ijer.2023.102258

Mohammadi Zenouzagh, Z., Admiraal, W., & Saab, N. (2025). Empowering students' agentive engagement through formative assessment in online learning environment. International Journal of Educational Technology in Higher Education, 22(1), 9. https://doi.org/10.1186/s41239-024-00498-7

Natarajan, S., McCullen, N., Lo, S., Coley, D., Arja, O. A., & Moran, F. (2020). Practice before theory? An approach for testing sequencing effects in pedagogical design. International Journal of Technology and Design Education, 31, 981–1000. https://doi.org/10.1007/s10798-020-09579-w

Reeve, J., Jang, H.-R., Shin, S. H., Ahn, J. S., Matos, L., & Gargurevich, R. (2022). When students show some initiative: Two experiments on the benefits of greater agentic engagement. Learning and Instruction, 80, 101564. https://doi.org/10.1016/j.learninstruc.2021.101564

Stenalt, M. H., & Lassesen, B. (2022). Does student agency benefit student learning? A systematic review of higher education research. Assessment & Evaluation in Higher Education, 47(5), 653–669. https://doi.org/10.1080/02602938.2021.1967874

Tapalova, O., & Zhiyenbayeva, N. (2022). Artificial intelligence in education: AIEd for personalised learning pathways. The Electronic Journal of E-Learning, 20(5), 639. https://doi.org/10.34190/ejel.20.5.2597

van Aken, J. E. (2004). Management research based on the paradigm of the design sciences: The quest for field-tested and grounded technological rules. Journal of Management Studies, 41(2), 219–246. https://doi.org/10.1111/j.1467-6486.2004.00430.x

Yang, H., & Markauskaite, L. (2025). Fostering language student teachers' transformative agency for embracing GenAI: A formative intervention. Teaching and Teacher Education, 159, 104980. https://doi.org/10.1016/j.tate.2025.104980

APPENDIX

Table 1. Interview Questions

Interview Question	Main purpose of the question
1. Which of the two tools did you use more actively — the course-trainer or the Telegram bot? Can you describe how you used it — in what format, how often, and in what context?	To determine which tool had greater impact and in what context it was used. This provides a foundation for comparing the effectiveness of different learning formats.
2. What did you find most helpful or convenient in this format? And what aspects were more difficult or didn't really work for you?	To identify strengths and weaknesses in each format that may support or hinder agency and engagement.
3. How did you perceive the approach of "a bit of practice before theory, then theory, then more practice"? Did this sequence help you understand the topic more deeply?	To assess how learners experience the "practice-before-theory" method, which is central to the thesis hypothesis.
4. Did you feel the urge to study the theory after trying the first tasks? Did the initial practice motivate you to dig deeper and figure out what you were doing?	To check if early practice activates cognitive engagement and intrinsic motivation to learn the theory.
5. Did you ever go back to the theory after completing some tasks — to compare your assumptions with the explanations? Or did you feel that theory was hard to retain without doing some practice first?	To understand whether the practice–theory cycle enhances meaningful understanding and reflection.
6. Did you ever take initiative — solving more tasks than required, looking for extra information, or setting your own questions?	To capture signs of self-direction and initiative — key indicators of student agency.
7. Did you feel a sense of freedom in the learning process? For example, being able to choose pace, try different approaches, or adjust difficulty?	To understand to what extent the tool design enabled learner autonomy and self-regulation.
8. What helped you get into the learning process? Was there any internal or external motivation to continue?	To identify motivational triggers for engagement with the AI-based tool.
9. Did your learning approach change while using these tools? For example, did you reflect more, pause to think, or revise your understanding?	To detect changes in cognitive behavior and metacognitive awareness resulting from tool use.
10. Did you feel like the learning process was in your hands? Or did it feel mostly predefined or externally controlled?	To evaluate learners' perceived control over their learning — a key element of agency.
11. Do you feel that the "practice → theory → practice" approach helped increase your agency as a learner? Did starting with action before explanation help you think more actively, ask questions, form hypotheses, and become more engaged?	This is a key question directly linked to the thesis hypothesis: whether action-before-explanation supports the development of learner agency.

Interface Screens Illustrating the Learning Tools

Figure 1. Overview screen of the personal development course simulator (translated via Google) Translate).

