Creative Education, 2026, 17(11), 2067-2095
https://www.scirp.org/journal/ce
ISSN Online: 2151-4771
ISSN Print: 2151-4755

Learning to Question Artificial Intelligence: Epistemic Agency, Emotions, and Uncertainty in Higher Education

Abílio Lourenço[1], Maria Olímpia Paiva[1], Sabina Valente[2,3]

[1]Institute of Education, University of Minho, Braga, Portugal
[2]Portalegre Polytechnic University, CARE-Research Center on Health and Social Sciences, Portalegre, Portugal
[3]University of Évora, Research Centre in Education and Psychology (CIEP), Évora, Portugal
Email: privadoxy@gmail.com, olimpiapaiva0212@gmail.com, svalente@uportalegre.pt

How to cite this paper: Lourenço, A., Paiva, M. O., & Valente, S. (2026). Learning to Question Artificial Intelligence: Epistemic Agency, Emotions, and Uncertainty in Higher Education. *Creative Education, 17,* 2067-2095.
https://doi.org/10.4236/ce.2026.1711116

Received: September 9, 2026
Accepted: October 31, 2026
Published: November 3, 2026

Copyright © 2026 by author(s) and Scientific Research Publishing Inc.
This work is licensed under the Creative Commons Attribution International License (CC BY 4.0).
http://creativecommons.org/licenses/by/4.0/
Open Access

Abstract

Integrating generative artificial intelligence into higher education is transforming how students seek information, formulate ideas, and produce academic knowledge. Although these technologies can support personalised learning, feedback, and content understanding, their seemingly authoritative responses may encourage uncritical acceptance, cognitive delegation, and reduced metacognitive engagement. This critical, interpretive narrative review analyses the relationship between epistemic agency, epistemic emotions, tolerance of uncertainty, and students' interaction with generative artificial intelligence. Drawing on contributions from Educational Psychology, epistemic cognition, self-regulated learning, and research on artificial intelligence in education, it is argued that meaningful use of these tools depends on students' ability to formulate questions, evaluate information, tolerate ambiguity, regulate emotional responses, and justify academic decisions. The article discusses the roles of curiosity, surprise, confusion, doubt, frustration, and anxiety, highlighting that these emotions may promote inquiry or favour premature acceptance, depending on how they are interpreted and regulated. The article also addresses the risks of cognitive delegation and metacognitive passivity, proposing pedagogical strategies centred on verification, source comparison, reflection, and justification of decisions supported by artificial intelligence. It concludes that higher education should teach students not only to use artificial intelligence, but also to question, evaluate, and integrate it responsibly.

Keywords

Generative Artificial Intelligence, Epistemic Agency, Epistemic Emotions, Tolerance of Uncertainty, Self-Regulated Learning, Higher Education, Critical Artificial Intelligence Literacy

1. Introduction

The rapid expansion of generative artificial intelligence (GenAI) is transforming learning, research, and academic production practices in higher education. Tools that can produce texts, summarise documents, translate content, explain concepts, suggest arguments, and provide feedback have become part of the daily lives of many students and teachers. These technologies can support personalised teaching, facilitate access to content, and create new opportunities for practice and clarification. However, they also raise important questions about students' intellectual autonomy, the nature of cognitive effort, and the conditions necessary for their use to effectively contribute to deep learning.

The presence of these systems in the academic context should therefore not be assessed only in terms of speed or productivity. We need to understand how they influence students' relationship with knowledge. When used judiciously, generative AI can support the planning, monitoring, and evaluation of the learning process. Lan and Zhou (2025) identified potential in different AI applications to support distinct phases of self-regulated learning (SRL), including goal setting, performance monitoring, and evaluation of the process itself. However, the authors also emphasise the need to ensure that agency remains centred on the student and is not transferred to the technological system.

In this context, learning with GenAI requires more than technical skills: it involves exercising epistemic agency, understood as the ability to participate actively in formulating, evaluating, justifying, and revising knowledge. It also presupposes recognising the role of emotions in the cognitive process and developing the capacity to deal with uncertainty, ambiguity, and doubt. Learning with artificial intelligence therefore implies learning to question its responses and to evaluate the foundations on which they rest.

1.1. Generative Artificial Intelligence in Higher Education

Generative AI differs from traditional technological applications by producing new content from patterns identified in large volumes of data. In higher education, it can support research, explain concepts, generate examples, organise ideas, revise texts, translate documents, create study questions, and provide preliminary feedback. Its versatility allows integration across different scientific fields and at various stages of the learning process.

The literature has highlighted several pedagogical possibilities associated with these tools. Kasneci et al. (2023) note that language models can support learning through personalised explanations, interactive dialogue, and adaptation to students' needs. Lan and Zhou (2025) likewise identified applications such as chatbots, adaptive feedback systems, serious games, and intelligent digital textbooks that can support different stages of SRL. Zawacki-Richter et al. (2019) had already identified, within artificial intelligence in higher education, applications related to assessment, personalisation, adaptive systems, and intelligent tutors. Artificial intelligence can thus increase content accessibility, support different learning paces,

and offer additional opportunities for practice and clarification.

Personalisation is one of the main potential benefits of artificial intelligence in education. A system can adapt the language, level of difficulty, or type of explanation according to the student's responses. This possibility is particularly relevant in university contexts characterised by diversity in prior knowledge, language skills, and academic objectives. However, technological personalisation does not, in itself, guarantee understanding or pedagogical appropriateness. A response tailored to the request may be incomplete, decontextualized, or scientifically incorrect.

Bender et al. (2021) warned that language models may produce plausible texts without truly understanding the meaning of the statements presented. This problem is particularly important in higher education, where knowledge requires grounding, contextualisation, and an explicit relationship with evidence. The fluency of a response does not, in itself, constitute a guarantee of its validity. Similarly, chatbots can facilitate dialogue and individualised support, but they may also raise concerns about information accuracy, technological dependence, and academic integrity (Tlili et al., 2023).

Generative AI can alter the relationship between the student, the tool, and the academic product, particularly when the system helps develop arguments, organise literature reviews, or write assignments. In these situations, it is important to consider who defines the objectives, evaluates the quality of the responses, and assumes responsibility for the decisions made. AI can support autonomy by stimulating question formulation, analysis, and reflection, but it can also weaken it when it replaces essential cognitive operations. Its pedagogical integration should therefore preserve student agency, teacher oversight, and critical evaluation of the results (UNESCO, 2023). The tool's educational value depends not only on its functionality but also on the quality of the interaction and the judgement exercised by the student.

1.2. The Problem of Uncritical Acceptance

Uncritical acceptance occurs when students use AI-produced content without properly evaluating its accuracy, relevance, origin, or appropriateness. This behaviour may be encouraged by the linguistic fluency of responses, the speed of production, and the apparent confidence with which they are presented. The convincing form of a response can thus be confused with its validity (Bender et al., 2021; Kasneci et al., 2023).

The problem is particularly relevant in higher education because academic learning is not limited to acquiring information. It involves distinguishing arguments, interpreting evidence, recognising limitations, comparing perspectives, and constructing justified positions. When AI provides an apparently complete response, students may stop formulating their own hypotheses, seeking alternative sources, or confronting the difficulty inherent in understanding complex problems (Tlili et al., 2023).

Uncritical acceptance can take the form of cognitive delegation. Some routine tasks can be transferred to a technological tool, allowing students to focus on more complex activities. However, when AI begins to perform operations such as interpreting, arguing, evaluating, or deciding, delegation begins to replace essential learning processes. A form of metacognitive passivity may thus emerge: the student recognises an explanation as clear, but cannot reconstruct the reasoning, apply it to a new situation, or identify possible errors (Lan & Zhou, 2025).

Emotions play an important role in this process. Anxiety in the face of a difficult task may lead to the immediate search for an answer that reduces discomfort, while frustration may favour giving up or accepting the first explanation provided. On the other hand, curiosity and doubt may stimulate new questions, comparison of sources, and deeper investigation (Pekrun, 2006; Vogl et al., 2020). The influence of emotions depends, however, on the context and on how they are regulated.

Tolerance of uncertainty constitutes another decisive dimension. Academic research frequently involves incomplete information, contradictory results, and provisional conclusions. If students expect AI to eliminate all uncertainty, they may interpret ambiguity as a failure and fluency as evidence of truth. Critical use of AI therefore requires verification, source comparison, and recognition of the system's limitations (Bender et al., 2021; UNESCO, 2023).

1.3. Objective, Guiding Question and Scope of the Review

This article critically analyses the relationship between epistemic agency, epistemic emotions, tolerance of uncertainty, and the use of generative artificial intelligence in higher education, seeking to understand its implications for autonomy and the quality of learning.

The guiding question is: How can epistemic agency, emotions, and tolerance of uncertainty contribute to a more critical, self-regulated, and responsible use of generative artificial intelligence in higher education?

The article adopts a narrative review of a critical and interpretive nature. It does not seek to provide an exhaustive or statistical synthesis of the literature, nor does it follow a systematic review protocol. Instead, it integrates selected contributions from educational psychology, epistemic cognition, SRL, emotional regulation, and research on artificial intelligence in education, identifying conceptual convergences, theoretical tensions, and pedagogical implications.

