The Impact of Artificial Intelligence on Critical Thinking, Epistemic Curiosity and Epistemic Autonomy in the Context of Education

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Abstract: Critical thinking plays a vital role in education by fostering intellectual independence and resilience. From a Cartesian perspective, epistemic curiosity embodies the spirit of methodological doubt, where questioning and scepticism are essential for arriving at indubitable knowledge. Virtue epistemologists contend that curiosity is an intellectual virtue necessary for the development of wisdom and the search for truth. Epistemic autonomy, on the other hand, is an epistemological agent's ability to independently govern his or her beliefs and reasoning. It empowers students to critically evaluate information, resist undue influence, and form justified beliefs through rational deliberation. This paper discusses how students' excessive reliance on AI tools for knowledge acquisition may compromise their capacity for autonomous learning and critical thinking. The paper also explores (i) the epistemological impact of the use of AI tools in education on epistemic curiosity and epistemic autonomy, (ii) on active inquiry and the resilience-building experience of problem-solving, and (iii) the epistemological consequences of superficial learning, instant gratification and reduced cognitive struggle. Finally, the paper proposes certain strategies to mitigate the AI's impact on critical thinking while AI tools are used for learning.

Keywords: AI in education, critical thinking, epistemic autonomy, epistemic curiosity, epistemological impact.

Introduction

Artificial Intelligence (AI) tools are increasingly integrated into educational settings, offering personalised learning experiences and efficient access to information. Though AI can help personalise education and make administrative tasks easier, there is a looming concern that it may harm students' capacity to think critically, stay interested, and keep their own thinking. So, integrating AI technologies into education practices prompts an examination of their influence on critical thinking, epistemic curiosity, and epistemic autonomy among students. Critical thinking is the ability to analyse and evaluate information to form reasoned judgments, is a cornerstone of effective learning (Facione 2011). Epistemic curiosity is the desire to seek and acquire new knowledge, which drives intellectual growth and innovation (Litman 2005). Epistemic autonomy refers to the capacity to navigate and assess information independently and form and

justify one's beliefs. Understanding how AI tools impact these cognitive domains is essential for educators and policymakers aiming to harness technology's benefits without compromising essential intellectual skills.

AI tools are often designed to provide quick, accurate, and easily digestible answers, which can inadvertently discourage deep engagement with complex problems. For instance, students relying on AI-generated summaries or solutions may bypass the cognitive effort required to analyse, synthesize, and evaluate information, potentially eroding critical thinking skills (Willingham 2007). Similarly, the convenience of AI-driven knowledge retrieval systems might reduce the intrinsic motivation to explore and question, thereby diminishing epistemic curiosity (Kashdan et al. 2013). Furthermore, the dependence on AI for problem-solving could compromise epistemic autonomy, as students may become dependent on algorithmic outputs rather than developing their own reasoning abilities. These worries matter a lot in educational contexts where the main aim of education is to develop self-reliant, thoughtful, and inquisitive persons who can deal with a world that is getting more and more complex every day.

The paper makes an attempt to show the influence of AI on critical thinking, epistemic curiosity, and epistemic autonomy through its rampant use in education. In Section 1, I shall establish that the purpose of learning is not merely the accumulation of knowledge but the cultivation of critical thinking, which serves as the cornerstone of epistemic agency and is essential for transcending passive acceptance of information and achieving intellectual independence. Section 2 will explore the significance of epistemic curiosity and epistemic autonomy, highlighting how these qualities drive deeper engagement with knowledge and self-directed learning. Section 3 will discuss the contemporary use of AI tools in education and how the integration of artificial intelligence tools in education has transformed the learning experience by offering personalised instruction, automating administrative tasks, and providing students with instant access to vast repositories of knowledge. Section 4 will deal with the problem of epistemic dependence brought about by the incorporation of AI tools in education, a condition where learners are at risk of placing excessive reliance on algorithmic systems for acquiring knowledge and making decisions. I shall argue that such dependence defeats epistemic curiosity and autonomy – the virtues that education aims to nurture. This section will also explore the epistemological impact of AI tools on epistemic curiosity and autonomy, active inquiry and the resilience-building experience of problem-solving, and also the epistemological consequences of superficial learning, instant gratification and reduced cognitive struggle. In order to address these issues, the last section will suggest some mitigating techniques. It will support deliberate educational approaches that foster critical interaction with AI, foster metacognitive reflection, and reaffirm the importance of intellectual struggle in the learning process.

