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Creativity and simplexity in the use of educational technologies: an exploratory study

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Abstract: The growing complexity of contemporary educational contexts, accentuated by the spread of digital technologies (Ahmed, 2012), requires a rethinking of teacher training models that goes beyond the acquisition of technical skills (DM 66/23), promoting the development of critical, creative and reflective thinking capable of guiding conscious educational choices (de Bono, 1986; Schön, 2006; Berthoz, 2019; Sibilio et al., 2023). In this perspective, a broader research hypothesis proposes the integration between the method of the Six Hats for Thinking and the theory of simplexity (La Manna et al., 2025), to foster a multiperspective analysis of the educational context and a flexible and adaptive didactic action. This integration could also affect the way technologies are used in teaching. The paper presents the results of an exploratory survey aimed at investigating how trainee teachers spontaneously conceptualize the use of technologies, in the absence of specific training on the subject. The study involved 189 trainees, future secondary school support teachers, enrolled in specialization courses at the University of Salerno. Participants were asked to design educational actions based on the properties and rules of simplexity (Sibilio, 2023), without explicit indications on the use of technologies. The results show that less than half of the trainees hypothesized the use of digital tools, mainly for compensatory and inclusive purposes, suggesting the need for training courses oriented towards a more conscious and creative use of technologies.

Keywords: simplex didactics; creativity; lateral thinking; technology; teaching.

1. Introduction[1]

The socio-technological transformations that are going through contemporary educational systems have contributed to significantly increasing the complexity of teaching-learning contexts, prompting a profound revision of teacher educational models (Ferrante, 2014; Kaur, 2023). The intensification of the use of digital tech-

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EDIZIONI UNIVERSITARIE ROMANE
editoria scientifica dal 1952

nologies, accelerated in recent years by educational and social emergencies, has made it clear that digitization cannot be understood exclusively as the introduction of tools or platforms, but must be configured as a cultural and pedagogical process that invests teaching methodologies, the organization of learning environments and the professional role of the teacher (Schon, 2006; Del Gottardo, 2016; Akram, 2022). In the Italian context, recent educational policies, particularly those promoted as part of the National Recovery and Resilience Plan (PNRR), have placed in-service training of school staff at the center of innovation strategies, with a specific focus on the development of digital skills and the adoption of inclusive teaching methodologies (Ministerial Decree 65/2023; Ministerial Decree 66/2023). However, although these interventions have contributed to strengthening the technological dimension of school systems, there remains the risk of training mainly oriented towards technical-operational skills, to the detriment of a deeper reflection on thought processes, teaching decisions and the professional action of the teacher in complex contexts. Therefore, the need emerges to identify theoretical-methodological frameworks capable of supporting teachers not only in how to use digital technologies, but above all in why, when and how to integrate them in a conscious, flexible and consistent way with educational needs. The theory of simplexity, developed by Alain Berthoz (2019) and subsequently declined in the didactic field (Sibilio, 2014; 2023), offers an interpretative paradigm useful for understanding complexity as a structural dimension of didactic action, emphasizing adaptive, *non-linear* and *situated* processes. The properties and rules of simplexity describe cognitive and emotional devices that allow us to deal with complex contexts through quick, flexible and sense-oriented decisions (Sibilio, 2014). In a complementary way, Edward de Bono's Six Thinking Hats method (1970) proposes an intentional structuring of thought processes, favoring the adoption of multiple perspectives and the development of critical-creative and metacognitive thinking (de Bono, 1970).

In the field of education, this method can support teachers in overcoming linear and automated approaches, promoting the ability to analyze the educational context from different points of view and to explore alternative teaching solutions, particularly relevant in contexts characterized by high complexity and the pervasive presence of digital technologies. In light of these premises, the present contribution is placed within a research perspective that hypothesizes the integration between the theory of simplexity (Berthoz, 2019; Sibilio, 2014; 2023) and the method of the Six Hats for Thinking (de Bono, 1970) as a possible training approach to support the development of *critical*, *creative* and *reflective* thinking in teachers in education. In particular, the study aims to explore how teachers spontaneously conceptualize the use of digital technologies within a didactic action inspired by the principles of simplicity, in the absence of prescriptive indications or a specifically digital-oriented training.