The literature informing this review was identified through searches of Scopus, Web of Science, and ERIC, complemented by the examination of reference lists in relevant publications to identify additional contributions. The selection of publications was guided by their conceptual and empirical relevance to the review's central focus, particularly the relationships between epistemic agency, epistemic emotions, tolerance of uncertainty, self-regulated learning, and human-AI interaction in higher education. The literature considered included theoretical contributions, empirical studies, and relevant reviews from educational psychology, epistemic cognition, self-regulated learning, and research on artificial intelligence in

education. The selected literature was synthesised through a critical, thematic, and interpretive approach, integrating complementary theoretical perspectives and empirical findings while identifying convergences, tensions, and implications for educational practice. Consistent with the narrative nature of the review, the aim was conceptual integration rather than exhaustive coverage or quantitative aggregation of the available evidence.

The central thesis is that the responsible integration of AI in higher education depends not only on access to the tools or the technical ability to use them, but also on students' ability to formulate questions, evaluate responses, and assume responsibility for their judgements. Learning to question artificial intelligence thus constitutes a fundamental dimension of epistemic autonomy and of students' active participation in their own learning.

2. Conceptual Foundations

The growing presence of GenAI in higher education is modifying the conditions under which students access, process, evaluate, and produce knowledge. Generative systems can participate directly in activities that traditionally required significant cognitive engagement from students, such as explaining concepts, generating ideas, synthesising information, proposing solutions, reformulating arguments, and producing texts. This transformation is not merely the introduction of a new technological tool into established learning environments. It raises deeper questions about how knowledge is constructed, the criteria students use to evaluate claims, and students' epistemic responsibility when part of a task is carried out through interaction with AI systems.

In this context, the educational use of GenAI should not be analysed exclusively in terms of its potential or risks. Its relevance to learning also depends on how students interpret, question, evaluate, and integrate the content the systems produce. The UNESCO guidance (Miao & Holmes, 2023) emphasises the need for a human-centred approach in which GenAI use preserves human agency and is framed by pedagogical, ethical, and educational purposes. Recent reviews of GenAI in higher education likewise reinforce the idea that its effects are determined not only by the technological capabilities of the systems, but also by how these are incorporated into teaching and learning activities (Xia et al., 2024).

Within this framework, three conceptual dimensions are particularly relevant to the present article's theoretical foundations: the relationship between GenAI and university learning, epistemic agency as a dimension of knowledge construction, and the role of epistemic emotions, uncertainty, and SRL. These dimensions are interconnected and make it possible to understand learning with AI beyond a logic centred on efficiently obtaining answers, placing students' active participation in the construction, evaluation, and regulation of knowledge at the centre.

2.1. Generative Artificial Intelligence and University Learning

GenAI refers to systems capable of producing new content from instructions pro-

vided by users, including text, code, images, and other forms of representation. In higher education, large language models have become particularly relevant because they can interact with students through discursive responses, explanations, reformulations, examples, and suggestions. This characteristic distinguishes GenAI from many earlier digital resources, since students can interact with the system during the learning activity itself, rather than merely using it as a source of information.

Recent research has identified various educational possibilities associated with the use of GenAI. It can facilitate access to explanations, support idea generation, provide immediate feedback, present concepts in different ways, and contribute to more individualised learning processes. In this context, Xia et al. (2024) conducted a scoping review specifically examining how GenAI is transforming assessment in higher education. Their review of 32 empirical studies examined implications for students, teachers, and institutions, highlighting opportunities and challenges associated with assessment practices and institutional responses. Studies on SRL likewise suggest that AI-based tools can support planning, monitoring, and reflection when integrated into activities with explicit pedagogical objectives (Ng et al., 2024; Xu et al., 2025).

However, getting an answer quickly does not necessarily mean learning occurs. University learning involves cognitive activities through which students interpret information, relate new content to prior knowledge, evaluate evidence, identify inconsistencies, and construct well-founded interpretations. GenAI can facilitate some of these operations, but it can also make the cognitive work required to perform them less visible. As Bearman and Ajjawi (2023) emphasise, integrating AI into teaching requires students to learn to work with systems whose internal processes are not fully transparent, while maintaining a critical relationship with their outputs.

This issue is particularly important because generative systems can produce linguistically coherent responses without such coherence, in itself, constituting a guarantee of accuracy or validity. The fluency of responses can make the need to verify content less evident and create an appearance of authority that requires user evaluation. Reviews of AI-based dialogue systems have therefore highlighted the risk of excessive dependence and the possible consequences of uncritical acceptance of generated content (Zhai et al., 2024). The fundamental educational question is consequently not merely whether AI can provide an answer, but how the student cognitively interprets and uses that answer.

GenAI should therefore be understood as part of the cognitive and pedagogical environment in which learning takes place, rather than simply as a neutral instrument. Its use can redistribute certain cognitive activities, making some tasks more accessible or partially externalising aspects of the learning process. This redistribution can be pedagogically productive when it expands opportunities for exploration and reflection, but it can also reduce student engagement if it replaces operations that are essential to the learning process itself. At this point, student agency becomes especially important, since the quality of learning depends not

only on access to AI-generated content but also on students' active participation in interpreting and integrating it.

2.2. Epistemic Agency and Knowledge Construction

Epistemic agency concerns the student's active participation in the processes through which knowledge is produced, evaluated, used, interpreted, and transformed. The concept goes beyond a generic understanding of agency as the capacity to act autonomously, because it focuses attention on the individual's relationship with knowledge: what they accept or question, the sources they consider relevant, the arguments they seek to support, and the interpretations they construct.

This perspective is close to constructivist and sociocultural traditions that understand learning as an active process of meaning construction. It is also related to research on epistemic cognition, which analyses how individuals understand knowledge and the processes of knowing, including issues concerning certainty, sources, justification, and the limits of claims. In higher education, epistemic agency adds a dimension of participation and action to these perspectives. Damşa et al. (2010), for example, conceptualised shared epistemic agency through dimensions related to producing and sharing ideas and defining and monitoring goals.

This conception has been developed in different educational contexts. Heikkilä et al. (2020) highlighted the importance of students recognising themselves as active participants in knowledge-related activities, while Zhang et al. (2022) showed how epistemic agency can involve students' participation in defining and transforming the processes of research and knowledge construction. In higher education, Nieminen and Ketonen (2024) propose a conceptualisation that is particularly relevant to the present argument, understanding epistemic agency as an active relationship with knowledge that involves evaluating, producing, using, and transforming it.

This dimension becomes particularly relevant when students work with GenAI. A generative system can produce an explanation, suggest an interpretation, or present an argument, but the content produced does not automatically acquire the status of valid knowledge. Using it for learning implies that the student determines the meaning, relevance, and place this content can occupy in the process of knowledge construction. The availability of AI-generated information therefore does not eliminate the need for epistemic participation; it may even make it more relevant.

In this sense, it is important to distinguish between generating information and constructing knowledge. GenAI produces linguistic and symbolic representations, but learning depends on how these representations are examined and integrated by the student. Constructing knowledge involves relating new information to prior knowledge, recognising relationships and contradictions, evaluating evidence, and developing well-founded interpretations. Epistemic agency thus constitutes a central dimension of the student's participation in this process, preventing the use of AI from being reduced to the simple reception or transfer of answers.

This distinction is particularly important in an environment in which part of textual and informational production can be automated. Epistemic agency should not be understood merely as an additional competence, but as a way for the student to position themselves in relation to knowledge as a user, producer, and potential transformer (Nieminen & Ketonen, 2024). Within this framework, the educational question is not to preserve a rigid separation between student activities and technology-supported activities, but to understand how student participation can remain active and intellectually meaningful when generative systems become part of learning tasks.

Epistemic agency thus establishes a conceptual bridge between the technological transformation introduced by GenAI and the cognitive and regulatory processes involved in learning. The question is no longer merely what AI can produce, but also the role that the student plays in attributing meaning and epistemic value to the content produced. This shift in focus prepares the analysis of epistemic agency specifically in human-AI interaction, developed in the following chapter.

2.3. Epistemic Emotions, Uncertainty and Self-Regulated Learning

Knowledge construction is not an exclusively cognitive process. Students experience emotions associated with knowing, questioning, discovering, understanding, or not understanding. Curiosity, surprise, confusion, doubt, interest, and frustration can accompany different moments of epistemic activity and influence how students respond to new, complex, or contradictory information. Pekrun and Linnenbrink-Garcia (2014) situated epistemic emotions within the affective processes relevant to learning. Muis et al. (2018) further developed this theoretical perspective by synthesising research on personal epistemology, epistemic emotions, and SRL, outlining how epistemic emotions may facilitate or constrain planning, motivation, the use of cognitive and metacognitive strategies, and learning outcomes. Empirical evidence for the mediating role of epistemic emotions was provided by Chevrier et al. (2019). Across two studies, these authors examined the relationships between epistemic cognition, epistemic emotions, self-regulatory strategies, and learning in the context of complex and conflicting information. Their findings indicated that epistemic emotions mediated relationships between epistemic beliefs and learning strategies, while the analyses also supported a mediated pathway linking epistemic beliefs, emotions, learning strategies, and learning achievement. These findings support the relevance of epistemic emotions to self-regulatory processes, although they do not establish that the same relationships necessarily occur during interaction with generative AI.