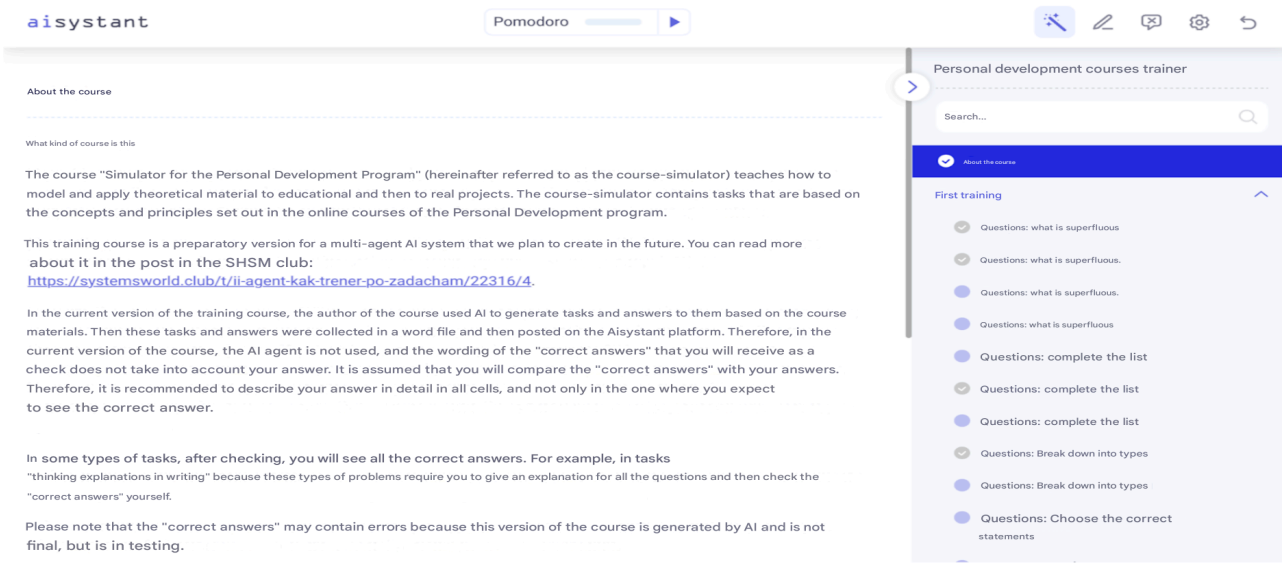

Figure 2. Course introduction and explanation of correct answers policy (translated via Google Translate).

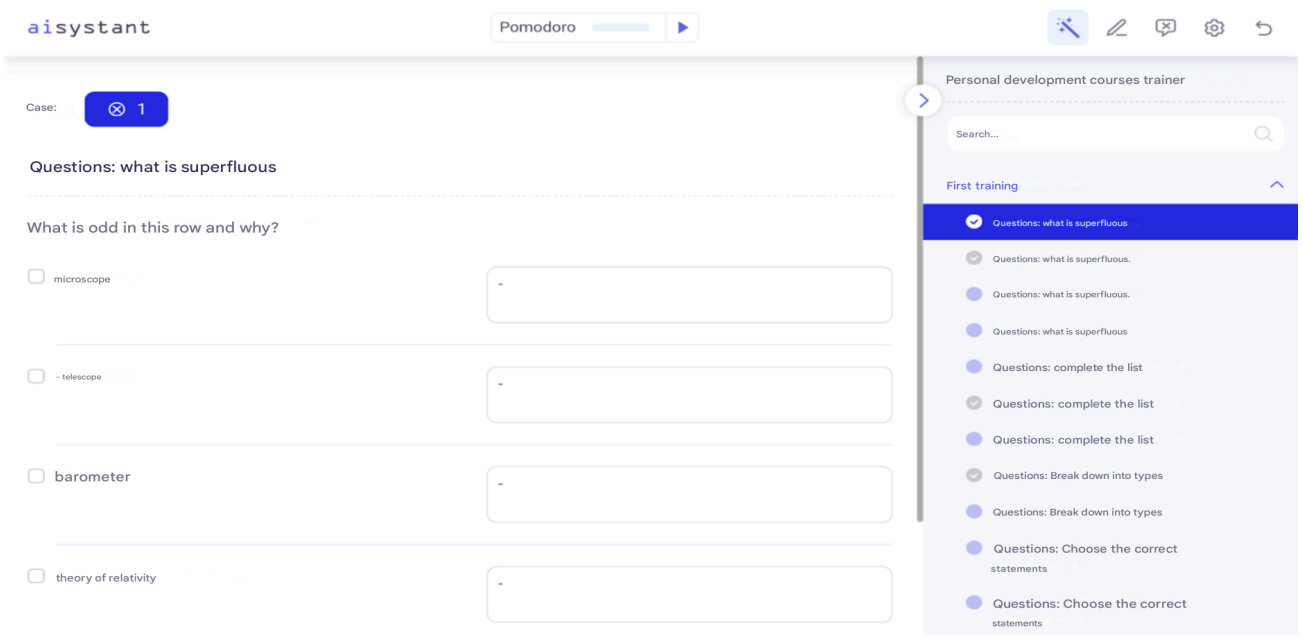

Figure 3. Example of multiple-choice task: identifying the odd concept (translated via Google Translate).