2. Thought and action: creativity and simplexity

In the context of the socio-technological transformations that characterize contemporary education systems, teacher training and the development of digital skills represent a strategic plan of European and national educational policies (Buffardi, 2019). The intensification of digitization processes, accelerated both by technological evolution and by recent educational and social emergencies, has made clear the need to review teaching models, curricula and teacher professionalism pro-

EDIZIONI UNIVERSITARIE ROMANE
editoria scientifica dal 1952

files (of education, M., 2022). In this scenario, the National Recovery and Resilience Plan (Law of 13 July 2015; Law of 29 June 2022), through Mission 4 "Education and Research" and investment line 2.1 dedicated to integrated digital teaching and the digital transition of school staff, outlined a structured and permanent system of in-service training, oriented not only to the development of digital and language skills, but also to the adoption of innovative and inclusive teaching methodologies (Ministerial Decree 65/2023; Ministerial Decree 66/2023). The planned actions, from the *Next Generation Classrooms to the Next Generation Labs*, underline how digitization cannot be reduced to a mere introduction of devices or software, but must be configured as a cultural and pedagogical process that invests methodologies, the organization of spaces and the role of the teacher himself (Statale & Majorana, 2025). In this framework, the teacher is called to assume the function of mediator and designer of complex learning environments, capable of integrating presence and virtuality, autonomy and cooperation, cognitive and emotional dimensions, critical thinking and creativity (Colazzo, 2005). However, the state of the art of teacher training in Italy, although strongly guided by the European reference framework DigCompEdu, highlights the risk of a predominantly technical focus on digital skills, to the detriment of a deeper reflection on decision-making processes, on educational thinking and action in complex contexts (Redecker, 2017).

In the light of these considerations, it is necessary to ask ourselves what theoretical-methodological frameworks can support teachers not only in how to use technologies, but above all in why, when and how to integrate them in a conscious, flexible and inclusive way. In this perspective, the theory of simplexity, developed by Berthoz (2019) and subsequently declined in the didactic field (Sibilio, 2014; 2023), would offer a useful interpretative paradigm to understand and address the complexity of educational contexts as dynamic adaptive systems, characterized by non-linearity and flexibility. The rules and properties of simplexity (Berthoz, 2019; Sibilio, 2023) (Tab.1), such as separation of functions, flexibility, adaptation to change, decision-making speed, reliability, memory and generalization, describe cognitive and emotional devices that allow individuals to act effectively in complex situations, anticipating future scenarios and modulating action according to the context (Berthoz, 2019). Applied to the teaching-learning process, simplexity can guide a didactic action capable of responding adaptively to the plurality of educational needs, promoting inclusion, involvement and active participation (Di Gennaro et al., 2017; Aiello & Di Tore, 2015; Sibilio, 20214).

In this framework, the contribution of the method of the Six Hats for Thinking by Edward de Bono (1970; 2015) (tab.2), which proposes an intentional structuring of thought processes through the adoption of different cognitive and emotional perspectives, would be inserted in a complementary way. The method allows you to train multidimensional thinking, alternating moments of objective analysis, critical evaluation, creative exploration, emotional consideration, and metacognitive regulation (de Bono, 1970; 2015). In the educational field, the use of the Six Hats could support the development of critical-creative thinking of teachers, favoring the ability to suspend automatisms, explore alternatives, evaluate risks and opportunities, and attribute meaning to educational choices. In particular, the emphasis on lateral and creative thinking could be particularly relevant in contemporary school contexts, characterized by high complexity and the need to overcome linear and standardized approaches to the use of technologies.

EDIZIONI UNIVERSITARIE ROMANE
editoria scientifica dal 1952

The hypothesis that guides the present contribution is that the integration between the theory of simplexity and the method of the Six Hats for Thinking could constitute an effective training approach to support teachers in the development of critical, creative, and reflective thinking oriented towards the use of digital technologies. Such integration could make it possible to conceive digital technology not only as a compensatory or ancillary tool, but as a transversal teaching resource, capable of enriching educational design, supporting more flexible decision-making processes, and promoting truly inclusive learning environments. In this perspective, training for the digital transition would be configured as a path that acts "upstream" of the devices, working on the teacher's thought processes and on the awareness of his or her professional actions.