These emotions matter because they are not merely secondary reactions to cognitive processes. Curiosity, for example, can favour metacognitive engagement, while surprise can stimulate the reconsideration of unexpected information. Emotions associated with knowledge can therefore shape the cognitive and regulatory processes themselves, influencing decisions to continue exploring a question, seek additional information, or reconsider an interpretation.

Uncertainty occupies a central place in this process. Encountering incomplete, contradictory, or ambiguous information can create epistemic tension that requires further activity. For SRL, this situation can trigger monitoring, evaluation of understanding, selection of strategies, and eventual adaptation of behaviour. Uncertainty therefore does not necessarily obstruct learning; its meaning depends on how the student interprets and regulates it.

The presence of GenAI changes the conditions under which students experience this uncertainty. Faced with a difficult concept, a question without an immediate answer, or a contradictory interpretation, the student can instantly request an explanation from the system. This possibility can support learning when the response provides a starting point for investigation and reflection. However, it can also reduce the need to remain with an unresolved question for a time. The immediate availability of an answer can thus modify not only access to information, but also the conditions under which the student monitors their own understanding.

The integration of epistemic emotions and tolerance of uncertainty adds a process-oriented dimension to existing frameworks of epistemic agency. Whereas these frameworks emphasise students' active participation in evaluating, justifying, and transforming knowledge (Nieminen & Ketonen, 2024), research linking epistemic cognition, epistemic emotions, and self-regulated learning highlights the role of emotional processes in shaping regulatory activity (Muis et al., 2018). Building on these contributions, the present review proposes a conceptual mechanism involving three interrelated processes: appraisal of uncertainty, emotional regulation, and epistemic decision-making. When students recognise gaps, inconsistencies, or insufficient evidence in AI-generated content, their appraisal of these uncertainties may elicit curiosity or doubt, encouraging further investigation, or frustration and anxiety, which may increase the desire for immediate closure. The way students regulate these responses may then influence whether they verify claims, compare sources, and seek corroborating evidence, or accept the generated content without further examination. Tolerance of uncertainty may help students remain engaged with unresolved questions long enough to evaluate the reliability of a response, whereas difficulty managing uncertainty may favour premature acceptance, particularly when AI-generated content appears fluent and authoritative. This proposed mechanism extends existing conceptualisations by specifying how emotional and regulatory processes may shape the enactment of epistemic agency in human-AI interaction; its specific relationships require further empirical investigation.

SRL involves goal setting, monitoring, evaluation, and adaptation, articulated through cognitive, motivational, emotional, and behavioural dimensions (Panadero, 2017; Zimmerman, 2002). When learning occurs in AI-mediated environments, these processes develop in a context where students have an additional, highly responsive source of information and assistance.

Recent research suggests that GenAI can support self-regulatory processes when an adequate metacognitive structure is present. Xu et al. (2025), for example,

found that metacognitive support matters for SRL in GenAI environments, reinforcing the idea that the mere presence of technology does not guarantee regulated use. Similarly, studies on ChatGPT and SRL point to possibilities for supporting proactive learning and reflection, but also show the importance of how the interaction is pedagogically structured (Ng et al., 2024).

Thus, the question is not to determine whether certainty is preferable to uncertainty or whether epistemic emotions are positive or negative. The central point is to understand how students use these states to guide cognitive and regulatory activity. Uncertainty can trigger investigation, surprise can lead to revising an interpretation, and curiosity can sustain exploration; conversely, the need to obtain an answer quickly can lead to premature closure of an investigative process.

Taken together, these foundations make it possible to establish a conceptual sequence for understanding learning in GenAI-mediated contexts. Technology modifies the informational and cognitive environment of learning; epistemic agency defines the student's active participation in the relationship with knowledge; and epistemic emotions, uncertainty, and self-regulation help explain how this participation is sustained, guided, and adjusted. The central question thus shifts from an analysis of the capabilities of the technology to an analysis of the relationship between technology, student, and knowledge. Figure 1 synthesises the relationships between epistemic agency, epistemic emotions, tolerance of uncertainty, and self-regulated learning. The conceptual framework illustrates their reciprocal interactions and their relevance to promoting critical and responsible use of generative artificial intelligence in higher education.

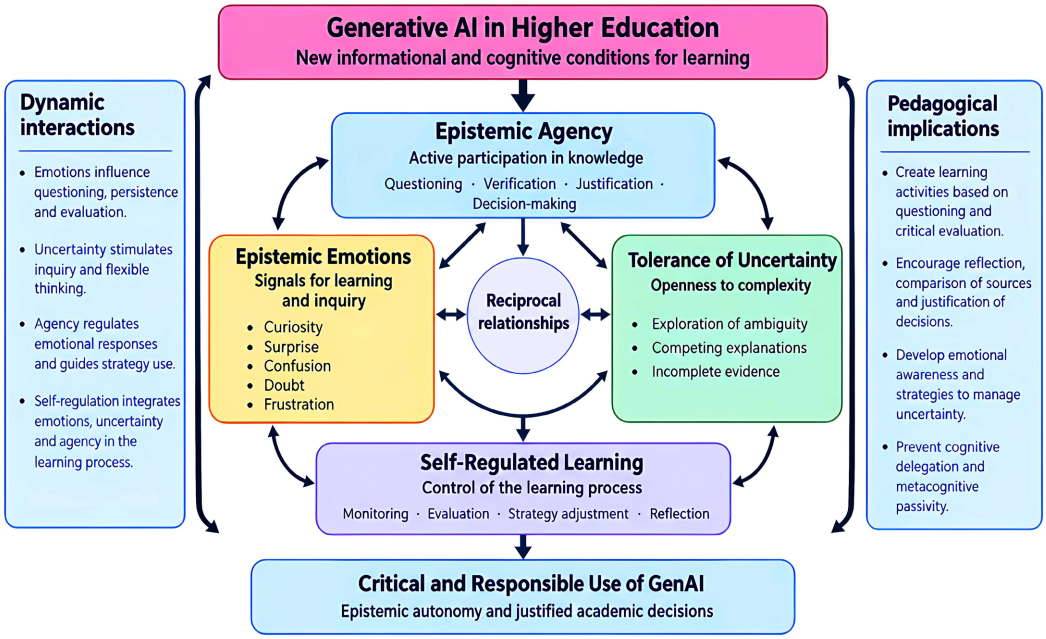


Figure 1. Conceptual framework of epistemic agency, epistemic emotions, tolerance of uncertainty, and self-regulated learning in generative AI-mediated contexts. **Source:** Author's own elaboration, based on the conceptual integration of the literature reviewed in this article. **Note.** The relationships shown are conceptual and do not represent empirically demonstrated causal effects.

From this framework, the following chapter examines epistemic agency in human-AI interaction more specifically.

3. Epistemic Agency in Human-AI Interaction

The integration of GenAI in higher education changes not only the resources available for learning, but also how students participate in knowledge-related activities. When a generative system produces explanations, interpretations, arguments, or syntheses, part of the cognitive activity begins to take place in an interaction between student and system. This configuration can expand the possibilities for exploration and elaboration, but it also introduces a fundamental question: who formulates the questions, evaluates the responses, decides what to accept, and assumes responsibility for the conclusions? Epistemic agency thus becomes particularly relevant for understanding the nature of student participation in AI-mediated learning environments.

3.1. From Instrumental Use to Epistemic Participation

The use of digital technologies in learning has often been conceptualised in instrumental terms: technology is a resource students use to seek information, perform a task, or communicate a result. GenAI introduces a different configuration because it is not limited to providing previously organised information. Generative systems respond to requests, reformulate problems, propose alternatives, and produce content that can become an object of analysis and transformation during the learning activity itself. The relationship therefore ceases to be exclusively between student and resource and becomes an interaction in which the system participates in producing the representations that the student subsequently interprets and evaluates.

This transformation does not imply that AI acquires, in itself, the status of an epistemic agent equivalent to the student. The central point is to understand how the student's epistemic activity is reorganised when a generative system carries out part of the operations of producing and transforming information. Nieminen and Ketonen (2024) emphasise that epistemic agency involves an active relationship with knowledge, which is particularly relevant when students need to assume responsibility for how knowledge is produced, evaluated, and used. In the context of AI, this responsibility includes the ability to question the system's output, compare it with other sources, and decide what role it can play in knowledge construction.

Recent research has begun to address this issue more specifically. Wu et al. (2025) conceptualise human epistemic agency in interaction with generative AI as an active dimension of the learning partnership, emphasising the need to preserve reflective epistemic positions and human judgement in relation to system-produced content. Similarly, Tian et al. (2025), in a study with university students, found that they recognised ChatGPT's usefulness in certain epistemic activities, but also the need to keep evaluation of the truth and validity of the content pro-

duced under human responsibility. This perspective aligns with the notion of epistemic co-agency, according to which interaction with generative systems can constitute a shared cognitive activity without eliminating the student's epistemic responsibility (Samuel, 2025).

Within this framework, it is important to distinguish between using AI to obtain an answer and using AI to develop an epistemic activity. In the first case, the interaction may end when the system provides seemingly satisfactory content. In the second, the response constitutes merely an intermediate element in a process that may include questioning, comparison, reformulation, seeking evidence, identifying inconsistencies, and revising interpretations. The difference is therefore not simply in the presence of the technology, but in the role that the student plays in relation to what is produced.

