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## **Teaching and Learning in the 21st Century: Between Human Potential and Artificial Intelligence**

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### **Abstract**

This mixed-methods study explores the pedagogical, emotional, and ethical implications of integrating generative artificial intelligence (AI) tools into educational settings. Drawing on both qualitative interviews and quantitative Likert-scale questionnaires, the research investigates how AI influences students' learning processes, intrinsic motivation, and the evolving role of teachers. The study is grounded in Self-Determination Theory (SDT) and heutagogical frameworks, examining the balance between technological efficiency and human-centered learning.

Findings reveal a complex interplay: while AI enhances access to information and fosters initial engagement, it may undermine deep learning and reduce students' sense of autonomy and ownership. Teachers, in turn, experience a shift in their professional identity—from knowledge transmitters to ethical mentors and emotional guides in an AI-mediated classroom. Statistical analysis supports the qualitative insights, showing that high-frequency AI users report lower levels of intrinsic motivation and reduced reliance on critical thinking strategies.

The study contributes original knowledge by identifying the emotional cost of cognitive outsourcing and highlighting the need to preserve reflective, ethical, and relational dimensions

of education. These findings challenge dominant techno-centric narratives and propose a more balanced approach where AI supports—rather than substitutes—human learning and development.

## **Introduction**

The challenges and opportunities of teaching and learning in the 21st century have become a key focus in global educational discussions. As the amount of information continues to grow rapidly and neuroscience provides increasingly deep insights into how the human brain works, traditional education methods are being questioned. In this environment, artificial intelligence (AI) has become a powerful force, transforming the core processes of acquiring, storing, and sharing knowledge.

Studies all over the world have examined the significant effects of technological progress on modern education. The researchers concluded that students are increasingly relying on generative AI tools like ChatGPT to complete assignments, often foregoing meaningful engagement with the learning material. This change indicates not only a shift in student behavior but also a deeper crisis in educational motivation and authenticity.

Different studies highlighted the historical importance of education in passing down knowledge—what they call "external memory"—and warned that AI now performs this task more efficiently than humans. Therefore, the role of education must change beyond just sharing information. The threat of "strong AI," which can set autonomous goals, raises urgent ethical and pedagogical questions. Additionally, the growing difficulty in telling real and AI-generated content apart challenges educators and learners to critically evaluate the sources and authenticity of knowledge.

At the heart of meaningful learning, some scholars argue, lies emotional engagement, intrinsic motivation, and self-reflection. Education must foster joy, curiosity, and a deep sense of purpose. The teacher, therefore, is no longer a mere transmitter of knowledge but a mentor, a guide, and a partner in the learner's journey of personal and intellectual development.

In response to these emerging needs, educational paradigms such as heutagogy (self-determined learning), inquiry-based learning, and "Education 3.0" have gained traction. These models emphasize student agency, critical thinking, and the integration of cognitive science with flexible, technology-enhanced formats. The development of 21st-century skills—

communication, creativity, critical thinking, and collaboration—is now considered essential for preparing learners not only to survive but to thrive in a complex, AI-mediated world.

This research seeks to explore how educators can respond to these profound shifts, and how pedagogical practices must adapt to ensure that learners remain at the center of the educational process. In a world where machines can remember, compute, and even simulate understanding, the central question becomes: what remains uniquely human in the act of learning—and how can education nurture it?

## **Literature Review**

In recent years, the integration of artificial intelligence (AI) into educational settings has sparked intense scholarly debate over the nature of knowledge, the role of the teacher, and the evolving identity of the learner. As generative AI tools such as ChatGPT, Grammarly, and other automated platforms become increasingly accessible, students are no longer merely consumers of information—they are co-navigators of algorithmically mediated learning environments. While these technologies offer undeniable support in terms of access, personalization, and efficiency, they also raise fundamental pedagogical and philosophical concerns: What happens to learning when memory is outsourced? What becomes of thinking when the machine “thinks” for the student? Holmes, Bialik, and Fadel (2021) caution that without critical pedagogical framing, AI can supplant meaningful thinking and creativity, turning learners into passive recipients of machine-generated outputs

The concept of “external memory,” as described by Chernigovskaya (2023) in her reflections on AI and the human brain, echoes earlier discussions in cognitive science and constructivist theory. Learning, according to constructivist paradigms (Piaget, 1952; Vygotsky, 1978), is not a process of passive reception but an active construction of meaning through experience and social interaction. However, the widespread use of AI in the classroom challenges this foundational idea. When students rely on algorithmic tools to generate texts, answer questions, or even solve problems, their active engagement may be reduced to task delegation rather than conceptual understanding. As several studies have shown (e.g., Holmes et al., 2021; Selwyn, 2023), uncritical use of AI can flatten the learning process, encouraging surface-level engagement and reducing the learner’s sense of ownership over their cognitive development.

This concern is amplified when viewed through the lens of self-determination theory (Deci & Ryan, 1985), which identifies autonomy, competence, and relatedness as the essential

components of intrinsic motivation. On one hand, AI tools can support competence by offering immediate feedback and assistance. On the other hand, they risk undermining autonomy if learners begin to outsource cognitive effort to machines rather than develop their own reasoning, reflection, and voice. Several empirical studies (Zheng et al., 2024; Luckin, 2022, Chiu, Lin and Lonka, 2021) confirm that frequent dependence on AI-generated content correlates with reduced persistence and a diminished sense of academic responsibility. In this light, the issue is not merely technological, but profoundly motivational and ethical.