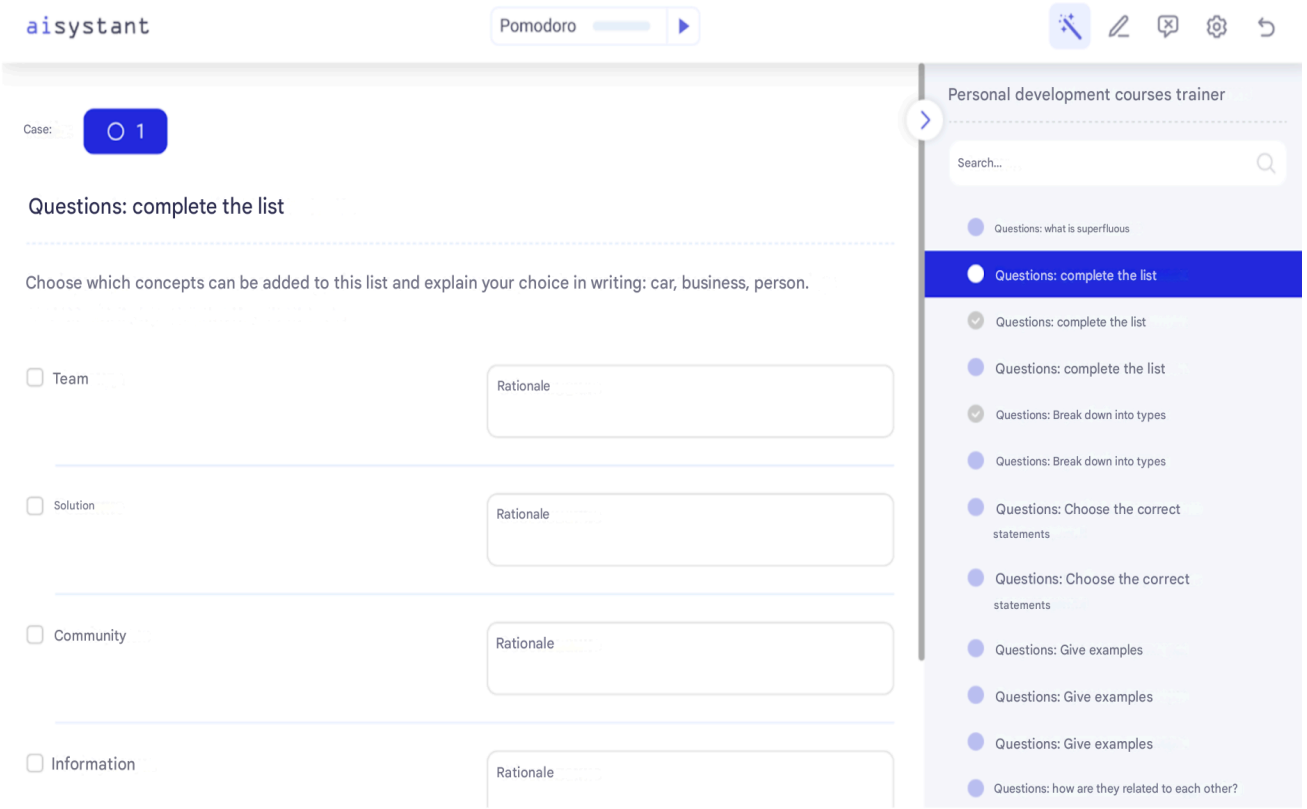

Figure 4. Example of a task requiring conceptual expansion and written justification (translated via Google Translate).