GenAI can thus expand the space for exploration without transferring responsibility for epistemic decision-making to the technology. The student can request an alternative explanation, ask for counterarguments, test an interpretation, or use the system's response as an object of criticism. Recent work on epistemic co-agency suggests precisely that interaction with AI outputs can involve questioning assumptions, identifying contradictions, and maintaining responsibility for the knowledge constructed.

In this sense, a pedagogically meaningful use of GenAI does not require the student to systematically reject or accept its content, but to maintain the capacity to evaluate its relevance and decide what status to attribute to it in the learning process. Human-AI interaction thus becomes epistemically relevant when the system's generative capacity remains articulated with the student's judgement.

3.2. Cognitive Delegation and Metacognitive Passivity

The possibility of transferring certain operations to generative systems introduces a second dimension of epistemic agency: cognitive delegation. Cognitive offloading describes situations in which individuals use external resources to reduce or redistribute a task's cognitive demands (Risko & Gilbert, 2016; Risko & Dunn, 2015). This externalisation is not necessarily problematic. Tools, notes, calculators, and other external supports allow cognitive operations to be distributed and free up resources for more complex activities.

The issue changes when delegation involves precisely those operations that form part of the process the student should learn to perform. A generative system can summarise a text, organise arguments, propose an interpretation, identify possible answers, or produce a first version of an assignment. These functions can reduce the demands associated with certain tasks and, under some conditions, support learning. However, when the student accepts the result without reconstructing the reasoning underlying it, externalisation can replace a relevant cognitive operation.

Recent research has drawn attention to the relationship between AI-assisted performance, perceived effort, and metacognitive monitoring. In an experimental

study with university students, Urban et al. (2024) found that ChatGPT improved performance on a creative problem-solving task, with higher ratings for the quality, elaboration, and originality of the solutions. Participants using ChatGPT also perceived the task as easier and as requiring less mental effort. However, the effects on metacognitive monitoring accuracy were inconclusive: although absolute accuracy did not differ significantly between the groups, the relationship between students' self-evaluations and their actual performance suggested difficulties in calibrating these judgements. Perceived usefulness of ChatGPT was also associated with greater overestimation of the quality and originality of responses. These findings are specific to performance on the experimental task, perceived mental effort, and metacognitive calibration. They do not establish that students retained the knowledge involved or could transfer it to comparable tasks performed independently.

Beyond immediate task performance, the central issue concerns how students monitor and evaluate their own understanding. SRL depends on the ability to monitor one's own understanding and use this information to decide what to do next, articulating cognitive, motivational, and regulatory processes (Lourenço et al., 2025a). When AI provides a fluent and seemingly complete response, the student may feel they understand without performing all the operations needed to construct that understanding. Urban et al. (2025) reinforce this concern by linking the integration of ChatGPT-generated content to epistemic beliefs and metacognitive accuracy, underscoring the importance of critically evaluating generated content before incorporating it into academic work.

The risk of metacognitive passivity should not, however, be confused with intensive AI use. A student may frequently resort to a generative system and maintain high cognitive engagement if they use the responses to test hypotheses, identify gaps, or produce counterarguments. Conversely, occasional use may be epistemically passive if the student transfers to AI a decision that they should understand and justify. The decisive element is therefore the relationship between delegation and metacognitive control.

In this sense, GenAI can assume two distinct functions within the learning activity. It can act as a support for cognitive activity when it externalises secondary operations and allows the student to concentrate on more complex processes, or as a substitute for cognitive activity when it reduces precisely the operations through which the student should develop understanding, judgement, and autonomy. The boundary between these functions depends on the task, the student's prior knowledge, the mode of interaction, and the pedagogical demands. This distinction is consistent with the conception of self-regulation as a process in which students mobilise volitional control strategies to deliberately guide their learning activity (Lourenço & Paiva, 2025).

This distinction reinforces the need to preserve some productive cognitive friction. Not every difficulty should be eliminated during learning. Some difficulties require the student to retrieve information, compare alternatives, formulate ex-

planations, and confront inconsistencies. AI can support these processes, but it can also eliminate them prematurely. The educational question therefore becomes one of determining which operations can legitimately be externalised and which should remain under the student's active control.

3.3. Verification, Justification, and Academic Responsibility

If GenAI can produce plausible content without guaranteeing its accuracy, verification constitutes a central condition of epistemic agency. Verification does not simply mean looking for factual errors. It involves analysing the information's origin, confronting claims with independent sources, assessing the quality of the evidence, and determining whether the conclusion is adequately supported. Epistemic agency manifests itself, in this context, in the ability to temporarily suspend acceptance of a response and subject it to evaluation procedures.

This requirement is particularly important because the linguistic form of content produced by generative systems can create an appearance of consistency and authority. The system's response should therefore become the object of a new cognitive activity, in which the student determines whether the information is correct, relevant, and sufficiently well-founded for the purpose in question.

Recent results reinforce this need. Gómez et al. (2025), in a pre-experimental study with 30 university students, found higher results in identifying relevant characteristics of evidence after an activity focused on source verification, although difficulties remained in assessing the quality and verifiability of sources provided by AI. These results reinforce the importance of verification as a component of critical thinking and the responsible use of GenAI in higher education.

Verification should be accompanied by justification. Knowing a claim appears correct is not the same as being able to explain why it should be accepted. Justification requires the student to be able to relate a conclusion to the evidence and reasons supporting it. In academic activities, this ability matters because knowledge is defined not solely by the availability of an answer, but by the ability to support a claim in the face of other interpretations and evidence.

Interaction with AI can, in this sense, be organised around questions that preserve the justificatory activity: What evidence supports this claim? What sources allow it to be confirmed? Are there alternative interpretations? What assumptions are involved? What could make this response incorrect? These questions transform AI from a provider of answers into an object of scrutiny and make explicit operations that, in a merely instrumental use, could remain hidden.

Academic responsibility then emerges from the need to keep these operations under the student's control. If they use AI-generated content in an academic activity, the student remains responsible for evaluating its appropriateness, the accuracy of the claims they present, and the way in which they use it. This responsibility is not limited to declaring the use of AI; it also involves the ability to account for the epistemic decisions underpinning the work produced.

This responsibility should not be reduced to academic integrity understood

merely as the prevention of fraud. It is a broader issue of epistemic responsibility: who makes the claim, who justifies it, who decides that evidence is sufficient, and who is accountable for the conclusion presented? Coates et al. (2025) discuss the need to preserve the authenticity of thinking and forms of academic achievement in the face of the expansion of GenAI, while Kofinas et al. (2025) show that content produced or modified by GenAI can be difficult to distinguish from work produced without AI, posing challenges to the integrity of assessment.

This issue becomes particularly relevant as LLMs move from peripheral tools to regular components of learning activities and knowledge production. Lindebaum et al. (2025) argue that these systems can transform the conditions under which knowledge is produced, disseminated, and validated in higher education, consequently affecting epistemic agency. In this context, preserving agency does not mean excluding AI, but ensuring that judgement about the content and the decisions that follow remain under human responsibility.

Epistemic agency in human-AI contexts can therefore be understood as the ability to keep the fundamental operations of interpretation, evaluation, justification, and decision-making under the student's control, even when certain tasks are supported or externalised to a generative system. The aim is not to artificially preserve all cognitive operations within the individual, but to ensure that externalisation does not eliminate the intellectual participation necessary for learning.

Taken together, the three dimensions analysed make it possible to understand a fundamental condition of GenAI-mediated learning. Epistemic participation defines the student's active involvement in the relationship with knowledge; cognitive delegation highlights the operations that can be externalised without compromising essential intellectual activity; and verification, justification, and responsibility establish the conditions under which AI-generated content is subjected to academic judgement. Human-AI interaction thus becomes epistemically productive when it allows cognitive operations to be distributed without shifting responsibility for the knowledge the student claims, uses, and defends to the technology.

4. Emotions, Uncertainty, and Self-Regulated Learning

SRL involves more than cognitive and metacognitive processes. The emotions that emerge during task performance influence how students interpret difficulties, mobilise strategies, and persist in the face of obstacles. Emotions thus constitute an integrated dimension of self-regulation, potentially facilitating or hindering the use of cognitive and metacognitive strategies, depending on their nature, intensity, and context (Efklides, 2011; Zheng et al., 2023). This dimension becomes particularly relevant in GenAI-mediated environments, where response speed, linguistic fluency, and the permanent availability of support may modify the emotional experience of learning. The question is to understand how interaction with generative systems can alter the conditions under which students regulate emotions, deal with uncertainty, and maintain cognitive engagement.

4.1. Epistemic Emotions as Resources or Obstacles

Epistemic emotions emerge in response to a task's cognitive characteristics and the relationship between new information and previously constructed knowledge. Surprise, curiosity, confusion, frustration, and anxiety may arise from unexpected information, conceptual incompatibilities, or difficulties in understanding (Pekrun et al., 2017; Nerantzaki et al., 2022; Zheng et al., 2023). These emotions should be distinguished from achievement emotions, which are associated with achievement-related activities or their perceived outcomes. For example, confusion arising from difficulties in understanding contradictory evidence is epistemic in nature, whereas anxiety about receiving a low examination mark is an achievement emotion. Although these categories may overlap, the distinction depends on what elicits the emotional experience. These experiences do not, in themselves, necessarily serve an adaptive or detrimental function. Their effect depends on task conditions, the student's interpretation of the situation, and the strategies they mobilise to respond.