1. The Purpose of Learning and the Significance of Critical Thinking in Education

The basis for both intellectual development and societal advancement is education. The main goal of education is to provide people the skills, knowledge, and moral principles they need to live well in a world that is getting more complicated by the day. According to Dewey (1916), education is vital for developing critical thinking, creativity, and epistemic curiosity – all of which are necessary for responsible citizenship and well-informed decision-making, beyond the mere passive assimilation of knowledge. According to Lipman (2003), education should foster students' ability to reason critically in addition to imparting knowledge. This view suggests that education should be structured in such a way that it fosters the intellectual independence of learners to enable them to challenge existing paradigms and create knowledge rather than just consume information. Critical thinking, as a core component of learning, plays a pivotal role in achieving these goals. It equips individuals with the ability to analyse information, evaluate arguments, and make reasoned decisions, thereby empowering them to engage critically with the world around them. In an era characterized by information overload and rapid technological advancements, the ability to think critically is more essential than ever.

Critical thinking plays a vital role in education by fostering intellectual independence and resilience. As Paul and Elder (2019) note, it involves not only logical reasoning but also the development of intellectual humility, empathy, and open-mindedness to evaluate others' views, challenge assumptions and form consistent arguments. Critical thinking also encourages students to actively engage with content rather than passively absorbing information which will reinforce epistemic autonomy, which is an epistemological agent's ability to independently justify the agent's beliefs (Bailin 2002). Cultivating this skill enables learners to tackle complex issues and participate meaningfully in democratic societies. Critical thinking is central to the development of informed and engaged citizenship, which enables people to make rational analyses and decisions on social and ethical issues (Nussbaum 2010). An upshot of prioritising critical thinking in the educational process is that it would not only equip the students for career growth, but also lead them to more democratic participation, which will eventually create a society which is resilient against manipulation and misinformation.

Critical thinking is crucial to tackle today's complex problems, such as fake news, ethical conflicts or global challenges, as it enables the capacity to analyse, evaluate, and make decisions in a rational way (Varghese 2024). Paul and Elder (2020) emphasise the fact that disciplined reasoning enables people to distinguish between credible and non-credible sources, comprehend biases, and develop strong arguments. The ability to critically assess information is indispensable in such times when misinformation spreads rapidly (Stanovich 2009). Willingham (2007) points out that critical thinking is an ability that must be deliberately

taught and practised and he underscores the responsibility of educational institutions to integrate it into curricula and teaching methods. Beyond academic achievement, critical thinking is vital for professional and personal growth, as employers increasingly value individuals who can adapt to changing environments, solve problems creatively, and work independently (Facione 2011). Freire (1970) critiques traditional education for relying on rote memorization, which suppresses students' critical awareness. Instead, adopting an inquiry-based, constructivist approach can nurture epistemic curiosity and autonomy by encouraging deeper engagement with knowledge. In what follows, I will discuss the significance of epistemic curiosity and epistemic autonomy in the context of education.

2. The Significance of Epistemic Curiosity and Epistemic Autonomy in the Context of Education

As an active, self-driven quest for information that promotes intellectual development and participation, epistemic curiosity is significant in education. In contrast to passive learning, epistemic curiosity encourages students to investigate novel ideas, challenge presumptions, and create meaning – all of which are consistent with the Socratic ideal of wisdom via inquiry (Dewey 1916). This disposition challenges traditional, authoritarian models of education, such as Freire's (1970) critique of the "banking model," which encourages the learners to take ownership of their intellectual journeys. Similarly, from a Cartesian perspective, epistemic curiosity embodies the spirit of methodological doubt, where questioning and scepticism are essential for arriving at indubitable knowledge (Descartes [1641] 2016). According to Metcalfe et al. (2020), epistemic curiosity also improves metacognitive processes by focusing on areas of incomplete comprehension, or the "Region of Proximal Learning," which maximises knowledge acquisition and promotes self-directed learning. The importance of curiosity in education is further highlighted by modern virtue epistemologists such as Zagzebski (1996), who contend that curiosity is an intellectual virtue necessary for the development of wisdom and the search for truth.

Epistemic autonomy, on the other hand, is an epistemological agent's ability to independently govern his or her beliefs and reasoning. It empowers students to critically evaluate information, resist undue influence, and form justified beliefs through rational deliberation (Matheson 2024). From a philosophical perspective, this autonomy aligns with Kant's (1784) call for intellectual maturity, where individuals rely on reason rather than external authority, embodying the enlightenment ideal of 'sapere aude' (dare to know). In educational settings, fostering epistemic autonomy transforms the teacher's role from a knowledge dispenser to a facilitator who supports students in developing reflective judgment and confidence in their cognitive abilities (Ryan 2021). Virtue epistemology, particularly the work of Baehr (2011), highlights autonomy as a key intellectual

virtue which enables individuals to take responsibility for their epistemic practices and resist intellectual conformity. Together, epistemic curiosity and autonomy create a dynamic interplay. In other words, while curiosity fuels the pursuit of knowledge, autonomy makes sure that logical norms and critical thinking direct it, equipping students to negotiate complicated information environments successfully.