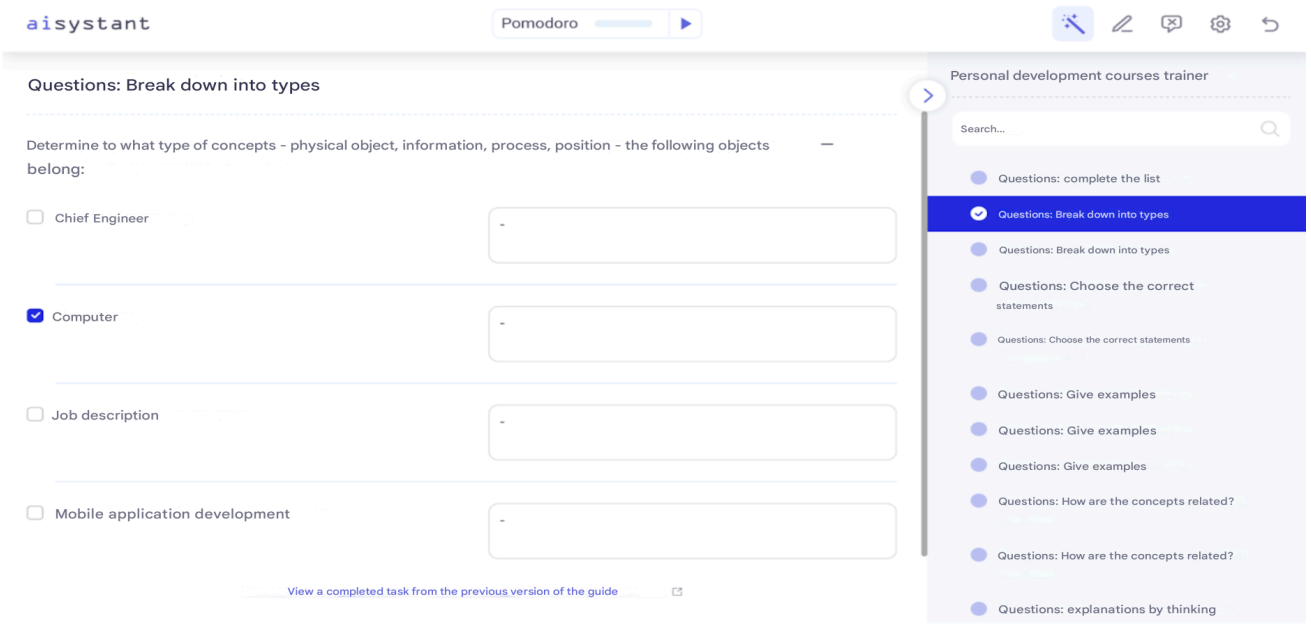

Figure 5. Categorization task: determine the type of given concepts (translated via Google Translate).

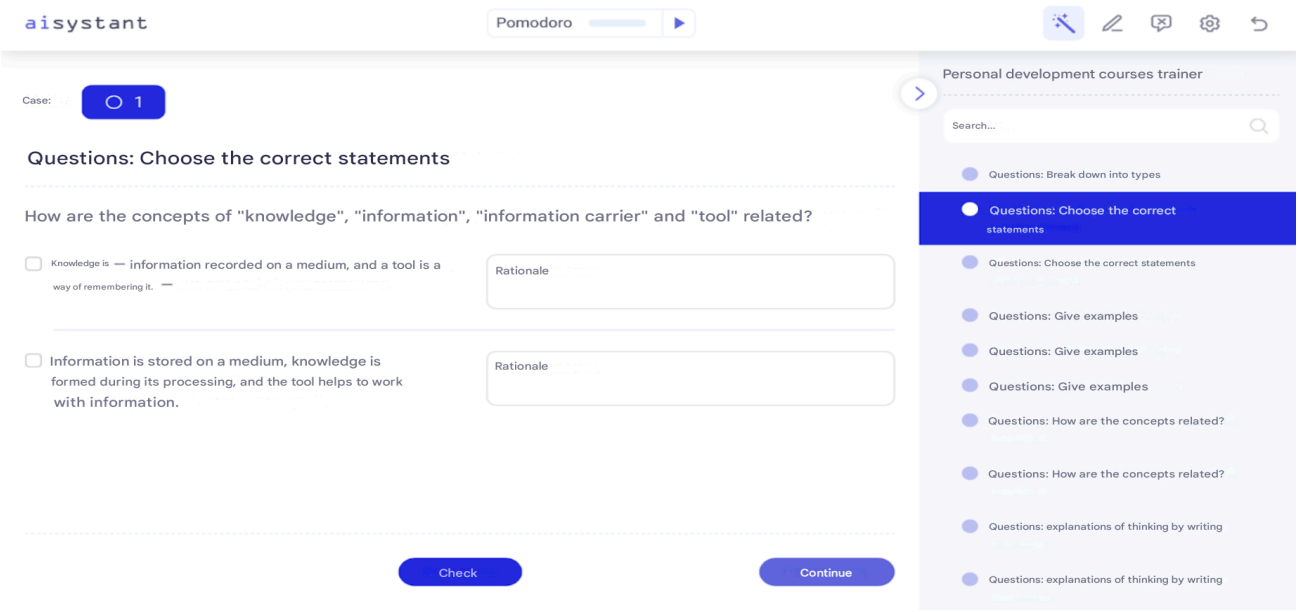

Figure 6. Semantic linking task: selecting the most accurate statement (translated via Google Translate).