An apparently unpleasant emotion may, under certain conditions, serve a regulatory function. Confusion may signal that the current representation of the problem is insufficient and trigger information-seeking, comparison of alternatives, or reformulation of an explanation (D'Mello & Graesser, 2014; Muis et al., 2015). Frustration may likewise accompany the perception that a strategy is not producing the expected results. When learners interpret these experiences as signals to adjust the activity, they can continue learning. Conversely, when difficulty is interpreted as evidence of inability or is immediately avoided, it may encourage withdrawal or superficial use of strategies.

The relationship between emotion and self-regulation is therefore dynamic. Emotions may result from task appraisal and, simultaneously, influence subsequent decisions. Zheng et al. (2023) show that the relationships between emotions and SRL strategies vary according to the emotion considered and the type of strategy mobilised. Similarly, Lourenço et al. (2025b) emphasise the interdependence between SRL and emotional regulation, highlighting their joint influence on motivation, engagement, and persistence.

The introduction of GenAI adds a particular condition to this dynamic. A generative system can quickly provide explanations, examples, or reformulations when students encounter difficulties. In some situations, this support may reduce unnecessary frustration and help students continue the activity. A systematic review and meta-analysis of experimental studies found positive effects of ChatGPT interventions on affective-motivational states, along with reduced mental effort, although the authors emphasise the heterogeneity of the studies and methodological limitations (Deng et al., 2025). However, if the AI response immediately eliminates any experience of confusion or difficulty, it may also reduce opportunities to identify what is not yet understood.

This distinction helps explain why epistemic emotions can constitute resources for SRL. Curiosity can guide exploration, surprise can trigger reassessment, and

confusion can signal the need for conceptual reorganisation. Doubt is treated here primarily as an epistemic state or judgement concerning the adequacy or credibility of available information, which may be accompanied by emotions such as curiosity, confusion, or anxiety. The educational function of GenAI should not simply neutralise these experiences, but support students in interpreting and regulating them. The aim is to reduce unnecessary obstacles without eliminating the emotional signals that can guide cognitive activity.

4.2. Uncertainty Tolerance and Critical Thinking

Learning inevitably involves situations in which students lack sufficient information to form a conclusion immediately. Uncertainty may result from incomplete evidence, contradictory information, new problems, or limitations in the available knowledge. The ability to remain intellectually active under these conditions is relevant to critical thinking because it allows conclusions to be postponed, additional evidence to be sought, and alternative interpretations to be considered (Facione, 2023; Stephens & Lazarus, 2024). Tolerance of uncertainty does not mean eliminating or ignoring uncertainty, but recognising it, acting on the available information, and remaining able to adjust one's response as new data emerge (Lazarus et al., 2025).

This ability becomes particularly important when generative systems present information. The linguistic fluency of a response can create an impression of resolution even when the question remains open or the evidence is insufficient. Students may thus confuse clarity of formulation with epistemic certainty. The need to distinguish plausibility from evidential support brings this issue closer to the critical evaluation of AI-generated information, in which the quality of the response depends not only on its linguistic coherence, but also on the possibility of verifying the claims and the sources supporting them (Gómez et al., 2025; Urban et al., 2025).

In this context, tolerance of uncertainty constitutes a condition for maintaining active critical thinking. Students who accept uncertainty can compare sources, formulate new questions, seek counter-examples, and revise an initial interpretation. Conversely, the need to obtain a conclusive answer quickly may encourage the premature acceptance of an explanation. Research on uncertainty in education precisely emphasises the importance of recognising uncertain situations and developing responses that allow individuals to act without requiring immediate resolution (Stephens & Lazarus, 2024; Lazarus et al., 2025). In interaction with GenAI, this ability becomes particularly relevant because the availability of successive responses may reduce the perceived need to remain with an unresolved question.

This relationship does not, however, imply that using AI necessarily leads to lower tolerance of uncertainty. Technology can also broaden the exploration of alternatives. Students can request different interpretations of a problem, compare contradictory arguments, or ask AI to identify the limitations of an explanation.

Under these conditions, AI can make uncertainty more open to exploration rather than simply eliminating it. Research on learning with GenAI also suggests that the technology's cognitive value depends on how students interact with its outputs and on the reflective and evaluative activities that accompany that interaction (Wu et al., 2025; Tian et al., 2025).

Uncertainty can thus constitute a productive condition for the pursuit of knowledge when students recognise it and use it to guide investigation, comparison, and revision. An epistemically productive use of GenAI should not seek to eliminate all uncertainty, but should support students in exploring possibilities while keeping the evaluation of evidence and decisions about which conclusions they can support under their control.

4.3. Emotional Regulation in Human-AI Interaction

Emotional regulation constitutes an essential dimension of this process because emotions influence the ability to initiate, maintain, and adjust learning activity. In self-regulation, students do not merely set goals and select strategies; they also need to manage emotional states that may facilitate or hinder the effort required to achieve those goals. The relationship between SRL and emotional regulation is bidirectional: emotions affect engagement and strategic decisions, while self-regulatory processes can help modify the emotional experience during learning (Efklides, 2011; Zheng et al., 2023; Lourenço et al., 2025b).

GenAI can indirectly support this process by modifying the task experience. Under certain conditions, rapid access to explanations, examples, and feedback can reduce some sources of frustration and facilitate continued engagement. A systematic review and meta-analysis found positive effects of ChatGPT interventions on affective-motivational states, alongside a reduction in mental effort, although the results showed considerable heterogeneity and should be interpreted with caution (Deng et al., 2025). Complementarily, Heung and Chiu (2025), in a systematic review and meta-analysis of 17 studies involving 1735 students, identified positive effects of ChatGPT use on behavioural, cognitive, and emotional engagement, although they also highlighted the risk of disengagement associated with overdependence on the technology. Rezai et al. (2024), in a study of 492 English as a foreign language student, identified positive relationships between ChatGPT use, emotional regulation, and well-being, with emotional regulation mediating the relationship between technology use and well-being. These results are specific to the context studied and do not, in themselves, establish general causal effects.

Interaction with generative systems may, however, also introduce new sources of emotional tension. Students may experience uncertainty about the quality of responses, concern about the academic appropriateness of the content produced, or difficulty determining how to use the technology appropriately. These experiences align with the literature on emotions in SRL, which shows that the effects of emotions depend on task characteristics, students' appraisal of its demands, and the resources available to respond to difficulties (Efklides, 2011; Zheng et al.,

2023). GenAI use should therefore be understood within a broader system of cognitive appraisal, expectations, and emotional regulation.

These possibilities show that GenAI should not be conceptualised as an autonomous emotional regulator. The technology can modify the emotional conditions of learning, but the student still interprets and manages these experiences. Using an AI response to better understand a difficulty may support regulation; systematically resorting to the system to avoid cognitive discomfort may, conversely, limit opportunities to develop personal strategies for dealing with difficulty. The difference therefore lies in the function that the technology performs within the self-regulatory process.

Within this framework, emotional regulation in human-AI environments requires balancing external support with internal control. Students can use the technology to reduce obstacles, reorganise a task, or obtain alternative perspectives, but they must remain capable of recognising their own emotions, interpreting their significance for the activity, and deciding how to respond. When an AI response does not answer a question or when responses conflict, emotional regulation can sustain the persistence needed to keep investigating rather than immediately seeking an apparently definitive solution.

Taken together, the three dimensions analysed show that emotions and uncertainty are not peripheral elements of GenAI-mediated learning. Epistemic emotions can signal and guide cognitive activity; tolerance of uncertainty keeps inquiry open when no immediately satisfactory answer is available; and emotional regulation helps students sustain effort and adjust their activity in the face of difficulties. GenAI can support these processes, but its contribution depends on students' ability to interpret their own experiences, remain with uncertainty, and deliberately regulate their engagement in learning.

5. Pedagogical and Institutional Implications

Preserving epistemic agency in GenAI-mediated learning contexts requires translating the principles discussed above into pedagogical practices, assessment procedures, and institutional guidelines. Making tools available or establishing general rules for their use is not enough; institutions must create conditions in which students continue to formulate problems, examine evidence, justify interpretations, and assume responsibility for the conclusions they present. This perspective shifts the focus from the mere use of technology to the quality of the intellectual participation it enables or requires, involving students, teachers, and higher education institutions.

5.1. Designing Learning Activities Centred on Questioning

Designing activities centred on questioning integrates GenAI without reducing academic work to obtaining answers. Instead of requesting only a summary, an explanation, or a final text, tasks can require students to formulate questions, compare interpretations, identify assumptions, and justify decisions. This ap-

proach aligns with Bearman and Ajjawi (2023), who emphasise the need to rethink pedagogical practices as AI systems become part of knowledge production and interpretation. The educational value of the interaction thus depends not only on the content generated, but also on the cognitive operations performed before, during, and after using the system.

This approach is close to inquiry-based learning, in which formulating questions, exploring evidence, and revising explanations play a central role. Chan and Hu (2023) identified favourable perceptions among higher education students about the potential of generative AI to support learning, but also concerns about accuracy, dependence, and academic integrity. These tensions reinforce the need for activities that link technology use to critical evaluation. Moundridou et al. (2024) also demonstrated the potential of generative tools to help teachers design and implement inquiry-based lesson plans.