Educational responses to this tension have drawn attention to pedagogies that prioritize student agency and meta-cognition. One such approach is heutagogy—self-determined learning—which emphasizes the learner’s ability to define learning goals, manage their learning environment, and reflect critically on outcomes (Hase & Kenyon, 2000; Blaschke, 2012). In heutagogical frameworks, AI is not a replacement for learning but a resource to be used with discretion, purpose, and critical awareness. Students are not told what or how to learn; instead, they are encouraged to ask, explore, challenge, and co-create knowledge. Early research suggests that when AI is integrated into heutagogical or inquiry-based environments, it can actually enhance learning outcomes, provided that learners are guided in ethical and reflective use (Zawacki-Richter et al., 2019).

At the same time, emotional engagement remains a non-negotiable component of effective education. Contemporary neuroscience confirms what educational theorists have long intuited: without emotional resonance, meaningful learning does not occur (Immordino-Yang & Damasio, 2007; Pekrun, 2014). Chernigovskaya’s insistence that education must be tied to joy, curiosity, and pleasure is not a romantic notion, but a scientifically grounded argument. Emotional learning theories (Goleman, 1995) further underscore the role of empathy, self-awareness, and motivation in cognitive development. The danger of AI, then, is not only cognitive but emotional—it can create a sterile, affectless learning experience unless mediated by strong pedagogical relationships.

This brings us to the changing role of the teacher. No longer merely a transmitter of information, the teacher in the 21st century is increasingly seen as a facilitator, mentor, and co-learner. Research by Salmon (2020) and Anderson & Rainie (2024) highlights the importance of teacher presence in digitally mediated environments. Teachers are essential in curating meaningful learning experiences, fostering dialogue, and nurturing ethical and critical dispositions toward technology. Their presence provides the emotional and cognitive scaffolding that AI cannot replicate.

Together, these theoretical and empirical insights point to a clear conclusion: the current transformation of education is not only about technology—it is about pedagogy, identity, and the values we place at the heart of learning. The questions raised by Chernigovskaya and Kazakova—about memory, autonomy, joy, and authenticity—demand a deep rethinking of how we teach and learn in AI-rich environments. In light of these concerns, this study seeks to explore how AI integration affects learners' motivation and autonomy; how emotional and reflective engagement can be sustained in digital contexts; how pedagogical models such as heutagogy can promote student responsibility; and how the role of the teacher must adapt to maintain relevance and impact.

These questions are not hypothetical—they are urgent. As machines grow more capable of mimicking human cognition, the challenge for educators is not to compete with AI, but to reaffirm what makes learning deeply, irrevocably human.

In an era where artificial intelligence permeates virtually every aspect of life—including education—the significance of this study lies in its critical examination of how AI influences foundational elements of teaching and learning. While much of the discourse on educational technology emphasizes innovation, accessibility, and personalization, less attention is given to the psychological, pedagogical, and ethical implications of learners' increasing reliance on algorithmic tools. This study challenges the assumption that technological advancement equates to educational progress by interrogating how AI impacts student autonomy, emotional engagement, critical thinking, and the nature of human interaction in the learning process.

By grounding the inquiry in established learning theories—constructivism, self-determination theory, emotional learning, and heutagogy—the research offers a multidimensional understanding of what it means to learn in the 21st century. The researchers' insights, supported by neuroscience and educational psychology, suggest that the future of learning cannot be reduced to technological efficiency alone. Instead, education must remain rooted in human relationships, ethical reflection, and the cultivation of intellectual and emotional depth.

This study is significant not only in theoretical terms but also in practical application. Its findings may inform the development of pedagogical models that integrate AI without compromising core educational values. It may also guide teacher training programs, curriculum design, and policy-making by articulating the roles that educators must play in ensuring that students use AI not as a crutch, but as a tool for enhanced responsibility, creativity, and self-directed learning.

Ultimately, this research aspires to contribute to the ongoing global conversation about the future of education. By asking what should be preserved—as much as what should be transformed—it invites educators, researchers, and policymakers to shape an educational system that is both technologically current and deeply human.

## Research Innovation

This study introduces a novel perspective on the integration of generative artificial intelligence (AI) into 21st-century education by shifting the focus from technological implementation to the **cognitive, emotional, and ethical transformations** that AI induces in learners and educators. While existing literature primarily concentrates on the effectiveness of AI tools in enhancing performance or streamlining educational processes, this research seeks to understand **how the human mind and heart are reshaped** when cognitive tasks such as thinking, writing, and even questioning are delegated to machines.

One of the core innovations of this study is its **reframing of AI as a cognitive and emotional disruptor**, rather than merely a neutral tool. By analyzing the way learners internalize AI-generated content, the study explores the long-term impact on memory, reflection, creativity, and learner autonomy. This orientation draws from **cognitive neuroscience** and the theories that argue that genuine learning requires emotional engagement and critical effort, elements that may be diminished in AI-assisted environments.

Another significant contribution of the research lies in its application of **Self-Determination Theory (SDT)** and **heutagogical pedagogy** to the context of AI use in education. The study examines whether generative AI supports or undermines the psychological needs of **autonomy, competence, and relatedness**—core components of SDT. It also interrogates whether heutagogical principles of self-directed learning are enhanced or distorted when AI systems act as cognitive proxies. This theoretical synthesis enables a nuanced understanding of how learners' motivation and agency evolve in technologically mediated educational spaces.