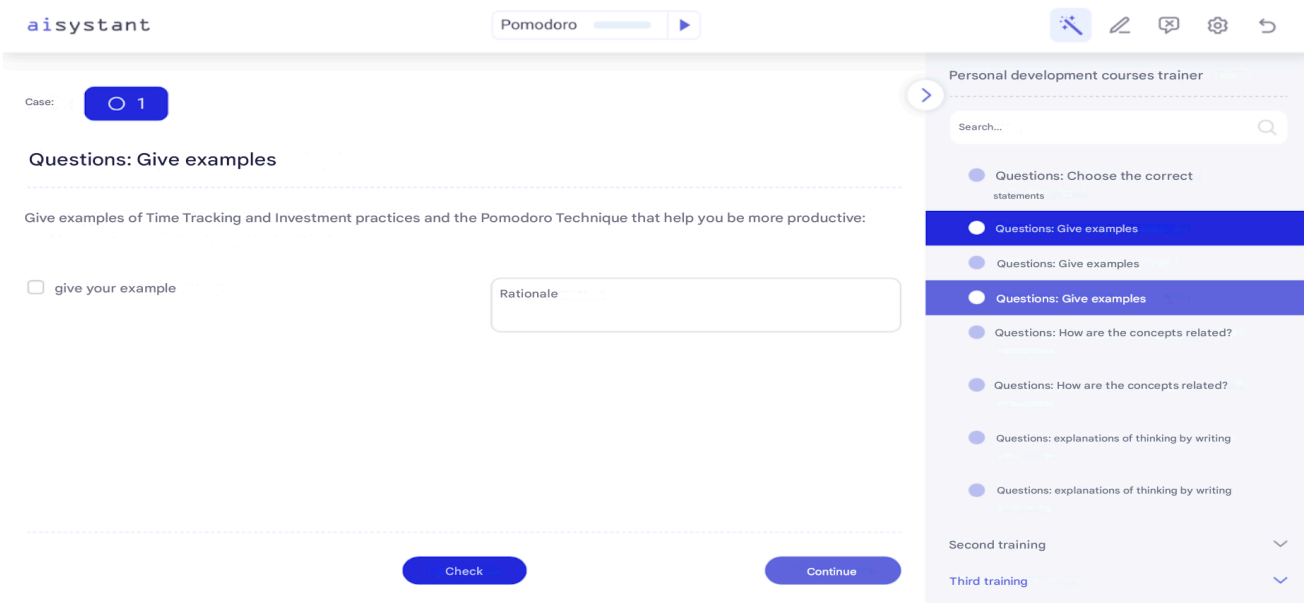

Figure 7. Open-ended task: providing practical examples for productivity methods (translated via Google Translate).

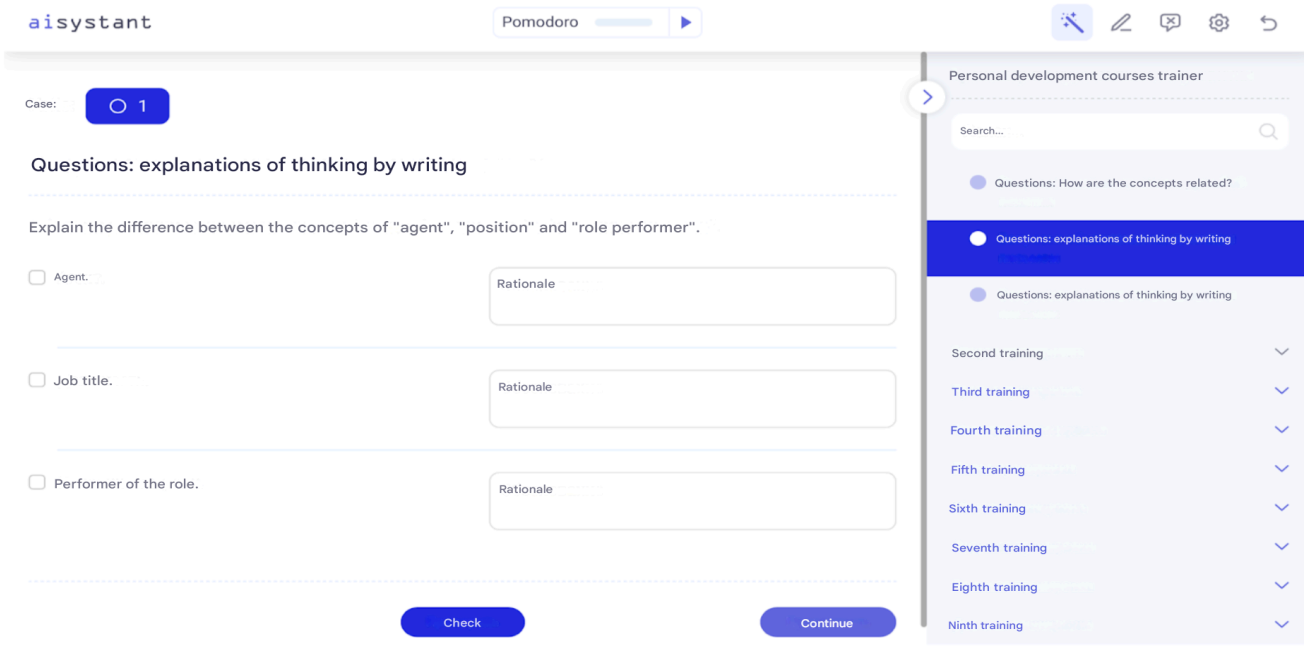

Figure 8. Reflective writing task: distinguishing concepts related to personal roles (translated via Google Translate).