An activity can begin with the individual analysis of a problem, followed by consultation of a generative system to obtain explanations or alternative perspectives. Students should identify how the response confirms, broadens, or contradicts their initial interpretation, verify relevant claims, and justify their acceptance or rejection of the proposals received. Gómez et al. (2025) specifically address evidence verification and source use in assignments produced with the help of generative AI, reinforcing the relevance of requiring students to substantiate the claims presented. Questions can also test the limits of responses: what evidence supports them, what assumptions they contain, under what circumstances they might be incorrect, and what alternative explanations remain plausible. In this context, Urban et al. (2025) examined students' epistemic beliefs and metacognitive accuracy when integrating ChatGPT-generated content into academic writing.

For example, students could be presented with an AI-generated explanation containing a claim that conflicts with evidence from another source. They would first identify and briefly describe any confusion, frustration, or uncertainty they experience, considering how these reactions might influence their judgement. They would then select an appropriate verification strategy, such as consulting the original research, comparing independent sources, or examining the evidence supporting each interpretation. Finally, they would formulate a provisional conclusion, explaining why the available evidence supports it, what limitations remain, and what additional information might change their judgement. This activity explicitly combines emotional regulation with tolerance of uncertainty by encouraging students to acknowledge and manage discomfort without prematurely resolving the question or accepting the first plausible answer. It also reinforces epistemic agency by requiring students to justify their conclusions on the basis of evidence rather than the apparent authority or fluency of AI-generated content.

Pedagogical design should also preserve periods of work without generative support when necessary to observe the knowledge, reasoning, or skills the activity aims to develop. This option does not mean excluding AI from all stages of learn-

ing, but distinguishing between situations where assistance can broaden exploration and those where it is necessary to observe students' ability to act autonomously. Wu et al. (2025) place human epistemic agency at the centre of the learning relationship with generative AI, providing a relevant framework for preserving students' intellectual participation. The combination of individual work, guided interaction with AI, and subsequent reflection can thus distinguish between using technology as support and transferring to the system decisions that require independent judgement.

The aim is not to make tasks artificially more difficult or to require the systematic rejection of generated content. Rather, it is to organise the activity so that technology supports inquiry without replacing essential intellectual decisions. When questioning, comparison, verification, and justification form part of the task criteria, epistemic agency becomes an observable dimension of learning. This approach is close to the conception of shared epistemic agency discussed by Damşa et al. (2010), although applying it to GenAI-mediated contexts requires recognising the differences between human collaboration and interaction with artificial systems.

5.2. Assessing Students' Epistemic Agency

Assessment constitutes a decisive dimension because it communicates to students which aspects of their work are genuinely valued. The literature on epistemic agency emphasises that assessment not only measures learning, but also influences students' relationship with knowledge, particularly their ability to evaluate, use, produce, and critically transform it (Nieminen & Ketonen, 2024). If grading focuses exclusively on the final product, students' intellectual contribution may become less visible, an issue that is particularly relevant when tasks previously used as indicators of cognitive performance can be partially completed using generative systems (Lodge et al., 2023; Thompson et al., 2023).

The final product nevertheless remains relevant. Evidence of the process can complement accuracy, argumentative coherence, and suitability to disciplinary requirements, such as justification of selected sources, explanation of changes introduced, identification of limitations in generated responses, and oral defence of the decisions made. This approach aligns with perspectives that create opportunities for students to position themselves as users and producers of knowledge (Nieminen et al., 2024). The DRIVE framework, proposed in a study on assessing learning through interactions with GenAI, likewise seeks to make the ways students guide interaction and express knowledge during dialogue with generative systems open to analysis. Oliveira et al. (2025) analysed 1,450 interaction annotations from 70 assessed essays and found a positive association between interaction quality with GenAI and essay results. Among other aspects, the framework distinguishes how students direct their reasoning and make the disciplinary knowledge they mobilise visible, although the authors present it as a guiding framework that requires adaptation to disciplinary objectives and contexts.

In practice, teachers can use explicit criteria to assess the quality of the ques-

tions formulated, the relevance of verification procedures, the consideration of alternative interpretations, and the justification of decisions to accept, modify, or reject generated content (Nieminen & Ketonen, 2024; Nieminen et al., 2024). A brief reflective commentary can ask students to identify a useful contribution from AI, a limitation they detected, and a decision made on the basis of their own judgement. Where appropriate, an oral discussion or a transfer task involving a new problem can verify whether the understanding demonstrated corresponds to the knowledge actually acquired. These opportunities can also make visible how students delimit, negotiate, and justify their use of technology (Chen & Zou, 2026).

These procedures should be proportionate to the objectives and resources available. Extensive records of all interactions may increase the workload and encourage merely formal documentation. Similarly, the number of prompts directed to AI, the length of the dialogue, or the number of revisions do not, in isolation, constitute valid indicators of learning. Assessment should focus on the quality of reasoning, the ability to verify and justify decisions, and the mobilisation of disciplinary knowledge, rather than using the intensity of GenAI use as an indirect indicator of learning (Nieminen & Ketonen, 2024; Oliveira et al., 2025).

It is equally important to ensure transparent criteria and equitable opportunities. Students should know in advance the conditions under which AI is permitted, the types of contribution they must declare, and the criteria used in assessment. Defining these conditions forms part of the assessment design itself, since opportunities to exercise agency also depend on the affordances and constraints created by the task (Nieminen et al., 2024). Chen and Zou (2026) likewise show that task characteristics, performance expectations, and the framework teachers provide shape students' agency in GenAI-mediated assessment. Decisions should not depend exclusively on automated detectors of generated text, whose indications do not, in themselves, constitute sufficient proof of authorship or learning. Assessing epistemic agency therefore requires contextualised, transparent evidence aligned with learning outcomes.

5.3. Institutional Responsibility and Teacher Education

Promoting epistemic agency cannot remain entirely dependent on the individual decisions of teachers or students. Higher education institutions must define guidelines on GenAI use, data protection, academic integrity, accessibility, and pedagogical training. UNESCO (2023) advocates a human-centred approach, calling for the educational integration of AI with privacy protection, ethical validation of tools, and the development of institutional capacities. Miao and Holmes (2023) likewise emphasise the need to frame generative AI through principles of ethical, responsible, and pedagogically grounded use. Institutional policies should therefore clarify the conditions under which its use is pedagogically appropriate, rather than merely authorising or prohibiting tools.

An institutional policy should distinguish activities and purposes. Using AI to

explore ideas, receive feedback, or compare explanations may be appropriate in one task, whereas in another it may compromise the observation of skills the student needs to demonstrate without assistance. Guidelines should allow teachers to specify authorised forms of use, declaration requirements, and verification expectations, while remaining consistent with assessment and academic integrity regulations. This articulation between technology, learning objectives, and task design is particularly relevant to a pedagogically grounded integration of GenAI (Xia et al., 2024).

Teacher education constitutes a complementary condition. It is not limited to technical mastery of the tools, including understanding the limitations of generative systems, assessing their pedagogical suitability, redesigning tasks, and defining criteria that value students' reasoning. Recent literature shows that integrating GenAI requires competencies that combine technological knowledge, pedagogical judgement, and the ability to guide students in the critical use of generative systems (Ng et al., 2024; Xu et al., 2025). In this context, language models raise questions about the relationship between teachers' and students' agency, highlighting the importance of dialogue and contextualised pedagogical responses (Kahn et al., 2025). Updated guidance, technical and pedagogical support, and opportunities for teacher sharing can foster more consistent responses. The critical integration of AI also requires teachers and students to recognise the limitations of these systems and not assume their outputs are automatically valid (Bearman & Ajjawi, 2023), reinforcing the need for critical literacy and discussion of the pedagogical implications of GenAI (Miao & Holmes, 2023).

Finally, institutional governance should preserve human responsibility without ignoring the diversity of disciplinary contexts. Common principles can coexist with well-founded local decisions, provided that students' rights, transparency, and learning objectives are safeguarded (Miao & Holmes, 2023; UNESCO, 2023). Epistemic agency therefore depends not only on individual recommendations but also on institutional environments that enable questioning, verification, justification, and responsibility for the knowledge produced.

In summary, integrating GenAI into education requires activities that value questioning, assessments that make students' intellectual participation visible, and institutional policies supported by teacher education. These dimensions are interdependent: tasks define opportunities for participation, assessment communicates the value attributed to that participation, and institutions create conditions for consistent, ethical, and pedagogically justified practices (Kahn et al., 2025; Xia et al., 2024). The central criterion is not the presence or absence of AI, but the ability to integrate it without shifting the judgement and responsibility associated with human learning to the generative system.

6. Conclusions

GenAI has introduced new possibilities and challenges for understanding learning in higher education. This article analysed the relationship between GenAI, epis-

temic agency, epistemic emotions, tolerance of uncertainty, and SRL, focusing on the conditions under which interaction with generative systems can support or constrain students' active engagement with knowledge. The analysis developed supports the view that the educational significance of GenAI should not be understood solely in terms of access to information, task automation, or content production. Rather, it depends on how students formulate questions, evaluate and verify information, interpret uncertainty, regulate their responses to epistemic difficulty, and assume responsibility for the judgements they make when interacting with generative systems. From this perspective, GenAI can support learning, but it can also displace, externalise, or weaken essential learning processes when students accept its responses without questioning.