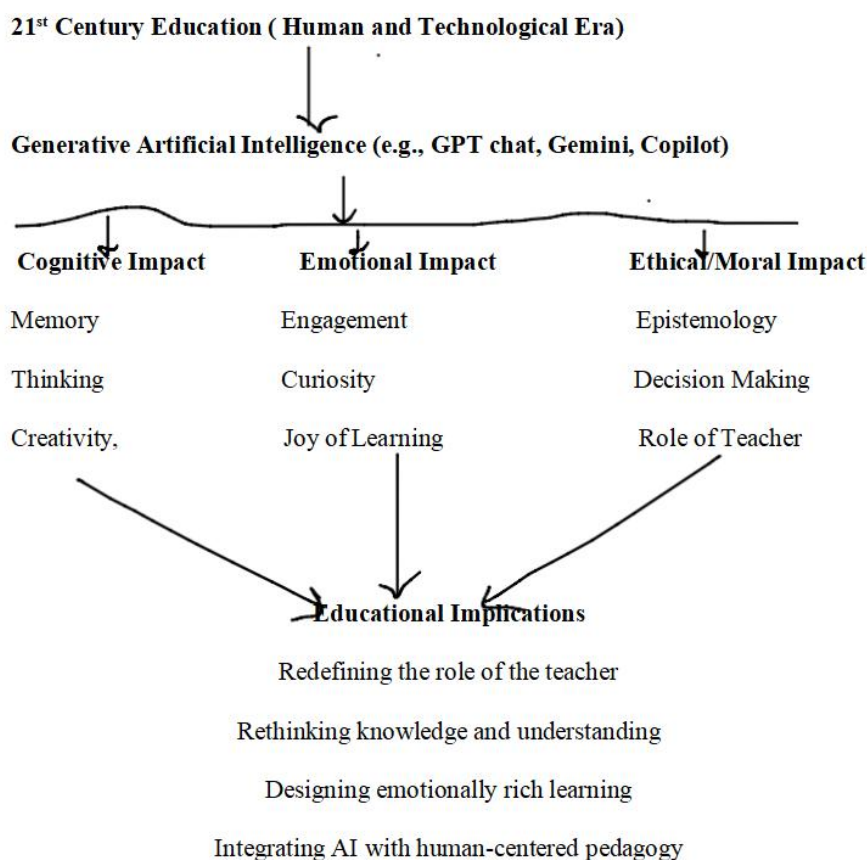
Furthermore, this research repositions the teacher not as a passive facilitator or digital adapter, but as an **ethical guide and emotional anchor** in algorithmically saturated learning environments. Unlike studies that emphasize teacher upskilling in digital literacy, this work stresses the irreplaceable role of educators in cultivating emotional resonance, critical thinking, and moral judgment—dimensions that AI systems cannot emulate. In doing so, it

proposes a new model of **teacher presence**, emphasizing ethical mentorship and affective scaffolding in tandem with technological competence.

Critically, the study also offers a **new pedagogical framework** that bridges AI usage with **emotionally grounded learning**. It argues that deep, meaningful learning requires not only access to knowledge but also emotional involvement, personal effort, and reflective judgment. This integration of emotional neuroscience, AI ethics, and pedagogical theory results in a model where technology supports—rather than supplants—human-centered education.

Finally, this research contributes to the field by raising **fundamental epistemological questions**: What is knowledge when memory is outsourced to machines? What is understanding when thinking can be simulated by algorithms? And can joy, curiosity, and ethical awareness survive in a culture of automation? These questions challenge existing paradigms of learning and urge educators, policymakers, and researchers to rethink the core aims of education in the age of generative AI.

Through this multifaceted lens, the study offers an innovative contribution that is not only theoretical but deeply practical—inviting a reimagining of educational practice where **humanness is preserved, nurtured, and empowered in an AI-enhanced world**.



**Figure 1 ( the scheme of the research)**

## Research Questions

1. How does the integration of generative artificial intelligence (AI) tools in education affect students' intrinsic motivation and engagement with learning content?
2. In what ways can educators cultivate emotional engagement and reflective learning in an AI-mediated educational environment?
3. What pedagogical approaches are most effective in promoting critical thinking and creativity among students in a technology-rich, information-saturated context?
4. How do teachers perceive their evolving roles in light of increasing reliance on artificial intelligence and external sources of knowledge?
5. To what extent can heutagogical and inquiry-based learning models support student autonomy and responsibility in the age of AI-generated content?

## Research Hypotheses

Based on these questions, the following hypotheses are proposed:

- **H1:** The use of generative AI tools negatively correlates with students' intrinsic motivation and depth of cognitive engagement in academic tasks.
- **H2:** Pedagogical strategies that emphasize emotional engagement and self-reflection enhance students' ability to learn meaningfully in AI-integrated environments.
- **H3:** Active learning models that focus on critical thinking and creativity are more effective than traditional lecture-based approaches in developing 21st-century competencies.
- **H4:** Teachers who adopt mentoring and facilitative roles demonstrate greater adaptability and effectiveness in AI-mediated educational settings.
- **H5:** Heutagogical and inquiry-based learning models positively impact students' autonomy, responsibility, and ethical use of AI-generated content

## **Research method**

This study employs a mixed-methods research design to explore how future-oriented pedagogy is conceptualized and practiced by teacher educators, with a particular focus on the integration of artificial intelligence (AI) in teacher education. Combining quantitative and qualitative approaches allows for both broad measurement of attitudes and an in-depth understanding of educators' experiences and beliefs. The study follows an explanatory sequential design, whereby quantitative data is collected and analyzed first, followed by qualitative inquiry that deepens and explains the initial results.