3. The importance of simplex didactics

Contemporary pedagogy has integrated, in its studies, contributions from neuroscience, including Berthoz's Theory of simplexity, which offers an original interpretative key to understanding the functioning of complex systems and the mechanisms through which they manage to adapt to the environment. The theory of simplexity describes how living organisms and complex systems deal with complexity through the activation of evolutionarily developed biological devices, capable of simplifying the processing of information without reducing its richness (Berthoz, 2015). These devices allow you to make fast, efficient, and future-oriented decisions, integrating experience, anticipation, and the emotional dimension. In the educational field, simplicity can constitute a useful theoretical paradigm to orient teaching action according to a systemic perspective, in which teaching-learning is conceived as an epistemologically complex system, characterized by non-linear interactions, continuous adaptation, and emergent processes (Van Geert & Steenbeek, 2014).

Berthoz identifies six operational properties and six rules of use that guide action in complex adaptive systems (Table 1). These elements do not act in isolation, but can be activated in parallel or combined, generating multiple ways of responding to problematic situations. A central aspect of the theory is the principle of intersubjectivity, which allows one to understand and anticipate not only the consequences of one's own actions, but also the intentions of others (Berthoz, 2003; 2015). The logic underlying simplexity is neither linear nor merely reproductive: it rejects the idea of an unambiguous correspondence between problem and solution and instead values processes of situated, flexible and contextual understanding (Sibilio, 2023).

Applied to educational contexts, the theory of simplexity is particularly relevant to address the complexity of teaching-learning, especially in inclusive environments (Aiello, 2016; 2024). Numerous studies highlight the analogy between the characteristics of Adaptive Complex Systems and educational processes, which are configured as dynamic systems in continuous interaction with multiple variables (Sibilio, 2015; 2017; 2023). These systems are characterized by non-linear behaviors and constant internal reorganization, which can generate unpredictable outcomes. In this perspective, awareness of the properties and rules of simplexity can support teachers in managing emerging complexity more effectively and intentionally (Aiello et al., 2016).

Although teachers use these devices implicitly daily, their explicitness is essential. As is the case with many instinctive or learned behaviors, teaching practices also tend to be structured in habits that are not always conscious (Aiello et al., 2021).

The literature shows how reflective attention to these processes can improve their effectiveness and professional well-being. In this sense, reflexivity before, during and after the action represents a key competence for a transformative practice (Schön, 2017), recognized as central also in teaching professionalism (Smuha, 2019; EADSNE, 2012).

In the educational context, one of the fundamental properties of simplicity is the *separation of functions and modularity*. Faced with complex teaching tasks, the teacher can break down the educational action into simpler and more targeted activities, which are then integrated into a coherent design. This process makes complexity more manageable and favors a didactic mediation adapted to the different needs of students (Berthoz, 2012; Sibilio, 2015). Another relevant property is speed, understood as the ability to react promptly to unforeseen events or situations of disinterest, modifying strategies and activities to keep engagement high.

Reliability is another key element, as it allows you to reduce the margin of error and increase the chances of success. Through differentiated and flexible teaching strategies, teachers can adapt methods and tools to different learning styles, promoting effective inclusion. In this framework, *flexibility, adaptation and vicariance* make it possible to select, from time to time, the most functional strategies, recognizing the uniqueness of each classroom context. *Memory*, understood as a heritage of previous experience, allows you to anticipate action, while generalization allows you to transfer skills and knowledge between different situations, ensuring continuity and didactic coherence.

In addition to the properties, the rules of use of simplexity offer further operational indications. The rule of *inhibition and rejection* emphasizes the need to select some options to the exclusion of others, not because they are useless, but because they are less functional in a given context. This process stimulates creativity, favoring the inhibition of automatic responses and the development of innovative solutions (Sibilio, 2013; 2023). The rule of specialization and selection recalls the importance of focusing on essential and significant stimuli, avoiding cognitive overload. In the educational field, this implies careful planning of the content and activities proposed.

Cooperation and redundancy help to strengthen learning, ensuring stability and reliability through the repetition and integration of information. Probabilistic anticipation guides educational action based on the prediction of possible outcomes and students' reactions, supporting a continuous adaptation of instructional design. The detour rule enhances non-linear paths, which, although they appear more complex, can be more effective in overcoming difficulties. Finally, the rule of meaning highlights the central role of attributing meaning to educational action: clear and shared objectives make the learning experience more motivating and encourage the active involvement of students.