The main theoretical argument developed is that the use of GenAI creates a new epistemic environment in which students' agency becomes particularly important. Students interact with systems that can produce explanations, suggestions, alternatives, and content in response to their requests, but the epistemic value of these outputs cannot be assumed from their fluency or apparent completeness. The ability to formulate meaningful questions, evaluate response quality, recognise uncertainty, consider alternative interpretations, and decide when and how to use generated content therefore becomes central to learning. Epistemic agency does not disappear in the presence of technology; rather, its exercise becomes more dependent on students' capacity to maintain judgement and responsibility within the interaction. GenAI can function as a cognitive and regulatory resource, but it does not replace students' responsibility to interpret information, evaluate evidence, and make decisions about their own learning.

Epistemic emotions and tolerance of uncertainty form an important part of this process. Curiosity and surprise may stimulate exploration and reconsideration, while confusion and doubt can signal the need for further investigation. Conversely, frustration, anxiety, or the desire to obtain an immediate answer may favour premature closure when these experiences are not adequately regulated. GenAI may modify these dynamics by making explanations and answers continuously available. Its educational value therefore depends not simply on reducing difficulty or uncertainty, but on supporting students in interpreting these experiences and using them to guide further cognitive activity.

This framework helps shift the discussion on GenAI in higher education from a predominantly instrumental perspective to one centred on epistemic agency, cognitive regulation, and responsibility. From an educational perspective, this implies that integrating GenAI should prioritise activities that require questioning, comparison, verification, justification, and reflection on decisions made during the learning process. For teachers, the issue is not merely determining when GenAI may or may not be used, but designing pedagogical contexts in which technology use preserves students' cognitive and epistemic activity. For institutions, this orientation reinforces the need for policies that articulate responsible GenAI use, teacher education, AI literacy, academic integrity, data protection, and equity

of access.

However, it is important to recognise some limitations. The theoretical-conceptual nature of the analysis does not allow causal relationships to be established between the use of GenAI and changes in epistemic agency, epistemic emotions, tolerance of uncertainty, or SRL processes. In addition, the rapid evolution of generative models makes it particularly difficult to stabilise conclusions about technologies and practices that are constantly evolving. The available literature also presents relevant conceptual and methodological differences, making direct comparisons between contexts, populations, and forms of GenAI use difficult. For these reasons, the arguments presented should be understood as a conceptual framework to guide research and practice, not as definitive evidence of GenAI's effects on learning.

Future research should therefore empirically examine how different forms of GenAI use affect epistemic agency, emotional responses to uncertainty, verification practices, and self-regulatory processes throughout learning activities. Longitudinal and experimental studies may help distinguish uses that support epistemic autonomy from those that promote dependence or reduced cognitive engagement. It will also be important to analyse differences associated with students' level of experience, academic tasks, and the characteristics of pedagogical contexts. Rather than determining whether GenAI is, in itself, beneficial or harmful to learning, future research should examine the conditions under which its use can be integrated in ways that strengthen students' capacity to question, evaluate, justify, and learn with progressively greater autonomy.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

Bearman, M., & Ajjawi, R. (2023). Learning to Work with the Black Box: Pedagogy for a World with Artificial Intelligence. *British Journal of Educational Technology, 54,* 1160-1173. https://doi.org/10.1111/bjet.13337

Bender, E. M., Gebru, T., McMillan-Major, A., & Shmitchell, S. (2021). On the Dangers of Stochastic Parrots: Can Language Models Be Too Big? In *Proceedings of the 2021 ACM Conference on Fairness, Accountability, and Transparency* (pp. 610-623). ACM. https://doi.org/10.1145/3442188.3445922

Chan, C. K. Y., & Hu, W. (2023). Students' Voices on Generative AI: Perceptions, Benefits, and Challenges in Higher Education. *International Journal of Educational Technology in Higher Education, 20,* Article No. 43. https://doi.org/10.1186/s41239-023-00411-8

Chen, J. X. J., & Zou, T. X. P. (2026). Students' Agency in Genai-Mediated Group Assessment: An Ecological-Emergent Perspective. *Assessment & Evaluation in Higher Education*. https://doi.org/10.1080/02602938.2026.2730644

Chevrier, M., Muis, K. R., Trevors, G. J., Pekrun, R., & Sinatra, G. M. (2019). Exploring the Antecedents and Consequences of Epistemic Emotions. *Learning and Instruction, 63,* Article ID: 101209. https://doi.org/10.1016/j.learninstruc.2019.05.006

Coates, H., Croucher, G., & Calderon, A. (2025). Governing Academic Integrity: Ensuring the Authenticity of Higher Thinking in the Era of Generative Artificial Intelligence. *Journal of Academic Ethics, 23,* 2015-2028. https://doi.org/10.1007/s10805-025-09639-7

D'Mello, S., & Graesser, A. (2014). Confusion and Its Dynamics during Device Comprehension with Breakdown Scenarios. *Acta Psychologica, 151,* 106-116. https://doi.org/10.1016/j.actpsy.2014.06.005

Damşa, C. I., Kirschner, P. A., Andriessen, J. E. B., Erkens, G., & Sins, P. H. M. (2010). Shared Epistemic Agency: An Empirical Study of an Emergent Construct. *Journal of the Learning Sciences, 19,* 143-186. https://doi.org/10.1080/10508401003708381

Deng, R., Jiang, M., Yu, X., Lu, Y., & Liu, S. (2025). Does ChatGPT Enhance Student Learning? A Systematic Review and Meta-Analysis of Experimental Studies. *Computers & Education, 227,* Article ID: 105224. https://doi.org/10.1016/j.compedu.2024.105224

Efklides, A. (2011). Interactions of Metacognition with Motivation and Affect in Self-Regulated Learning: The MASRL Model. *Educational Psychologist, 46,* 6-25. https://doi.org/10.1080/00461520.2011.538645

Facione, P. A. (2023). *Critical Thinking: What It Is and Why It Counts (2023 Update).* Insight Assessment. https://insightassessment.com/iaresource/critical-thinking-what-it-is-and-why-it-counts/

Gómez, S. V., Rebolledo, E. K. S., & Cano, J. M. M. (2025). Verificación De Evidencias Y Fuentes De Información De Trabajos Académicos Elaborados Con Inteligencia Artificial Generativa. *Educação e Pesquisa, 51,* e294421es. https://doi.org/10.1590/s1678-4634202551294421es

Heikkilä, M., Hermansen, H., Iiskala, T., Mikkilä-Erdmann, M., & Warinowski, A. (2020). Epistemic Agency in Student Teachers' Engagement with Research Skills. *Teaching in Higher Education, 28,* 455-472. https://doi.org/10.1080/13562517.2020.1821638

Heung, Y. M. E., & Chiu, T. K. F. (2025). How ChatGPT Impacts Student Engagement from a Systematic Review and Meta-Analysis Study. *Computers and Education: Artificial Intelligence, 8,* Article ID: 100361. https://doi.org/10.1016/j.caeai.2025.100361

Kahn, P., Carrigan, M., Smith, P., Murtagh, L., Liu, R., & Song, F. (2025). Teacher Agency and Generative Artificial Intelligence: Teaching in Higher Education as a Responsive, Cultural Activity. *Learning, Media and Technology*. https://doi.org/10.1080/17439884.2025.2575993

Kasneci, E., Sessler, K., Küchemann, S., Bannert, M., Dementieva, D., Fischer, F. et al. (2023). ChatGPT for Good? On Opportunities and Challenges of Large Language Models for Education. *Learning and Individual Differences, 103,* Article ID: 102274. https://doi.org/10.1016/j.lindif.2023.102274

Kofinas, A. K., Tsay, C. H., & Pike, D. (2025). The Impact of Generative AI on Academic Integrity of Authentic Assessments within a Higher Education Context. *British Journal of Educational Technology, 56,* 2522-2549. https://doi.org/10.1111/bjet.13585

Lan, M., & Zhou, X. (2025). A Qualitative Systematic Review on AI Empowered Self-Regulated Learning in Higher Education. *npj Science of Learning, 10,* Article No. 21. https://doi.org/10.1038/s41539-025-00319-0

Lazarus, M. D., Gouda-Vossos, A., Ziebell, A., Parasnis, J., Mujumdar, S., & Brand, G. (2025). Mapping Educational Uncertainty Stimuli to Support Health Professions Educators' in Developing Learner Uncertainty Tolerance. *Advances in Health Sciences Education, 30,* 259-280. https://doi.org/10.1007/s10459-024-10345-z

Lindebaum, D., Nolan, E., Ashraf, M., Islam, G., & Ramirez, M. F. (2025). The Transfor-

mation of Epistemic Agency and Governance in Higher Education through Large Language Models: Toward a Future of Organized Immaturity. *Organization Studies*. https://doi.org/10.1177/01708406251392002

Lodge, J. M., Thompson, K., & Corrin, L. (2023). Mapping Out a Research Agenda for Generative Artificial Intelligence in Tertiary Education. *Australasian Journal of Educational Technology, 39,* 1-8. https://doi.org/10.14742/ajet.8695

Lourenço, A. A., & Paiva, M. O. A. (2025). Key Factors in Academic Achievement: The Impact of Procrastination, Volitional Control, and Self-Regulated Learning. *Creative Education, 16,* 144-166. https://doi.org/10.4236/ce.2025.162009

Lourenço, A., Paiva, M. O., & Valente, S. (2025a). Strategies That Transform: Self-Regulation and Volitional Control as Keys to Academic Achievement. *Social Sciences, 14,* Article 285. https://doi.org/10.3390/socsci14050285

Lourenço, A., Paiva, M. O., & Valente, S. (2025b). The Dynamics of Self-Regulated Learning and Emotional Regulation in the Educational Path: A Theoretical Review. *Creative Education, 16,* 632-650. https://doi.org/10.4236/ce.2025.165039

Miao, F., & Holmes, W. (2023). *Guidance for Generative AI in Education and Research.* UNESCO.