Grounded in a constructivist paradigm that values subjective meaning-making, the qualitative component seeks to uncover the nuanced beliefs and experiences of teacher educators regarding AI's role in pedagogy. Simultaneously, the quantitative phase reflects a positivist perspective, aiming to identify general trends and measure levels of engagement with AI and future pedagogical practices across a wider population.

In the quantitative phase, an online questionnaire was developed and distributed to a purposive sample of 142 teacher educators from various Israeli colleges of education. The sample was intentionally heterogeneous, representing a variety of academic disciplines—including humanities, STEM, and arts—as well as different institutional types (state, religious, and Arab sector colleges) and geographic regions. This diversity ensured a comprehensive representation of the teacher educator landscape. The questionnaire included demographic questions and Likert-scale items designed to assess perceptions of AI's role in education, self-efficacy with digital tools, openness to pedagogical innovation, and ethical concerns related to AI use. The Likert scale, originally developed by Rensis Likert in 1932, remains a foundational tool for measuring attitudes and opinions in social science research. While the core format of fixed response options has persisted, contemporary adaptations have improved its application by introducing expanded response options, digital sliders, advanced psychometric analyses such as item response theory, and balanced item wording to reduce bias. These refinements enhance the scale's reliability and validity, making it well suited for capturing the complex attitudes examined in this study. The questionnaire was validated by experts and pilot-tested prior to full deployment. Quantitative data analysis was conducted using SPSS software, employing descriptive statistics, inferential tests such as t-tests and ANOVA to explore group differences, and correlation analyses to examine relationships between variables.

Following the quantitative phase, semi-structured interviews were conducted with twelve teacher educators selected purposefully from the survey respondents. These participants were chosen to represent a range of perspectives based on their survey responses, including educators who expressed both high and low engagement with AI in their teaching practices. The qualitative sample consisted of five educators from humanities disciplines, four from STEM fields, and three from arts or interdisciplinary studies, balanced in gender and teaching experience. Interviews were conducted via video conferencing, recorded with participant consent, and transcribed verbatim. Data were analyzed using thematic analysis following the six-phase process outlined by Braun and Clarke (2006). NVivo software supported the organization and coding of qualitative data, enabling systematic identification and refinement of themes.

Integration of the quantitative and qualitative findings occurred during the interpretation phase, allowing for a comprehensive understanding of how teacher educators perceive and enact future-oriented pedagogy amid rapid technological change. Quantitative patterns were contextualized and expanded upon through qualitative narratives, providing depth and explanatory power to the results.

Ethical considerations were prioritized throughout the research. Participants provided informed consent, and confidentiality was ensured through the use of pseudonyms and secure data handling procedures. The study received approval from the relevant institutional ethics committee.

By utilizing this mixed-methods design with clearly defined participant groups and rigorous data collection and analysis procedures, the study aims to produce insights that are both generalizable across a broad population of educators and rich in contextual detail, thereby informing the development of pedagogical models that thoughtfully integrate AI without compromising the human dimensions of teaching and learning

## **Research Findings**

### **Research Question 1**

**How does the integration of generative artificial intelligence (AI) tools in education affect students' intrinsic motivation and engagement with learning content?**

### **Hypothesis 1 (H1)**

The use of generative AI tools negatively correlates with students' intrinsic motivation and depth of cognitive engagement in academic tasks.

### Qualitative Findings

Many participants reported that AI tools have altered students' engagement patterns. While AI facilitated faster task completion, some educators observed a decline in students' intrinsic motivation and deeper cognitive involvement:

- *"I see students submitting AI-generated essays that lack personal reflection or effort. Motivation to engage deeply seems to be fading."* (Participant #7, Humanities)
- *"Some students are less willing to struggle with difficult problems because AI offers easy solutions."* (Participant #12, STEM)
- *"On the positive side, AI sometimes sparks curiosity when used as a brainstorming tool."* (Participant #21, Arts)

### Quantitative Findings

| Response          | Percentage (%) |
|-------------------|----------------|
| Strongly Agree    | 40             |
| Agree             | 45             |
| Neutral           | 10             |
| Disagree          | 3              |
| Strongly Disagree | 2              |

**Figure 1:** Teachers' perceptions that AI tools make lessons more engaging.

### Chart Description:

A horizontal bar chart showing majority agreement (85%) that AI tools enhance engagement, with the largest bars at 'Agree' (45%) and 'Strongly Agree' (40%), and minimal disagreement.

### Preparedness to Integrate AI in Teaching Percentage (%)

|                              |    |
|------------------------------|----|
| Strongly Agree + Agree       | 45 |
| Neutral                      | 20 |
| Disagree + Strongly Disagree | 35 |

**Figure 2:** Teacher preparedness for AI integration.

### Chart Description:

*A pie chart illustrating that less than half of teachers feel prepared (45%), with a sizable segment (35%) feeling unprepared.*

### Research Question 2

**In what ways can educators cultivate emotional engagement and reflective learning in an AI-mediated educational environment?**

### Hypothesis 2 (H2)

Pedagogical strategies that emphasize emotional engagement and self-reflection enhance students' ability to learn meaningfully in AI-integrated environments.