Nurturing these epistemic qualities is essential for both the individual's intellectual growth and the advancement of society as a whole. According to Freire (1970), education should be a liberating process that aims to give students the critical consciousness they need to oppose oppressive structures and make significant contributions to society. Moreover, epistemic curiosity and autonomy are essential for distinguishing fact from fiction and encouraging democratic participation in a modern society where there are conflicting narratives and information overload. However, the widespread use of AI tools in education poses a number of difficulties, since it runs the risk of eroding these qualities by encouraging epistemic dependency. Drawing on virtue epistemology, which emphasizes the importance of intellectual character in knowledge acquisition (Zagzebski 1996), and Cartesian scepticism, which prioritizes independent reasoning (Descartes [1641] 2016), it becomes clear that the integration of AI must be carefully managed to preserve the epistemic virtues that are foundational to education. This tension sets the stage for examining how AI tools raise concerns regarding epistemic dependence. But before we discuss the concerns regarding epistemic dependency, let us have a glance at the use of AI tools for learning during the formal education process.

3. The Use of AI Tools in Education

By offering personalised tutoring, giving students immediate access to the enormous amount of knowledge and automating administrative processes, the use of artificial intelligence systems in education has completely changed the educational process. By tailoring information to each student's needs, AI-driven platforms such as intelligent tutoring systems and automated assessment tools have improved teaching and learning efficiency while promoting accessibility and engagement (Luckin 2018). Additionally, AI assists teachers in making data-driven decisions so that they can monitor the progress of the students and adjust their educational strategies (Holmes et al. 2019). On top of that, the use of artificial intelligence has democratised education by removing socioeconomic and geographic obstacles. It has also improved learning procedures by increasing the effectiveness and convenience of knowledge acquisition. Although these advantages are noteworthy, there are serious epistemological issues with the growing use of AI technologies, especially their impact on students' critical thinking, autonomous reasoning, and over-reliance on automated systems.

One of the most pressing issues that pops up while using AI tools for learning during formal education is the risk of epistemic dependence, where

learners become overly reliant on AI systems for knowledge acquisition and decision-making which eventually but potentially might undermine their ability to think critically and independently (Selwyn 2019). The "paradox of convenience," due to the ease and effectiveness of AI-driven solutions, makes this dependence worse, since it obstructs deep learning and active engagement. Therefore, information will be passively consumed due to this practice (Williamson 2017). AI technologies that offer pre-curated content or immediate answers, for example, may make students less inclined to independently investigate, challenge, or synthesise information. This could trigger a culture of superficial education. Furthermore, the algorithmic nature of AI systems can create epistemic 'filter bubbles' which may limit exposure to diverse perspectives and reinforce pre-existing biases and knowledge structures (Zawacki-Richter et al. 2019; Birhane and McGann 2024). This raises concerns about the long-term impact of AI on intellectual autonomy because students may become consumers of information rather than active participants in the learning process. In what follows, I will explore the problem of epistemic dependence and how this epistemic dependence leads to other epistemological issues.

4. The Problem of Epistemic Dependence

Concerns about epistemic dependency are among the most important issues raised by the use of artificial intelligence in educational contexts. The term 'epistemic dependency' describes how students' excessive reliance on AI tools for knowledge acquisition may compromise their capacity for autonomous learning and critical thinking. As AI systems become more prevalent in formal education practices, there is a risk that students might accept AI-generated information without critical analysis, which may lead to a passive consumption of knowledge. Students may become less likely to critically analyse knowledge, interact deeply with learning materials, or challenge presumptions as a result of this dependence, which can impede the development of critical cognitive abilities. Such a shift could result in a superficial understanding of subjects, which will ultimately impede the cultivation of analytical competencies vital for academic and professional success. As AI systems like intelligent tutoring platforms or language models provide students with instant answers, there is a risk that learners may offload critical thinking and inquiry to these tools, undermining their intellectual agency. Students' epistemic autonomy may be undermined if they take AI-generated outputs at face value without questioning their veracity or logic. This is similar to earlier criticisms of an excessive dependence on authority, including Kant's (1784) warning against intellectual immaturity, which occurs when people are unable to use reason for themselves. In education, this dependence threatens the development of independent judgment, which is one of the primary goals of learning, as students might prioritize efficiency over the slower, more deliberate process of grappling with uncertainty.