Application in inclusive educational contexts would allow addressing complexity not as an obstacle, but as a resource, promoting flexible, reflective, and meaning-oriented teaching practices (Berthoz, 2012; Sibilio, 2013).

Table 1. Properties and rules of simplexity (Berthoz, 2019; Sibilio, 2023)

Principles	**Definition**	**Properties**	**Definition**
Inhibition and the principle of rejection	Every choice of educational action	Specialization and modularity	Decompose complex tasks into manageable

	implies the inhibition of alternatives; Reflecting on automatisms avoids rigid teaching models.		sub-tasks and reassemble them into a coherent structure.
Specialization and selection	Ability to filter and focus on information relevant to educational objectives.	Speed	Timely decisions based on forecasting and experience.
Cooperation and redundancy	Integration of sources of knowledge and repetition useful for consolidating learning.	Reliability	Teaching strategies that reduce uncertainty and increase the probability of success.
Probabilistic anticipation	Ability to predict educational outcomes based on experience and present conditions.	Flexibility, vicariance and adaptation to change	Personalization of strategies based on individual stimuli and needs.
Detour	Adoption of alternative paths and differentiated strategies for complex problems.	Memory	Use of past experience to prevent or manage educational difficulties.
Meaning	Clarification of objectives and connection between school knowledge and personal experience.	Generalization	Transfer of patterns and knowledge to new contexts.

4. Six hats to think about

The Maltese psychologist Edward de Bono argues that thought cannot be reduced to a mere logical-deductive operation but must be understood as a capacity oriented towards the search for meaning. According to the author, thinking means collecting information, reworking it functionally, and giving meaning to experience, to generate new and appropriate solutions to the problematic situations faced (de Bono, 1970; 2015). In this sense, two main modes of thinking are distinguished: vertical thinking and lateral thinking. The former represents the most widely used form of thought in everyday life and in formal learning contexts. It is linear, sequential, and

analytical thinking, which proceeds in successive steps, following consolidated logical rules and structured reasoning schemes. Vertical thinking aims to identify the correct solution through the consistent application of known procedures, favoring accuracy and internal consistency of reasoning.

Lateral thinking, on the other hand, is characterized by a non-linear approach and the ability to observe problems from different perspectives, favoring the production of alternative ideas and original solutions (Jesson, 2012). It does not limit itself to reorganizing existing information according to pre-established patterns but encourages the overcoming of established cognitive habits and the exploration of unusual connections between apparently distant elements. De Bono defines lateral thinking as a real mental disposition, a cognitive attitude that allows information to be reshaped in a transformative way, generating innovation and change (de Bono, 1970).

Although these two types of thinking are often presented as distinct, de Bono emphasizes the importance of integrating them. Lateral and vertical thinking are not mutually exclusive, but complementary. In the creative process, lateral thinking intervenes mainly in the idea generation phase, expanding the field of possibilities and stimulating the exploration of multiple solutions. Subsequently, vertical thinking allows one to critically evaluate the alternatives that have emerged, selecting the most effective and realistic ones (de Bono, 2015a). This alternation allows you to combine creativity and rigor, innovation and control.

Precisely because of its ability to promote the exploration of new perspectives and to foster unconventional connections, lateral thinking is closely associated with the concept of creativity. In education, creative thinking is considered a higher-order skill, fundamental to support learning, problem solving, and students' ability to deal with new and complex situations (Ahmed, 2017; Astuti et al., 2021; Rosca & Todoroi, 2019).

Among the different models proposed for the support of creative thought, there is the method of the Six Hats for Thinking (de Bono, 1970), which represents a structured way to analyze complex problems through differentiated points of view. The method is based on the metaphorical use of six hats (Tab.2), each of which corresponds to a specific mode of thought. The white hat recalls the information dimension and urges the collection and objective analysis of data, laying the foundations for evidence-based decisions. The red hat legitimizes the emotional component of thought, recognizing the role of intuitions, feelings, and perceptions in decision-making processes. The yellow hat represents a positive and constructive perspective, oriented towards the identification of opportunities, benefits and potential of the proposed solutions. The black hat performs a critical and precautionary function, highlighting risks, limits and possible criticalities. The green hat embodies creative and lateral thinking, encouraging the production of innovative ideas and the experimentation of alternative approaches. Finally, the blue hat performs a function of regulation and supervision, coordinating the process, defining objectives, times and rules of discussion.