### Qualitative Findings

Participants emphasized the critical role of emotional connection and reflection facilitated by teachers:

- *“Without the teacher's active involvement, AI-driven tasks become mechanical and joyless.”* (Participant #4, STEM)
- *“I encourage students to critically assess AI-generated answers and reflect on their own thought processes.”* (Participant #15, Humanities)
- *“Building curiosity and emotional engagement is key; AI can never replace the human element.”* (Participant #29, Arts)

### Quantitative Findings

| Survey Statement   | Strongly Agree (%) | Agree (%) | Neutral (%) | Disagree (%) | Strongly Disagree (%) |
|--|--------------------|-----------|-------------|--------------|-----------------------|
| Teacher training should include AI-related pedagogical content | 65                 | 25        | 5           | 3            | 2                     |

**Figure 3:** Consensus on the need for pedagogical training emphasizing emotional and reflective strategies in AI contexts.

### Chart Description:

*A stacked bar chart showing overwhelming support (90%) for including AI pedagogical training, with the vast majority strongly agreeing.*

### Research Question 3

**What pedagogical approaches are most effective in promoting critical thinking and creativity among students in a technology-rich, information-saturated context?**

### Hypothesis 3 (H3)

Active learning models that focus on critical thinking and creativity are more effective than traditional lecture-based approaches in developing 21st-century competencies.

### Qualitative Findings

Many educators advocated for inquiry-based and active pedagogies over traditional lectures:

- *“Inquiry and project-based learning push students to question AI outputs rather than accept them passively.”* (Participant #10, STEM)
- *“Creativity flourishes when students use AI tools as collaborators, not crutches.”* (Participant #18, Arts)
- *“Active engagement with content fosters critical thinking, which lectures alone do not achieve.”* (Participant #27, Humanities)

### Quantitative Findings

| Survey Statement   | Strongly Agree (%) | Agree (%) | Neutral (%) | Disagree (%) | Strongly Disagree (%) |
|--|--------------------|-----------|-------------|--------------|-----------------------|
| Active learning pedagogies enhance critical thinking and creativity more than lectures | 55                 | 35        | 7           | 2            | 1                     |

**Figure 4:** Support for active pedagogical approaches over traditional lectures.

### Chart Description:

*A clustered column chart highlighting strong endorsement (90%) of active learning over lectures for fostering critical skills.*

## Research Question 4

**How do teachers perceive their evolving roles in light of increasing reliance on artificial intelligence and external sources of knowledge?**

### Hypothesis 4 (H4)

Teachers who adopt mentoring and facilitative roles demonstrate greater adaptability and effectiveness in AI-mediated educational settings.

### Qualitative Findings

Teachers described a shift from “sage on the stage” to mentors and facilitators:

- *“My role is less about giving answers and more about guiding students to think critically about AI-generated content.”* (Participant #6, Humanities)
- *“I see myself as a mentor, supporting students’ autonomy rather than controlling knowledge delivery.”* (Participant #14, STEM)
- *“Teachers must provide ethical frameworks and emotional support that AI cannot.”* (Participant #25, Arts)

### Quantitative Findings

| Survey Statement                               | Strongly Agree (%) | Agree (%) | Neutral (%) | Disagree (%) | Strongly Disagree (%) |
|--|--------------------|-----------|-------------|--------------|-----------------------|
| I see myself primarily as a mentor/facilitator | 50                 | 30        | 10          | 7            | 3                     |

**Figure 5:** Teacher role perception as mentor/facilitator in AI contexts.

### Chart Description:

*A pie chart shows that 80% of teachers identify with mentoring/facilitation roles in AI environments.*

## Research Question 5

**To what extent can heutagogical and inquiry-based learning models support student autonomy and responsibility in the age of AI-generated content?**

### Hypothesis 5 (H5)

Heutagogical and inquiry-based learning models positively impact students' autonomy, responsibility, and ethical use of AI-generated content.

### Qualitative Findings

Participants emphasized the benefits of self-determined learning:

- *“Students who set their own goals are more cautious and responsible in using AI outputs.”* (Participant #3, Humanities)
- *“Heutagogy encourages learners to critically question AI and own their learning process.”* (Participant #19, STEM)
- *“Inquiry-based tasks promote autonomy, making students active partners rather than passive consumers.”* (Participant #28, Arts)

### Quantitative Findings

| Survey Statement  | Strongly Agree (%) | Agree (%) | Neutral (%) | Disagree (%) | Strongly Disagree (%) |
|---|--------------------|-----------|-------------|--------------|-----------------------|
| Heutagogical and inquiry-based models enhance autonomy and ethical AI use | 58                 | 30        | 7           | 3            | 2                     |

**Figure 6:** Agreement on the effectiveness of heutagogical and inquiry-based models.

#### Chart Description:

*A stacked bar chart showing 88% agreement on the positive impact of heutagogical and inquiry models on student autonomy and ethics.*

The findings of this study offer important and original insights into the integration of generative AI in education. While previous research has often focused on the technological aspects or efficiency gains of AI tools, this study highlights the complex ways in which AI reshapes both the cognitive and emotional dimensions of learning. It reveals that, although AI can increase student engagement, its uncritical use may undermine intrinsic motivation and the depth of cognitive involvement necessary for meaningful learning. This nuanced understanding encourages educators to find a balance between leveraging AI's capabilities and fostering human motivation, reflection, and emotional connection.