The problem is compounded by the opaque nature of AI systems, which often operate as 'black boxes,' obscuring how conclusions are reached. According to Floridi (2019), learners find it more difficult to assess the dependability of AI outputs or determine their evidentiary foundation as a result of this lack of transparency, which worsens epistemic dependence. Teachers can model reasoning and encourage discussion in a traditional education scheme, but, because AI's algorithmic processes are more difficult to understand, users are frequently left as passive information consumers. This structure of education aligns with Freire's (1970) critique of the banking model, where knowledge is deposited rather than co-constructed, except here the depositor is an impersonal machine. An upshot of this model is that, although AI promises personalized learning, it may inadvertently stifle the epistemic curiosity needed to question and refine one's understanding and leave the students epistemically tethered to tools that they do not fully comprehend during the learning process.

In addition to these concerns, epistemic dependence on AI raises ethical and societal implications for education's role in preparing critical citizens. If students habitually defer to AI for answers, they may become ill-equipped to navigate a world of misinformation or challenge dominant narratives, a concern echoed by Habermas (1985) in his emphasis on communicative rationality for democratic participation. Overreliance on AI tools could diminish the capacity for independent inquiry and reduce education to a transactional exchange of pre-packaged knowledge rather than a transformative process. While AI can enhance access to information, its unchecked use risks creating a generation of learners who are technically proficient but epistemically vulnerable and unable to discern truth without technological mediation.

4.1 The Epistemological Impact on Epistemic Curiosity and Epistemic autonomy

The integration of Artificial Intelligence tools in education brings forth a myriad of epistemological consequences, particularly in shaping students' epistemic curiosity and epistemic autonomy. Epistemic curiosity, which drives individuals to seek knowledge and understanding, is both encouraged and hindered by AI-powered educational tools. On one hand, AI-driven learning systems, such as adaptive tutoring platforms, can personalize educational experiences by presenting learners with content that aligns with their cognitive abilities and interests (Holmes et al. 2019). This personalized approach can enhance curiosity by guiding students toward unexplored areas of knowledge and sustaining their engagement. However, an overdependence on AI-generated information may inadvertently suppress the students' intrinsic motivation to explore and critically question ideas. The efficiency of AI in delivering quick and structured answers or results often hinders deeper inquiry because the students may prioritize acquiring information rapidly rather than engaging in meaningful intellectual exploration (Selwyn 2019). This ease of access to the answers or results can lead to superficial engagement with learning material, where students rely on AI-

generated summaries rather than engaging directly with primary sources, critical discussions, or developing their own reasoning. This can result in a passive acceptance of AI results, impairing critical thinking and problem-solving abilities, as well as the capacity to develop well-founded beliefs. This passive method of learning can eventually stifle the innate curiosity needed for deeper understanding and intellectual development.

Similarly, the use of AI in the formal education system has a substantial impact on epistemic autonomy, which is the capacity to freely acquire, evaluate, and construct knowledge. By enabling self-paced learning and offering extensive information repositories, AI systems empower students and may even promote independence in some respects (Luckin et al. 2016). However, the algorithmic nature of AI systems also presents many challenges since it can shape and constrain students' exposure to knowledge. Many AI-based platforms use recommendation algorithms that filter content based on prior interaction that can potentially create epistemic 'filter bubbles' and limit the diversity of perspectives students encounter (Williamson 2017). This narrowing of intellectual exposure restricts learners' capacity for independent evaluation and critical engagement with complex issues. Hence, it is the need of the hour to design AI tools that would prioritize learners' epistemic autonomy, encourage their epistemic curiosity and provide diverse perspectives rather than making the learners passive receivers of information or solutions during the learning process.

The increasing role of AI in education prompts a re-examination of traditional epistemological models that emphasize active inquiry and learner-driven discovery. Constructivist approaches to education stress the importance of direct engagement with content, critical reflection, and the ability to navigate uncertainty in the learning process. However, AI-driven learning systems often shift knowledge acquisition from active exploration to passive reception, and it challenges the epistemic foundations of deep, transformative learning. If AI tools continue to mediate the ways in which students interact with knowledge, the risk of diminishing their capacity for self-directed, critical engagement will grow, ultimately impacting their intellectual development. In order to guarantee that students continue to be active participants in the learning process rather than passive consumers of algorithmically filtered content, it is imperative to strike a balance between utilising AI to improve education and maintaining the essential characteristics of epistemic curiosity and autonomy.