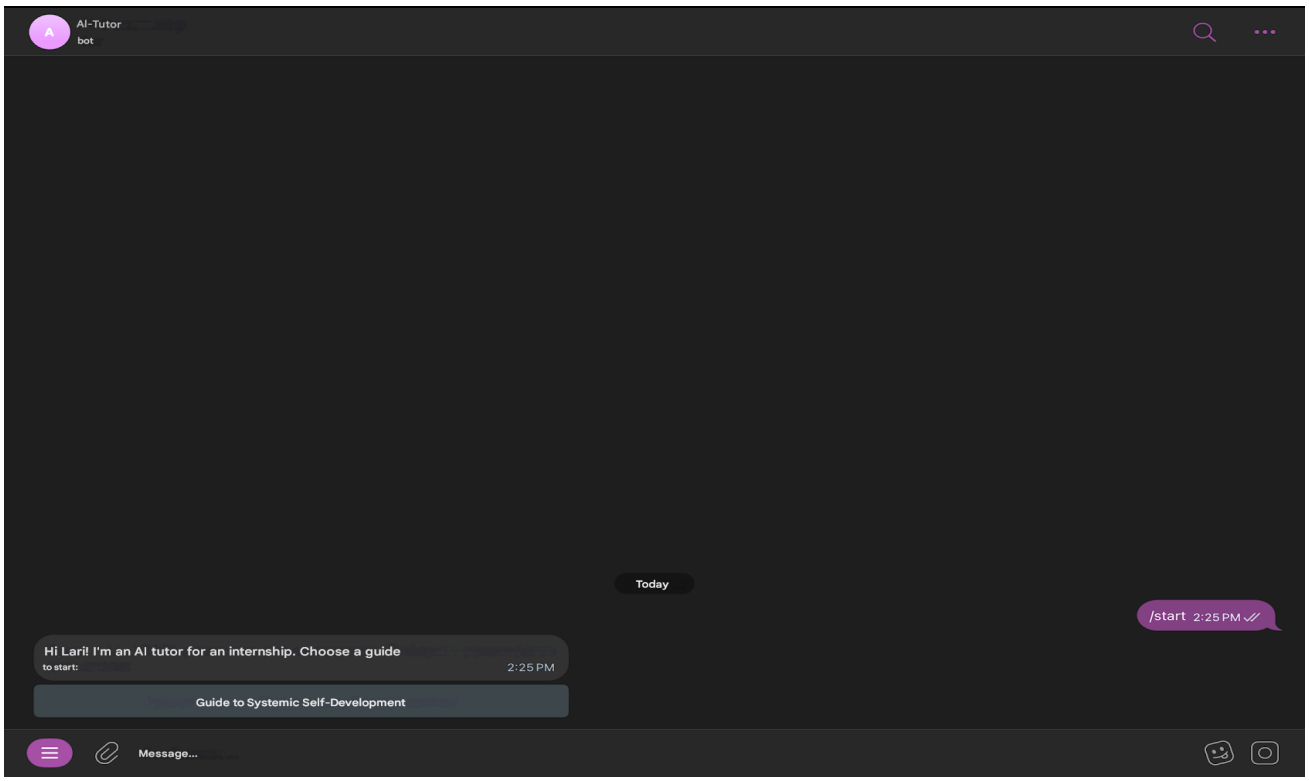

Figure 9. Initial prompt by the AI tutor offering multiple pathways (translated via Google Translate).