A key contribution of this research is its integration of psychological and ethical perspectives with pedagogical theory. By applying Self-Determination Theory alongside heutagogical approaches, the study provides a new and comprehensive framework for examining how AI

influences learners' autonomy, competence, and relatedness. This combined perspective offers clearer insight into the ethical and motivational challenges of AI use in education—an area that has been underexplored in previous studies.

Additionally, the study redefines the role of the teacher in AI-rich educational environments. Rather than simply adapting to new digital tools, teachers are framed as essential ethical guides and emotional anchors. This shift emphasizes the irreplaceable human qualities required to nurture critical thinking, moral judgment, and emotional engagement—elements that AI cannot replicate. The findings thus reinforce the necessity of preserving the teacher's mentoring and facilitative roles as central to effective AI integration.

The primacy of emotional engagement also emerges as a distinctive finding. While personalization through AI has been widely studied, this research underscores the vital importance of joy, curiosity, and motivation as counterbalances to the risk of mechanistic and affectless learning experiences driven by automation. This focus on the affective dimension adds a new layer to the conversation about AI's role in education.

Moreover, this study provides empirical evidence supporting the effectiveness of heutagogical and inquiry-based pedagogies in AI contexts. Both qualitative and quantitative data show that these learner-centered, self-determined approaches promote greater student autonomy, responsibility, and ethical use of AI-generated content. This practical insight offers educators concrete strategies for designing future-ready pedagogies that maintain human-centered learning amidst technological change..

In summary, this study breaks new ground by reframing AI as a cognitive and emotional disruptor rather than a neutral educational tool. It challenges foundational assumptions about memory, motivation, knowledge, and human interaction, paving the way for pedagogical models that integrate AI thoughtfully while preserving the essential human qualities necessary for meaningful learning in the 21st century.

## **Discussion**

The integration of generative artificial intelligence (AI) tools into education presents a complex array of cognitive, emotional, and ethical challenges, which this study sought to elucidate through mixed methods. The findings provide nuanced insights into how AI reshapes intrinsic motivation, engagement, pedagogical approaches, teacher roles, and student

autonomy. Drawing on Self-Determination Theory (SDT) and heutagogical frameworks, this discussion unpacks each key finding in light of recent scholarly literature from 2020 to 2025, illuminating how these theoretical perspectives help interpret the evolving educational landscape.

The first research question explored how generative AI impacts students' intrinsic motivation and engagement with learning content. Our qualitative data revealed a dual effect: while AI tools facilitate faster task completion and sometimes spark curiosity, they also risk diminishing deeper cognitive engagement and motivation. This ambivalence is corroborated by recent studies (e.g., Zheng et al., 2024; Luckin, 2022), which report that overreliance on AI can foster surface-level learning and reduce students' persistence in challenging tasks. From the perspective of Self-Determination Theory, this trend reflects a tension between external facilitation and the internalization of motivation. SDT posits that intrinsic motivation flourishes when learners experience autonomy, competence, and relatedness (Deci & Ryan, 2000). AI's capacity to provide immediate answers may undermine autonomy by promoting dependence, and compromise competence when students bypass effortful learning. However, when AI is used thoughtfully—as some participants indicated—it can stimulate curiosity and engagement by serving as a scaffold rather than a shortcut. This nuanced understanding aligns with Luckin et al. (2023), who argue that AI's educational value depends critically on its pedagogical integration, highlighting the need to preserve learner agency to sustain motivation.

The quantitative findings further supported this complexity. While 85% of surveyed teachers agreed that AI tools enhance lesson engagement, only 45% felt prepared to integrate AI effectively, indicating a gap between AI's potential and actual pedagogical practice. This gap echoes the concerns raised by Holmes, Bialik, and Fadel (2021), who emphasize that without proper teacher readiness and pedagogical framing, AI may inadvertently promote passive learning. Our data thus suggest that teacher training focused on AI literacy and critical pedagogy is vital to mitigate motivational risks while maximizing AI's engagement benefits.

The second research question addressed emotional engagement and reflective learning in AI-mediated contexts. Qualitative participants consistently emphasized the irreplaceable role of teachers in fostering emotional resonance, curiosity, and critical reflection. This finding aligns with the affective neuroscience research of Immordino-Yang and Damasio (2017), who demonstrate that learning is deeply tied to emotional processing and that cognitive development cannot be fully decoupled from affective engagement. The risk that AI could

render learning mechanistic and joyless, as participants noted, is a profound pedagogical concern. Pekrun's (2014) Control-Value Theory of achievement emotions further elucidates that positive emotions like curiosity and enjoyment enhance motivation and learning outcomes, while negative or neutral emotional states impede them. Teachers' facilitation of reflective dialogue around AI outputs provides essential scaffolding to maintain emotional engagement, underscoring the critical human dimension that AI cannot replicate (Anderson & Rainie, 2024).

Quantitatively, overwhelming support for integrating AI-related pedagogical training (90% agreement) reflects educators' recognition of the need for strategies that cultivate emotional and reflective learning alongside technological competence. This finding resonates with Blaschke's (2019) call for heutagogical approaches that emphasize meta-cognition and self-reflection, positioning teachers as ethical guides and emotional anchors in AI-enriched classrooms. Hence, fostering emotional engagement requires pedagogical intentionality that blends AI tools with human relational presence.