Overall, the Six Hats method offers the opportunity to develop flexible, multidimensional thinking, learning to separate different cognitive modalities and use them intentionally. In a school context characterized by high complexity and plurality of educational needs (Morrison, 2012; Pavone, 2015; Cottini, 2017), this approach could be particularly relevant. The adoption of lateral thinking would allow teachers to

overcome the limits of exclusively linear teaching, promoting inclusive and adaptive strategies to deal with problematic situations effectively and consciously.

Table 2. Six hats for thinking (de Bono, 1986)

Hat	Definition
Blue	Organizational thinking and process control
White	Data analytical thinking
Yellow	Asset Analysis
Black	Risk analysis
Red	Emotional thinking and insights
Green	Creativity and new ideas

5. Methodology

5.1. Aim of the study

This survey aims to outline a mapping of the current state of teachers' representations and didactic intentions with respect to the use of digital technologies, exploring whether and how they hypothesize their use in the educational field in the absence of prescriptive constraints or explicit operational indications.

5.2. Sample

The participants in the study were 189 trainees, future secondary school support teachers, attending the course of Metacognitive Didactics: Cooperative and Metacognitive Approach, included in the specialization course for TFA (Active Training Internship) support. Participation was voluntary, and only one class out of six of the groups of future support teachers in upper secondary school was involved, for organizational reasons. The age is between 25 and 60 years old, and only 26.6% of the trainees already work as curricular teachers.

5.3. Instrument and Procedure

The course of Metacognitive Didactics: Cooperative and Metacognitive Approach was divided into a total of 30 training hours, of which 15 were dedicated to the theoretical study of simplexity and the method of the Six Hats for Thinking. In detail, the lessons involved two main phases:

a. In the initial phase of the course, the main studies on creativity and divergent thinking were illustrated to the students, focusing in detail and depth on Edward de Bono's theories relating to lateral thinking and presenting the method of the "Six Hats for Thinking", as a tool to exercise one's creative thinking in the processes of analysis of the educational context on which to act didactically. Alain Berthoz's theory of simplexity was then explained with respect to which, with reference to the simple properties of flexibility and adaptation to change, and to the simple principles of inhibition, rejection, and detour, it was possible to identify interesting analogies with the concepts of creativity, divergent thinking, and lateral thinking.

EDIZIONI UNIVERSITARIE ROMANE
editoria scientifica dal 1952

b. The first phase, characterized above all by theoretical reflections on the subject, was followed by a practical-operational moment: the trainees, in fact, were offered an exercise aimed at exercising deviation and, therefore, creative thinking. Specifically, it was requested to develop a written production, aimed at the reflective description of one's teaching action, based on the rules and properties of simplexity in the different areas of general, disciplinary, and special teaching. In order to investigate in a non-prescriptive way, the representations and intentions of teachers with respect to the use of digital technologies, no explicit indications or constraints have been provided regarding their use. The textual productions of the trainees were collected through a questionnaire administered through the Google Forms platform. The exercise included, in a first section, the request to formulate a theoretical definition of the rules and properties of simplexity; subsequently, for each principle or property, the participants were invited to hypothesize a didactic action consistent with them, declined in the different areas of general, disciplinary and special teaching.

This structure made it possible to detect not only the level of conceptual understanding of the proposed theoretical constructs, but also the ways in which they were operationally translated into the didactic design.

6. Results

The analysis of the papers produced by the 189 trainees made it possible to detect the frequency with which the use of digital technologies was hypothesized in relation to the principles and properties of simplicity. Overall, about a third of the participants included explicit references to the use of digital tools in the planned educational actions. With reference to simplex properties, 44.4% of the students hypothesized the use of technologies in relation to the *separation of functions*, through the distinction of communication channels (oral, visual, bodily), citing tools such as tactile maps and braille systems. The same percentage (44.4%) referred to the ownership of *memory*, involving the use of videos, voice recordings, and digital mind maps. For *flexibility and adaptation to change*, 44.4% mentioned tools such as text-to-speech and magnifiers. Speed, understood as didactic readiness, was associated with the use of synthesis software and gamification tools by 44% of participants. *Reliability* was recalled in 43.4% of cases through the hypothetical use of screen readers and audiobooks, while generalization in 43.3% through visual maps and digital cards applicable to different contexts.