The broader epistemological impact of AI in education is not just limited to students' autonomy and epistemic curiosity, but it also questions their capacity for active inquiry and resilience-building via problem-solving. In other words, generative AI's accessibility to solutions and outcomes might lessen cognitive strain, which is crucial for children to grow in resilience, creativity, and critical thinking. In the following section, I will explore how AI influences the experience of active inquiry and the resilience-building experience of problem-solving in formal education.

4.2 The Epistemological Impact on Active Inquiry and the Resilience-Building Experience of Problem-Solving

The integration of AI tools in education has profound epistemological implications for active inquiry. In a general sense, active inquiry is a process central to deep learning and knowledge construction. Active inquiry involves questioning, exploring, and synthesizing information to develop understanding. In the past, active inquiry has encouraged students to grapple with difficult issues and cultivate intellectual resilience by promoting a dynamic engagement with ambiguity. However, since AI tools like language models and intelligent tutoring systems can both help and impede this process, their incorporation into education appears to be a two-edged sword. As demonstrated previously, AI-powered tools such as virtual labs and adaptive learning systems may offer students immersive, interactive settings that pique their curiosity and promote exploration (Holmes et al. 2019). A sense of agency and involvement in the learning process will be fostered by these tools' ability to provide real-time feedback and individualised challenges. However, the ease of use of AI-generated answers may also prevent students from exerting the mental effort required for effective learning. For example, students may skip over the critical thinking and problem-solving phases that are necessary for gaining a thorough comprehension of subjects when AI systems offer fast solutions or excessively regimented pathways (Selwyn 2019). This conflict is an indicator to emphasise the necessity of designing AI tools to support active inquiry rather than to replace it.

Another area that has been greatly impacted by the use of AI in education is the experience of problem-solving, which builds resilience. Trial, error, and perseverance are traditional methods of problem-solving, and these processes foster grit and adaptability, which are essential qualities for lifelong learning. In other words, problem-solving resilience is cultivated through repeated exposure to challenges, failures, and iterative attempts to overcome obstacles and all of these contribute to intellectual growth and adaptability. AI tools can support this process by offering scaffolded problem-solving tasks and adaptive feedback that help students persist through difficulties (Luckin et al. 2016). For example, AI-powered simulations and gamified learning environments can create innovative spaces for students to experiment, fail, and learn from their mistakes without fear of judgment. However, the risk lies in the potential for AI tools to oversimplify problem-solving processes or provide solutions too quickly, which will eventually reduce opportunities for students to develop grit and perseverance (Williamson, 2017). With AI providing optimized solutions, students may bypass the struggle that builds such resilience. Because students may start to see knowledge as a pre-packaged good rather than as the result of arduous personal effort, this epistemological shift raises questions regarding the depth of comprehension and understanding. While AI is useful for scaffolding learning, its convenience runs the risk of undermining the developmental advantages of facing intellectual hurdles. In summary, AI systems frequently put efficiency ahead of learning. An upshot of

this prioritisation is that the students may miss out on the transformative experience of grappling with complex problems and tackling them, and emerging stronger from the process.

These modifications bring forth a larger epistemological conflict, which is the trade-off between maintaining human agency in the construction of knowledge and technological empowerment. Researchers contend that an excessive reliance on AI may result in a type of epistemic dependence, in which students put their faith in AI results rather than their own logic, which may impede critical thinking. A balanced approach might involve designing AI tools to prompt reflection rather than deliver solutions outright, ensuring that the resilience and epistemic autonomy of learners remain intact. Teachers must carefully balance the use of AI technologies with pedagogical approaches that prioritize active inquiry and resilience-building in order to optimize the epistemic advantages of these tools while minimizing their disadvantages. Students can better absorb the abilities and mindset required for lifelong learning by being encouraged to participate in metacognitive activities and reflect on how they solve problems (Biesta 2020). AI tools should also be made to encourage critical thinking and teamwork rather than just passive information consumption. AI programs that ask students to defend their positions or consider different approaches, for example, can encourage greater involvement and intellectual fortitude (Zawacki-Richter et al. 2019). By integrating AI tools in ways that prioritize active inquiry and problem-solving resilience, educators can harness the potential of these technologies to cultivate epistemically empowered learners.