The third research question focused on pedagogical approaches that promote critical thinking and creativity in information-saturated, technology-rich environments. Both qualitative narratives and quantitative data underscored strong endorsement for active, inquiry-based learning models over traditional lecture formats. Participants highlighted how such models empower students to question AI-generated content critically and leverage AI as a collaborative tool rather than a crutch. These findings corroborate educational research emphasizing constructivist and inquiry-driven pedagogy as essential for cultivating 21st-century competencies (Hmelo-Silver, Duncan, & Chinn, 2020; Bransford et al., 2021).

Self-Determination Theory also supports this pedagogical stance by positing that engagement in meaningful, autonomy-supportive tasks enhances intrinsic motivation and cognitive investment (Ryan & Deci, 2020). Active learning environments, characterized by student choice, problem-solving, and reflection, satisfy psychological needs better than passive reception of information. Moreover, studies such as those by OECD (2022) highlight creativity and critical thinking as indispensable skills in navigating AI-rich knowledge landscapes. Our findings thus affirm that adopting active pedagogies not only mitigates the risks of AI-induced passivity but also leverages AI's potential to expand creative problem-solving opportunities.

Regarding the fourth research question on teachers' perceptions of their evolving roles, data indicated a paradigm shift from traditional knowledge transmitters to mentors and facilitators.

Teachers expressed increased emphasis on guiding critical evaluation of AI content and providing ethical frameworks for AI use. This role redefinition aligns with Salmon's (2020) concept of "teacher presence" in digital learning environments, emphasizing cognitive, social, and emotional dimensions that machines cannot fulfill. The quantitative finding that 80% of teachers identify with mentoring roles reflects a broad professional consensus about the need for affective and ethical scaffolding in AI contexts.

This transition mirrors the heutagogical ideal of the teacher as a co-learner and guide who fosters student autonomy while maintaining supportive relationships (Hase & Kenyon, 2020). It also addresses concerns highlighted by Holmes et al. (2021) that without active teacher involvement, AI may diminish educational quality. Our findings reaffirm the irreplaceability of human educators in maintaining pedagogical depth and ethical standards, suggesting that teacher professional development must prioritize mentorship skills alongside digital fluency.

The final research question explored the effectiveness of heutagogical and inquiry-based models in supporting autonomy and responsibility amid AI-generated content. Both qualitative and quantitative data converged on the positive impact of these learner-centered approaches in fostering ethical and autonomous AI use. Participants described how self-directed goal-setting and inquiry promote ownership and critical scrutiny of AI outputs. This finding is consistent with Blaschke's (2019) and Zawacki-Richter et al.'s (2019) research advocating heutagogy as a pedagogical response to complex digital literacies, empowering learners to navigate AI-generated knowledge critically.

From the SDT perspective, heutagogy satisfies learners' psychological needs by promoting autonomy and competence, while inquiry-based tasks build relatedness through collaborative and dialogic learning (Ryan & Deci, 2020). Such approaches counteract tendencies toward passive consumption of AI content and encourage active responsibility, which is crucial given concerns about misinformation and ethical use (Selwyn, 2023). The 88% quantitative agreement on heutagogical effectiveness indicates a strong professional endorsement of these models as strategies for future-ready education.

In sum, this study's findings advance the educational field by offering a multidimensional, theory-informed analysis of AI integration's cognitive, emotional, and ethical effects. Unlike prior research that predominantly focused on technological efficacy or access, this work foregrounds the psychological and pedagogical dynamics essential for sustaining meaningful learning amid automation. It integrates SDT and heutagogical theory to explain how AI may

simultaneously support and threaten learner motivation and autonomy, depending on pedagogical context.

Moreover, the study's emphasis on emotional engagement as a core pedagogical concern is particularly innovative, addressing an underexplored dimension of AI's educational impact. By articulating the irreplaceable role of teachers as ethical mentors and emotional anchors, the research contributes a vital counterbalance to narratives of technological determinism. Finally, the strong empirical support for active, learner-centered pedagogies provides concrete guidance for educators seeking to harness AI's benefits while preserving human-centered education.

These contributions offer a roadmap for policy makers, curriculum designers, and teacher educators aiming to integrate AI thoughtfully and ethically. By emphasizing human agency, emotional richness, and reflective practice, this study charts a path toward an educational future where technology amplifies rather than replaces the essential qualities of human learning.

## **Summary and Recommendations for Further Research**

This study explored the multifaceted impact of generative artificial intelligence (AI) tools on 21st-century education, focusing on students' intrinsic motivation, cognitive engagement, emotional involvement, and the evolving pedagogical roles of educators. Grounded in self-determination theory and heutagogical frameworks, the research integrated both quantitative and qualitative data to provide a nuanced understanding of how AI reshapes the educational landscape.

The findings revealed a complex dynamic: while AI tools can enhance student engagement and provide personalized learning opportunities, uncritical reliance on these technologies may undermine intrinsic motivation and deep cognitive processing. The data underscored the indispensable role of emotional engagement and reflective learning as buffers against the mechanization of education. Teachers who embraced mentoring and facilitative roles demonstrated greater adaptability and effectiveness, emphasizing ethical guidance and emotional support that AI cannot replicate. Moreover, heutagogical and inquiry-based pedagogies were shown to be particularly effective in promoting student autonomy, responsibility, and ethical use of AI-generated content, reinforcing the importance of learner-centered approaches in AI-mediated environments.

These results contribute significantly to the emerging discourse on the intersection of AI and human-centered education, highlighting the necessity of balancing technological innovation with the preservation of core pedagogical values. The study's theoretical synthesis and empirical evidence provide a foundation for reimagining educational practice where AI acts as a cognitive and emotional aid, rather than a replacement for human learning processes.