Moundridou, M., Matzakos, N., & Doukakis, S. (2024). Generative AI Tools as Educators' Assistants: Designing and Implementing Inquiry-Based Lesson Plans. *Computers and Education: Artificial Intelligence, 7,* Article ID: 100277. https://doi.org/10.1016/j.caeai.2024.100277

Muis, K. R., Chevrier, M., & Singh, C. A. (2018). The Role of Epistemic Emotions in Personal Epistemology and Self-Regulated Learning. *Educational Psychologist, 53,* 165-184. https://doi.org/10.1080/00461520.2017.1421465

Muis, K. R., Psaradellis, C., Lajoie, S. P., Di Leo, I., & Chevrier, M. (2015). The Role of Epistemic Emotions in Mathematics Problem Solving. *Contemporary Educational Psychology, 42,* 172-185. https://doi.org/10.1016/j.cedpsych.2015.06.003

Nerantzaki, K., Efklides, A., & Metallidou, P. (2022). Epistemic Emotions: Cognitive Underpinnings and Relations with Metacognitive Feelings. *New Ideas in Psychology, 63,* Article ID: 100904. https://doi.org/10.1016/j.newideapsych.2021.100904

Ng, D. T. K., Tan, C. W., & Leung, J. K. L. (2024). Empowering Student Self-Regulated Learning and Science Education through ChatGPT: A Pioneering Pilot Study. *British Journal of Educational Technology, 55,* 1328-1353. https://doi.org/10.1111/bjet.13454

Nieminen, J. H., & Ketonen, L. (2024). Epistemic Agency: A Link between Assessment, Knowledge and Society. *Higher Education, 88,* 777-794. https://doi.org/10.1007/s10734-023-01142-5

Nieminen, J. H., Haataja, E., & Cobb, P. J. (2024). From Active Learners to Knowledge Contributors: Authentic Assessment as a Catalyst for Students' Epistemic Agency. *Teaching in Higher Education, 30,* 970-990. https://doi.org/10.1080/13562517.2024.2332252

Oliveira, M., Zednik, C., Bombaerts, G., Sadowski, B., & Conijn, R. (2025). Assessing Students' DRIVE: A Framework to Evaluate Learning through Interactions with Generative Ai. *Computers and Education: Artificial Intelligence, 9,* Article ID: 100497. https://doi.org/10.1016/j.caeai.2025.100497

Panadero, E. (2017). A Review of Self-Regulated Learning: Six Models and Four Directions for Research. *Frontiers in Psychology, 8,* Article 422. https://doi.org/10.3389/fpsyg.2017.00422

Pekrun, R. (2006). The Control-Value Theory of Achievement Emotions: Assumptions,

Corollaries, and Implications for Educational Research and Practice. *Educational Psychology Review, 18,* 315-341. https://doi.org/10.1007/s10648-006-9029-9

Pekrun, R., & Linnenbrink-Garcia, L. (2014). *International Handbook of Emotions in Education.* Routledge. https://doi.org/10.4324/9780203148211

Pekrun, R., Vogl, E., Muis, K. R., & Sinatra, G. M. (2017). Measuring Emotions during Epistemic Activities: The Epistemically-Related Emotion Scales. *Cognition and Emotion, 31,* 1268-1276. https://doi.org/10.1080/02699931.2016.1204989

Rezai, A., Soyoof, A., & Reynolds, B. (2024). Disclosing the Correlation between Using ChatGPT and Well-Being in EFL Learners: Considering the Mediating Role of Emotion Regulation. *European Journal of Education, 59,* e12752. https://doi.org/10.1111/ejed.12752

Risko, E. F., & Dunn, T. L. (2015). Storing Information In-the-World: Metacognition and Cognitive Offloading in a Short-Term Memory Task. *Consciousness and Cognition, 36,* 61-74. https://doi.org/10.1016/j.concog.2015.05.014

Risko, E. F., & Gilbert, S. J. (2016). Cognitive Offloading. *Trends in Cognitive Sciences, 20,* 676-688. https://doi.org/10.1016/j.tics.2016.07.002

Samuel, A. (2025). Beyond Tools: Toward Epistemic Co-Agency in Medical Education. *Medical Education, 59,* 1151-1153. https://doi.org/10.1111/medu.70019

Stephens, G. C., & Lazarus, M. D. (2024). Twelve Tips for Developing Healthcare Learners' Uncertainty Tolerance. *Medical Teacher, 46,* 1035-1043. https://doi.org/10.1080/0142159x.2024.2307500

Thompson, K., Corrin, L., & Lodge, J. M. (2023). AI in Tertiary Education: Progress on Research and Practice. *Australasian Journal of Educational Technology, 39,* 1-7. https://doi.org/10.14742/ajet.9251

Tian, T., Chai, C. S., Chen, M. H., & Liang, J. C. (2025). University Students' Perceptions of Learning with Generative Artificial Intelligence. *Educational Technology & Society, 28,* 151-165.

Tlili, A., Shehata, B., Adarkwah, M. A., Bozkurt, A., Hickey, D. T., Huang, R. et al. (2023). What If the Devil Is My Guardian Angel: ChatGPT as a Case Study of Using Chatbots in Education. *Smart Learning Environments, 10,* Article No. 15. https://doi.org/10.1186/s40561-023-00237-x

UNESCO (2023). *Guidance for Generative AI in Education and Research.* https://doi.org/10.54675/EWZM9535

Urban, M., Brom, C., Lukavský, J., Děchtěrenko, F., Hein, V., Svacha, F. et al. (2025). "ChatGPT Can Make Mistakes. Check Important Info." Epistemic Beliefs and Metacognitive Accuracy in Students' Integration of ChatGPT Content into Academic Writing. *British Journal of Educational Technology, 56,* 1897-1918. https://doi.org/10.1111/bjet.13591

Urban, M., Děchtěrenko, F., Lukavský, J., Hrabalová, V., Svacha, F., Brom, C. et al. (2024). ChatGPT Improves Creative Problem-Solving Performance in University Students: An Experimental Study. *Computers & Education, 215,* Article ID: 105031. https://doi.org/10.1016/j.compedu.2024.105031

Vogl, E., Pekrun, R., Murayama, K., & Loderer, K. (2020). Surprised-Curious-Confused: Epistemic Emotions and Knowledge Exploration. *Emotion, 20,* 625-641. https://doi.org/10.1037/emo0000578

Wu, J. Y., Lee, Y. H., Chai, C. S., & Tsai, C. C. (2025). Strengthening Human Epistemic Agency in the Symbiotic Learning Partnership with Generative Artificial Intelligence. *Educational Researcher, 54,* 358-368. https://doi.org/10.3102/0013189x251333628

Xia, Q., Weng, X., Ouyang, F., Lin, T. J., & Chiu, T. K. F. (2024). A Scoping Review on How Generative Artificial Intelligence Transforms Assessment in Higher Education. *International Journal of Educational Technology in Higher Education, 21,* Article No. 40. https://doi.org/10.1186/s41239-024-00468-z

Xu, X., Qiao, L., Cheng, N., Liu, H., & Zhao, W. (2025). Enhancing Self-Regulated Learning and Learning Experience in Generative AI Environments: The Critical Role of Metacognitive Support. *British Journal of Educational Technology, 56,* 1842-1863. https://doi.org/10.1111/bjet.13599

Zawacki-Richter, O., Marín, V. I., Bond, M., & Gouverneur, F. (2019). Systematic Review of Research on Artificial Intelligence Applications in Higher Education—Where Are the Educators? *International Journal of Educational Technology in Higher Education, 16,* Article No. 39. https://doi.org/10.1186/s41239-019-0171-0

Zhai, C., Wibowo, S., & Li, L. D. (2024). The Effects of Over-Reliance on AI Dialogue Systems on Students' Cognitive Abilities: A Systematic Review. *Smart Learning Environments, 11,* Article No. 28. https://doi.org/10.1186/s40561-024-00316-7

Zhang, J., Tian, Y., Yuan, G., & Tao, D. (2022). Epistemic Agency for Costructuring Expansive Knowledge-Building Practices. *Science Education, 106,* 890-923. https://doi.org/10.1002/sce.21717

Zheng, J., Lajoie, S., & Li, S. (2023). Emotions in Self-Regulated Learning: A Critical Literature Review and Meta-Analysis. *Frontiers in Psychology, 14,* Article 1137010. https://doi.org/10.3389/fpsyg.2023.1137010

Zimmerman, B. J. (2002). Becoming a Self-Regulated Learner: An Overview. *Theory into Practice, 41,* 64-70. https://doi.org/10.1207/s15430421tip4102_2