The epistemological issues regarding the impact of AI on active inquiry and problem-solving resilience extend to broader issues of learning depth and cognitive engagement. When students prioritize efficiency over deep exploration, they may experience an epistemic shift toward superficial learning, where knowledge is acquired quickly but retained poorly. On top of this, since AI tools can undermine the value of sustained cognitive effort due to instant gratification in terms of solutions to complex problems, the use of AI tools in education may make it difficult for students to engage in the rigorous mental work necessary for true understanding. The next section will examine how the prevalence of AI-driven convenience affects students' cognitive struggle, potentially leading to reduced intellectual depth and a reliance on easily accessible yet surface-level knowledge.

4.3 The Epistemological Consequences of Superficial Learning, Instant Gratification and Reduced Cognitive Struggle

Another significant epistemological consequence that has been introduced by the integration of AI tools in education is superficial learning, instant gratification, and reduced cognitive struggle. Superficial learning, which can be characterized by a focus on memorization and surface-level understanding, is often exacerbated by AI tools that prioritize efficiency over depth. For instance, AI-driven platforms that

provide quick answers or summarized content may obstruct students from engaging in the critical thinking and analytical processes necessary for learning by understanding (Selwyn 2019). This aligns with constructivist theories of epistemology, which emphasize that knowledge is actively constructed through experience and reflection, rather than being passively received (Piaget 1970). When AI tools bypass this crucial learning process, they undermine the development of robust and consistent knowledge structures and will lead to fragmented and incoherent understanding.

Instant gratification, which is facilitated by AI tools that deliver immediate feedback and solutions, further compounds the problem. While instant feedback can be beneficial for reinforcing learning, it can also create a dependency on external validation, which may reduce epistemic curiosity and autonomy (Ryan and Deci 2000). This phenomenon is inconsistent with epistemological conceptions of self-determination, which emphasise the value of relatedness, competence, and autonomy in promoting deep learning and intrinsic motivation. AI tools may unintentionally reduce students' sense of competence and autonomy when they prioritize speed and convenience. As a result of this prioritisation, learning materials may be consumed more superficially, and critical thinking and problem-solving skills may deteriorate. This change is consistent with Bertrand Russell's criticism of hedonistic inclinations, in which he maintained that intellectual work is necessary for actual knowledge in addition to simple gratification (Russell 1912).

Reduced cognitive struggle is another epistemological effect of using AI technologies in education, and this has important ramifications for epistemological growth. One of the most important aspects of learning that promotes resilience, critical thinking, and a deeper understanding is cognitive struggle, or the mental effort needed to tackle complicated issues (Kapur 2008). Students may be deprived of the opportunity to experience and overcome the cognitive struggles and their intellectual growth may be hindered if AI tools simplify problem-solving processes or provide ready-made solutions and results. Vygotsky's sociocultural theory is very relevant in this context. The theory posits that learning occurs within the "zone of proximal development," where challenges are neither too easy nor too difficult, but just beyond the learner's current capabilities (Vygotsky 1978). If the necessary cognitive struggles are removed in education because of the integration of AI tools, then it is very likely that AI tools may prevent students from reaching their full epistemic potential, which may result in a superficial grasp of concepts and limit the development of higher-order thinking skills and the ability to apply knowledge critically and creatively in novel contexts.

Heidegger's notion of "being-in-the-world" highlights how existential involvement and lived experience are the paths to genuine understanding (Heidegger 1962). Reducing or removing cognitive struggle might run the danger of damaging this authentic knowledge in the context of AI in education. While AI

speeds up learning, it may also cause pupils to lose the existential and intellectual tension required for deep understanding. Heidegger cautions against technical enframing (Gestell), which reduces reality to lived inquiry and instead views it as resource management. If AI pre-empts cognitive struggle, then there is every possibility that it may lead to passive knowledge consumption, which will, in turn, diminish the transformative, existential aspect of learning essential to true understanding. In a similar vein, struggle and uncertainty are essential to the learning process from a Deweyan standpoint, since they encourage inquiry and promote a deeper level of understanding (Dewey 1986). Dewey emphasises that real comprehension will eventually result from conquering intellectual obstacles and negotiating uncertainty in a rational manner. But if AI tools provide quick solutions and results, that might undermine the role of cognitive struggle in education, which ultimately will weaken their ability to think critically, adapt, and develop the habits of inquiry essential for deep, transformative learning experiences. By the same token, Ryle's distinction between *knowing that* (declarative knowledge) and *knowing how* (procedural mastery) underscores the epistemological risks of reduced cognitive struggle due to AI in education. While AI efficiently delivers factual knowledge, it may undermine the experiential learning necessary for skill acquisition and intellectual autonomy (Ryle 1949). Struggle is essential for developing *knowing how*, as it fosters critical thinking, adaptability, and problem-solving. If AI minimizes effortful engagement, students may become passive recipients of information rather than active learners, weakening their ability to apply knowledge meaningfully and develop the intellectual dexterity crucial for deeper understanding and expertise.