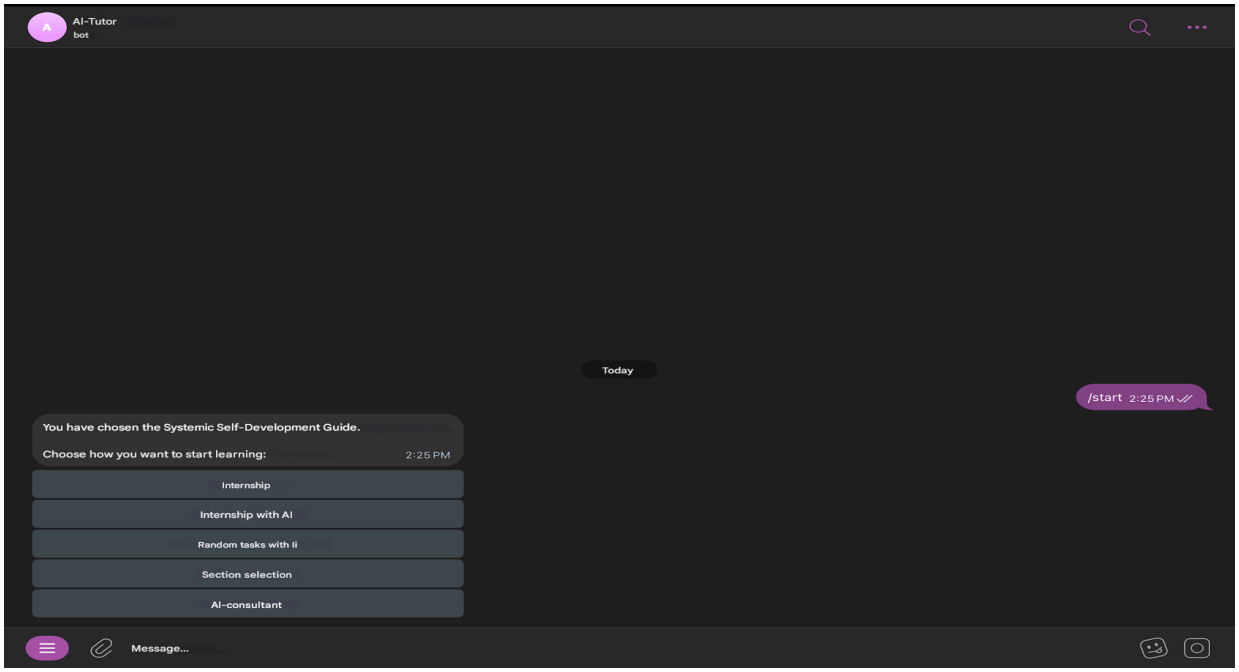

Figure 10. Learning pathway options after selecting the Systemic Self-Development Guide (translated via Google Translate).

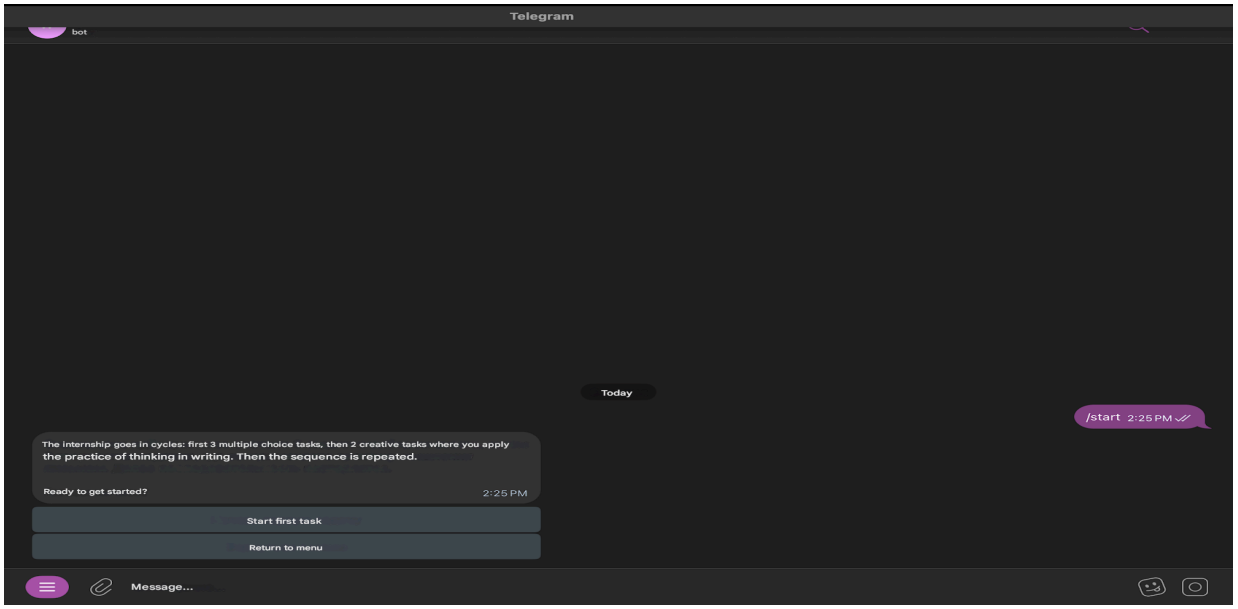

Figure 11. Explanation of the internship cycle and learning process (translated via Google Translate).