As far as simplex rules are concerned, the rule of *inhibition and rejection* was associated with the critical use of technologies by 40.7% of the trainees, as well as the principle of specialization and selection. The principle of *probabilistic anticipation* was recalled in 39.7% of cases, through the monitoring of feedback with audio supports and digital games. *Cooperation and redundancy* and deviation were both mentioned by 39.7% of the participants, while the rule of meaning emerged in 38.6% of the papers, with reference to digital tools to support the teaching action.

7. Data Discussion

The results of the exploratory survey show a limited presence of the hypothetical use of digital technologies in the educational designs developed by teachers in training. In fact, only about a third of the participants integrated explicit references to

EDIZIONI UNIVERSITARIE ROMANE
editoria scientifica dal 1952

digital, despite the absence of constraints or prescriptive indications in this regard. This figure appears significant if read in the light of the current training context, strongly characterized by an intensification of policies and investments on digital skills, and would suggest the existence of a distance between the institutional discourse on technologies and their effective conceptualization in educational action. A further relevant element concerns the nature of the hypothetical technological uses. Technologies, according to this evidence, are mainly associated with compensatory and inclusive functions, in relation to the simple properties of separation of functions, memory, *reliability and flexibility*. This confirms how, in the representation of teachers in training, digital is still conceived above all as a support tool to respond to specific educational needs, rather than as a transversal resource for didactic design and methodological innovation. The limited variety of digital tools mentioned would reinforce this reading, showing a recurrent use of assistive technologies and accessibility-oriented devices. As far as the rules of simplexity are concerned, the association between technologies and decision-making processes appears less frequent and more fragmented. References to the rules of *probabilistic anticipation*, *cooperation and redundancy, deviation* and *meaning*, although present, involve a smaller percentage of participants. This data would suggest that the integration between simplex thinking and the use of technologies is not yet fully internalized as a structural dimension of educational action, but tends to remain anchored to individual operational functions. Overall, the results seem to indicate that, in the absence of training explicitly oriented towards digital education, teachers in training tend to reproduce an instrumental and sectoral vision of technologies, consistent with predominantly compensatory teaching models. In this perspective, the integration between the theory of simplicity and the method of the Six Hats for Thinking could, potentially, provide a theoretical-methodological framework to support the development of more flexible, creative, and conscious decision-making processes, capable of expanding the ways of conceiving and integrating technologies in educational contexts. These results reinforce the need to rethink the initial training paths of teachers, promoting approaches that are not limited to the development of technical skills, but that encourage a metacognitive reflection on the use of technologies as an integral part of simple and *non-linear* didactic action.

8. Conclusions and future perspectives

The paper has proposed an exploratory investigation aimed at mapping the ways in which teachers in training spontaneously conceptualize the use of digital technologies within a didactic action inspired by the rules and properties of simplexity. The results show how the integration of digital emerges in a limited way and is mainly oriented towards compensatory and inclusive purposes, moving the hypothesis that at present, there is probably the centrality of a functional vision of technologies rather than their full integration into the overall educational design. In this context, digital would rarely appear to be conceived as a transversal device capable of supporting flexible, creative, and adaptive decision-making processes. However, the study has some limitations that should be made explicit. Firstly, digital technologies were not an explicit subject of the course or of the proposed exercise; The absence of intentional indications, if on the one hand has made it possible to detect spontaneous ideas, on the other hand may have affected the frequency and variety of the technological solutions hypothesized. Furthermore, at the time of the survey, the training activities

specifically dedicated to ICT envisaged in the specialization course had not yet been completed, an element that may have influenced the representations that emerged. Considering these limitations, future lines of research could include longitudinal or comparative studies, aimed at observing how training intentionally oriented towards the integration of simplexity, Six Hats for Thinking and educational technologies can affect the teaching design methods of teachers. It would be of interest to explore whether and to what extent these theoretical-methodological frameworks can support a more conscious, creative and non-reductive use of digital technologies, contributing to the development of adaptive professional skills consistent with the complexity of contemporary educational contexts.

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