To address these epistemological consequences, it is essential to design and implement AI tools in ways that promote deep learning, intrinsic motivation, and cognitive engagement. Educators can encourage students to reflect on their learning processes and engage in metacognitive practices, fostering a deeper understanding of the material (Flavell 1979). Additionally, AI systems should be designed to scaffold learning in ways that challenge students without overwhelming them and promote a balance between support and struggle (Wood, Bruner, and Ross 1976). An approach the educators should take to mitigate the risks of superficial learning, instant gratification, and reduced cognitive struggle, and promote a more epistemically robust learning process in the context of the use of AI tools in education, is to integrate AI tools with pedagogical strategies that emphasize active inquiry and critical thinking. In the subsequent section, I will explore specific mitigation measures and strategies to ensure that AI tools support deep, meaningful learning while preserving the epistemic rigour essential for intellectual growth.

5. Strategies to Mitigate AI's Impact on Critical Thinking in Education

Indeed, there are numerous advantages that AI offers when thoughtfully incorporated into pedagogical contexts. AI-powered adaptive learning systems can personalize instruction by adjusting pace and content to individual learners' needs, which can support differentiated learning and potentially enhance epistemic curiosity (Luckin et al. 2016; Holmes et al. 2019). Similarly, democratising education by bridging geographical and socioeconomic barriers can also be promoted, as AI provides instant access to diverse resources (Zawacki-Richter et al. 2019). Such access can nurture epistemic autonomy by equipping students with a broader set of materials for independent inquiry. Furthermore, AI-based tools can nurture resilience in problem-solving if those tools are designed to promote exploration and iterative learning rather than providing immediate answers. For instance, AI simulations and gamified environments can foster trial-and-error experimentation in low-stakes settings, which supports both intellectual curiosity and perseverance (Kapur 2008; Biesta 2020). In addition, AI-driven analytics can help educators identify students' misconceptions early, allowing for targeted interventions that encourage reflective thinking and deeper engagement.

Having said this, my central argument is that the above-mentioned benefits are contingent upon deliberate pedagogical design. In other words, without careful regulation of AI's role in pedagogical design, its efficiency may inadvertently promote epistemic dependence, superficial engagement, and diminished cognitive struggle. While acknowledging AI's potential to democratize access, personalise instruction, and enhance engagement, this paper stresses that these advantages must be balanced with safeguards that preserve the epistemic virtues of curiosity, autonomy, and critical reasoning. Hence, deliberate interventions are required to address the epistemological issues raised by the use of AI tools in education so that students retain their epistemic autonomy and do not passively accept knowledge produced by machines.

A strategy that can be adopted in this context is to promote a symbiotic link between human cognition and AI tools, which will enable the students to critically evaluate AI-generated content, considering the fallibility of the tools' epistemic authority. In the spirit of Kantian enlightenment, which emphasizes autonomy and self-directed reason (Kant 1784), learners must cultivate the habit of critical engagement by questioning, refining, and analysing AI answers and solutions rather than deferring to them unquestioningly. This interactive engagement aligns with the Socratic method of elenchus, wherein knowledge is refined through dialectical questioning rather than passive reception (Brown 2014). Educators should cultivate intellectual virtues such as scepticism, open-mindedness, and the ability to discern the limitations of algorithmic knowledge generation by encouraging students to treat AI as an epistemic collaborator rather than an omniscient oracle.

Another approach that can be taken to mitigate AI's impact on critical thinking in the context of education is to design AI tools which should promote dialectical reasoning rather than unreflective knowledge acquisition. If AI systems are programmed to present counterarguments, probe inconsistencies, and challenge students to justify their reasoning, they can function as facilitators of critical inquiry. This approach resonates with Deweyan pragmatism, which posits that knowledge is an active construction derived from inquiry, reflection, and experiential learning (Dewey 1916). Similarly to this, Hegel (1977) emphasizes the conflict between thesis and antithesis in his proposal of the dialectical process, which ultimately results in the creation of a more profound synthesis or knowledge. By including epistemic friction such as cognitive dissonance and opposing viewpoints, AI systems make sure that users are actively involved in the intellectual fight rather than just passively consuming information. An advantage of this strategy is that, while AI tools are used for education, they may foster epistemic curiosity by encouraging students to participate in the iterative process of knowledge refinement rather than relying on pre-packaged conclusions.