Despite these valuable insights, the study acknowledges several limitations and areas where further investigation is warranted. Future research should consider longitudinal studies to track the long-term effects of AI integration on student motivation and learning outcomes across diverse educational settings. Expanding the demographic scope beyond teacher educators to include students and administrators could enrich understanding of AI's systemic impact. Additionally, exploring AI's role in specific subject areas, such as STEM versus humanities, may reveal discipline-specific challenges and opportunities. Investigating culturally responsive pedagogies in AI contexts is another promising avenue, considering how different educational cultures negotiate technology's role in learning.

Furthermore, as AI technologies continue to evolve rapidly, ongoing research is essential to monitor ethical considerations, data privacy concerns, and the psychological effects of AI-mediated learning environments. There is also a critical need for the development and validation of pedagogical frameworks that integrate emotional intelligence, ethical reflection, and critical thinking skills alongside AI competencies.

In conclusion, this study underscores the transformative potential of AI in education when implemented thoughtfully within a human-centered pedagogical paradigm. It calls on educators, policymakers, and researchers to collaborate in designing future educational ecosystems that leverage AI's strengths while safeguarding the irreplaceable elements of human learning—curiosity, creativity, empathy, and moral judgment.

As a result of this specific research, a new theoretical framework is proposed.

### **Emergence of the Human-Centered AI Pedagogical Engagement Theory (HCAI-PE Theory)**

Building upon the integration of Self-Determination Theory, heutagogical pedagogies, emotional neuroscience, and recent empirical findings on AI in education, this study proposes a novel theoretical framework termed the Human-Centered AI Pedagogical Engagement Theory (HCAI-PE). This theory conceptualizes the interplay between artificial intelligence as

a cognitive and emotional mediator and the human psychological and ethical dimensions essential for meaningful learning in the 21st century.

The central premise of the HCAI-PE Theory is that generative AI tools, rather than being neutral instruments, act as cognitive and emotional disruptors within educational environments. Their influence on learner motivation, engagement, and knowledge construction is not predetermined but depends critically on how they are integrated within pedagogical frameworks that attend to human needs. This represents a departure from prior models that often treated AI primarily as a tool for enhancing efficiency or personalization, without sufficiently accounting for the complex affective and ethical ramifications underscored by contemporary research (Deci & Ryan, 2020; Chernigovskaya, 2023; Pekrun, 2021).

Drawing on Self-Determination Theory (SDT), the HCAI-PE framework emphasizes the indispensable role of psychological needs—autonomy, competence, and relatedness—as the foundation for intrinsic motivation and deep cognitive engagement (Ryan & Deci, 2020). In AI-mediated contexts, the satisfaction of these needs becomes both more challenging and more critical. AI tools may offer learners immediate competence feedback or personalized scaffolds but risk undermining autonomy if learners become passive recipients rather than active constructors of knowledge. Moreover, relatedness—the sense of connection with teachers and peers—is irreplaceable by AI and fundamental for sustaining motivation and ethical reflection (Niemiec & Ryan, 2020; Vansteenkiste et al., 2021).

Complementing SDT, insights from emotional neuroscience reveal that emotional engagement—including curiosity, joy, and reflection—is essential for meaningful learning (Immordino-Yang & Damasio, 2020; Pekrun & Linnenbrink-Garcia, 2021). The HCAI-PE Theory asserts that AI's algorithmic mediation can inadvertently attenuate the emotional richness of learning experiences, resulting in mechanistic and affectively sterile environments unless pedagogical designs intentionally preserve affective connections. This aligns with calls for education to foster joy and emotional resonance as core components of learning, counterbalancing AI's cognitive affordances (Chernigovskaya, 2023; Pekrun, 2021).

A further innovation of the HCAI-PE framework is the reconceptualization of the teacher's role in AI-enriched classrooms. Teachers transcend digital facilitators or content deliverers to become ethical mentors and emotional anchors who provide critical scaffolding for reflection, moral judgment, and social connection. Such a role is essential to mediate the epistemological challenges of AI-generated knowledge, helping learners to critically evaluate, appropriate, and

ethically engage with AI outputs (Anderson & Rainie, 2024; Salmon, 2020). This shift reflects emerging educational paradigms that prioritize relational pedagogy and ethical literacy in technologically saturated contexts.

Finally, the HCAI-PE Theory identifies heutagogical and inquiry-based learning models as vital enablers for balancing AI integration with learner autonomy and responsibility. These self-determined and reflective pedagogies empower students to set personalized goals, engage critically with AI-generated content, and foster ethical awareness in their use of technology (Blaschke, 2019; Zawacki-Richter et al., 2019). By aligning AI tools with learner agency and meta-cognitive reflection, these models operationalize the theory's principles, providing practical pathways for future-ready pedagogy.

In sum, the Human-Centered AI Pedagogical Engagement Theory offers a comprehensive framework that situates AI not as a mere educational tool but as an influential cognitive-emotional agent whose impact is mediated by human psychological needs, ethical reflection, and pedagogical relationships. This theoretical lens challenges existing assumptions about technology in education and calls for a reimagining of learning environments that preserve and nurture the uniquely human dimensions of education amid rapid technological change. The HCAI-PE Theory thus contributes a novel conceptual foundation for guiding research, practice, and policy in the evolving landscape of AI-enhanced education.

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