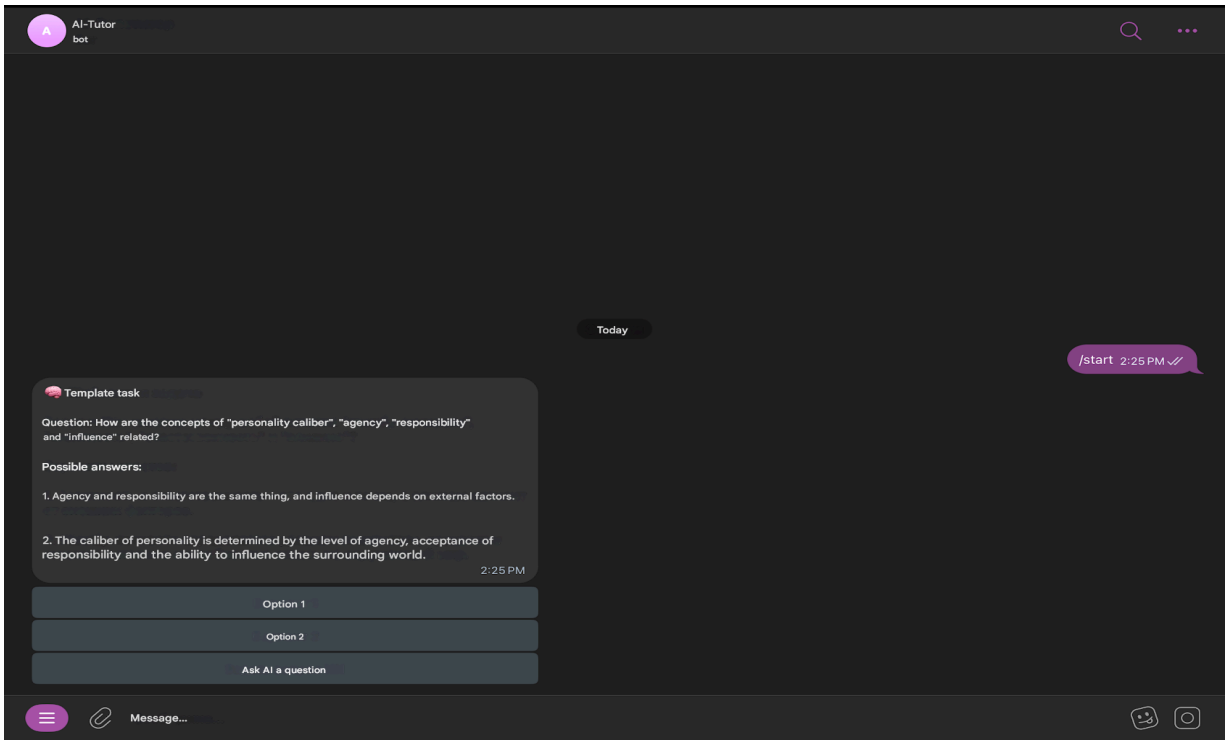

Figure 12. Example of a template task requiring semantic reasoning (translated via Google Translate).

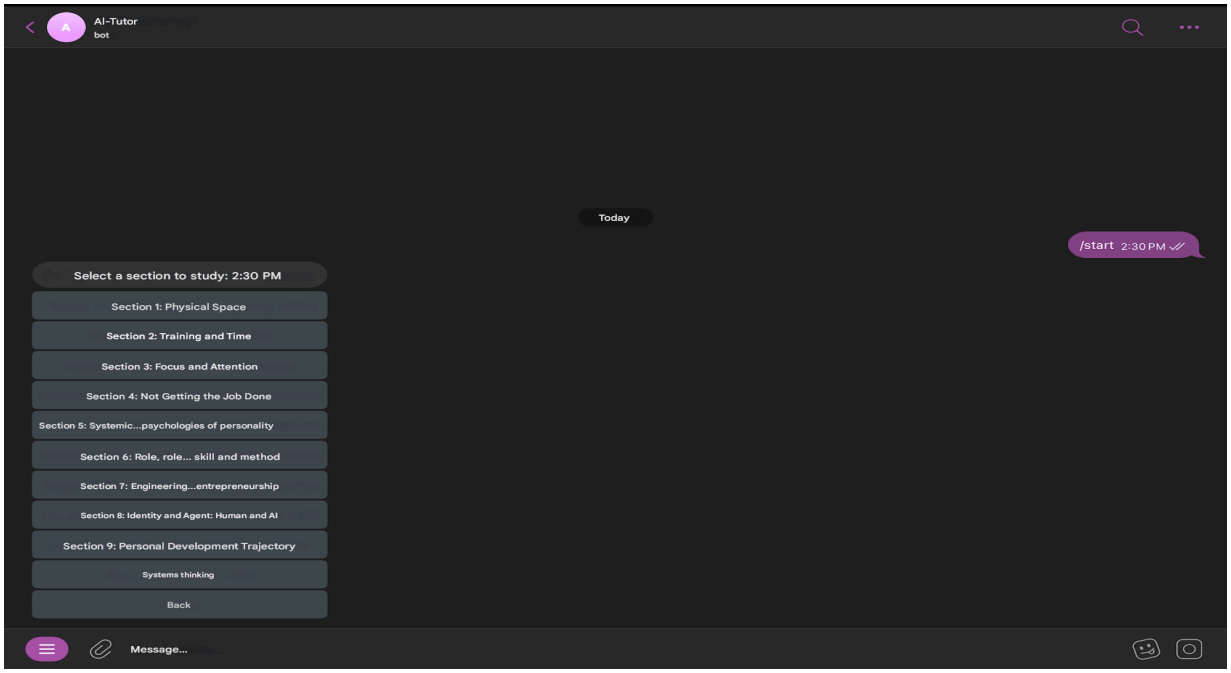

Figure 13. Section overview of the Self-Development course in the Telegram interface (translated via Google Translate).