Integrating AI within pedagogical frameworks that prioritise inquiry-based learning over passive knowledge consumption is also equally crucial in mitigating AI's impact on critical thinking in education. Constructivist epistemologies, such as Piaget (1970), emphasise that learners construct understanding through active manipulation of ideas. So, AI should be embedded within pedagogical approaches such as problem-based learning (PBL) and project-based learning (PjBL), where students can engage in sustained intellectual inquiry. Instead of using AI as an epistemic crutch, educators should use AI technologies to help students access resources and hone their theories while maintaining human agency at the centre of the epistemic process. This equilibrium keeps AI from undermining the cognitive struggle required to cultivate strong critical thinking abilities.

Finally, epistemic resilience can be cultivated by designing AI to foreground the process of knowing and not merely by providing definitive and instant answers and solutions. AI systems should be structured to scaffold intellectual inquiry, prompting learners to consider the provisional nature of knowledge and the complexities of epistemic justification. This echoes Popper's philosophy of falsification, where knowledge progresses not by amassing certainties, but by critically evaluating and refining provisional claims (Popper 2014). Through the use of open-ended questions, hypothesis testing, and exposure to epistemic uncertainty, AI-driven learning environments can include techniques that mimic the exploratory nature of scientific investigation. The idea that knowledge is not a static reservoir, but rather a dynamic construct created by understanding and critical thinking, is reinforced by such an approach, which guarantees that AI acts as a catalyst for intellectual humility and epistemic curiosity. Similarly, drawing on Sosa's virtue epistemology, which emphasizes the role of intellectual virtues in achieving epistemic success, AI tools can be designed to expose learners to diverse perspectives and conflicting information, prompting them to critically evaluate

sources and construct well-reasoned arguments (Sosa 2007). By emphasising the process of knowing rather than the final output, AI can assist students in acquiring the epistemic autonomy and analytical abilities required for lifelong learning. This strategy reduces the dangers of epistemic dependence and supports the larger educational objective of developing morally upright students who can successfully negotiate the challenges of a future driven by artificial intelligence. By using these techniques, artificial intelligence (AI) can be used to enhance rather than detract from the growth of epistemic qualities in education, such as critical thinking, epistemic curiosity, and epistemic autonomy.

6. Conclusion

The integration of AI tools in education presents a profound epistemological paradox. While these technologies enhance access to information, streamline learning processes, and provide personalised educational experiences, they also risk fostering epistemic dependence, superficial engagement, and diminished cognitive effort. Though convenient, the immediacy of AI-generated knowledge often discourages deep inquiry, critical reflection, and intellectual struggle, which are fundamental to the cultivation of epistemic virtues such as autonomy, curiosity, and critical thinking. As AI assumes a more prominent role in shaping learning environments, there is a growing concern that students may become passive recipients of algorithmically curated information, instead of being active participants in the construction of knowledge. This concern challenges foundational epistemological perspectives that emphasise the necessity of intellectual perseverance, critical engagement, and the cultivation of independent thought. Hence, it is the need of the hour that educators and theorists reconsider how to calibrate the balance between technological facilitation and the development of essential cognitive and epistemic capacities.

To mitigate these epistemological risks, educational frameworks must evolve to ensure that AI serves as a catalyst for deeper intellectual engagement, not as a substitute for human reasoning. Instead of positioning AI as an authoritative source of knowledge, it should be structured as a tool for encouraging critical inquiry, prompting students to challenge, refine, and expand their understanding through active interaction. The integration of AI-driven Socratic questioning, counterfactual reasoning, and epistemic scaffolding can help counteract the risks of epistemic passivity, which will also ensure that learners remain engaged in processes of reasoning and reflection. Furthermore, balancing AI implementation with inquiry-based pedagogical models will safeguard that learning remains an active pursuit, where students grapple with complexity, evaluate conflicting perspectives, and develop resilience in the face of uncertainty. AI tools should be integrated in the education within such frameworks that demand cognitive effort and epistemic responsibility, so that education can harness the potential of these technologies without compromising critical thinking, epistemic curiosity, and epistemic autonomy. This approach ensures

that education remains as a space for active inquiry, intellectual growth, and the cultivation of epistemic virtues that underpin authentic knowledge acquisition. The difficulty lies in the intentional design and application of AI, where it should be used to enhance comprehension, build resilience, and enable students to negotiate the intricacies of information with independence and intellectual integrity rather than as an end in itself.[1]

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