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Commentary

Beyond Technology Acceptance: Rethinking the Role of Epistemic Curiosity in Digital Literacy

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Abstract

This commentary reconsiders the relationship between epistemic curiosity and digital literacy by examining how curiosity, technology perceptions, and digital engagement may contribute to capability development. It argues that favorable perceptions of usefulness and ease of use should be distinguished from demonstrated digital capability because perceived competence does not necessarily indicate what learners can perform in authentic tasks. The commentary therefore proposes purposeful digital engagement as a conceptual bridge connecting epistemic curiosity and technology perceptions with opportunities to develop digital knowledge, skills, and judgment. Purposeful engagement includes deliberate practice, source verification, iterative problem solving, feedback seeking, digital content creation, and transfer across tasks. The commentary also distinguishes interest-type and deprivation-type epistemic curiosity, suggesting that they may support different patterns of engagement depending on task demands, self-regulatory resources, feedback, and instructional scaffolding. Cultural and linguistic conditions are also considered, particularly in international learning contexts. The proposed progression is conceptual rather than causal and requires further longitudinal, experimental, cross-cultural, behavioral, and performance-based investigation. This framing emphasizes educational processes beyond technology acceptance and adoption.

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INTRODUCTION

Digital technologies have become integral to higher education, shaping how students access information, communicate, collaborate, create content, and solve learning-related problems. As these practices become embedded in academic life, digital literacy can no longer be understood merely as the technical ability to operate devices or software. It encompasses a broader combination of knowledge, skills, and dispositions required to locate and evaluate information, communicate and create content, protect personal data, solve problems, and engage with digital technologies critically and responsibly (Ng, 2012; Reddy et al., 2023; Smith et al., 2022; Vuorikari et al., 2022). These demands may be particularly salient for international students, who often navigate digital learning environments while simultaneously adapting to new academic conventions, languages, communication practices, and sociocultural contexts.

Within this setting, epistemic curiosity provides a useful motivational lens for understanding why learners seek information, explore unfamiliar ideas, and persist when they encounter gaps in their knowledge. Epistemic curiosity has been associated with information seeking, self-regulation, and engagement in technology-supported learning environments (Lauriola et al., 2015; Lee et al., 2022; Nakamura et al., 2022). Ma et al. (2025) extend this line of inquiry by examining epistemic curiosity in relation to the digital literacy of international students studying in China. Drawing on the Technology Acceptance Model (TAM), they tested whether perceived usefulness and perceived ease of use statistically mediated the relationships between two forms of epistemic curiosity and self-reported digital literacy. Their findings indicated positive associations between both forms of curiosity and digital literacy, with perceived usefulness and perceived ease of use accounting for part of these statistical relationships.

These findings are theoretically informative because they connect learners' cognitive motivation with their perceptions of digital technologies. They should not, however, be interpreted as suggesting that TAM itself was designed to explain the development of digital competence. TAM primarily addresses beliefs about technology and the conditions associated with acceptance and use (Davis et al., 1989; Venkatesh et al., 2003). The more specific question raised by Ma et al.'s findings is therefore what may occur beyond favorable technology perceptions. If curious learners perceive digital technologies as useful and manageable, through what activities might these perceptions contribute to the development of more substantive digital abilities?

Addressing this question requires clearer construct boundaries. In this commentary, digital literacy is used as the broader multidimensional construct encompassing the knowledge, skills, and attitudes required for effective, critical, safe, and responsible participation in digital environments. Perceived digital competence refers to learners' judgments of their own digital abilities, including those captured through self-report instruments. Digital capability, by contrast, is used more specifically to denote the demonstrable enactment of digital knowledge, skills, and judgment in authentic or performance-based tasks. These constructs are related but should not be treated as interchangeable. Self-perceptions of competence can be educationally meaningful because they may influence confidence, persistence, and willingness to participate, yet they do not necessarily provide direct evidence of what learners can perform in practice (Porat et al., 2018).

This distinction creates space for a further conceptual extension of the findings reported by Ma et al. (2025). We propose that purposeful digital engagement may constitute an important mechanism linking motivation and favorable technology perceptions with opportunities for capability development. Here, digital engagement refers not simply to access, frequency of use, or exposure to technology, but to active behavioral and cognitive participation in digitally mediated learning activities. Such participation may include deliberate practice, evaluating and verifying information, experimenting with unfamiliar tools, creating and revising digital content, seeking feedback, solving problems iteratively, and transferring strategies across tasks. Through these activities, learners gain opportunities to translate curiosity and willingness to use technology into observable digital performance.

Accordingly, this commentary distinguishes three levels of argument. First, Ma et al. (2025) empirically demonstrated statistical relationships among epistemic curiosity, perceived usefulness, perceived ease of use, and self-reported digital literacy. Second, we infer that these findings point to an explanatory space between technology perceptions and the development of digital capability. Third, we propose that purposeful digital engagement may occupy this space by providing the activities through which learners practice, evaluate, refine, and transfer digital knowledge and skills. This proposed sequence should not be interpreted as an empirically validated causal or temporal model. Rather, it represents a conceptual proposition that requires testing through longitudinal, experimental, behavioral, and performance-based research.

The distinction between interest-type and deprivation-type epistemic curiosity further complicates this proposed process. Although both forms were positively associated with digital literacy in Ma et al. (2025), they may motivate qualitatively different patterns of digital engagement. Interest-type curiosity may encourage exploratory and intrinsically rewarding interaction with new information, whereas deprivation-type curiosity may generate more focused and persistent attempts to resolve uncertainty. The educational consequences of these tendencies are likely to depend on regulatory resources, task difficulty, feedback, and instructional scaffolding rather than on either form of curiosity being inherently more beneficial.

The international-student context also suggests that these relationships may operate within important cultural and linguistic boundary conditions. Language proficiency, prior digital experience, disciplinary norms, academic expectations, help-seeking practices, and familiarity with local learning environments may shape how curiosity is expressed and how learners engage with digital technologies. These considerations are especially relevant when moving from a model of technology acceptance toward an educational account of digital capability development.

This commentary therefore does not seek to correct TAM or to replace the model proposed by Ma et al. (2025). Instead, it extends the discussion beyond technology acceptance by asking how epistemic curiosity and favorable technology perceptions might be translated into purposeful learning activity and, potentially, demonstrable digital capability. The sections that follow clarify these construct boundaries, elaborate digital engagement as a proposed developmental bridge, examine how different forms of curiosity may produce different learning experiences, and consider implications for assessment, research design, instructional support, and culturally responsive digital learning.

EPISTEMIC CURIOSITY AS A MOTIVATIONAL FOUNDATION FOR DIGITAL LEARNING

Epistemic curiosity refers to the motivation to seek, acquire, and understand knowledge, particularly when learners encounter unfamiliar information or recognize gaps in what they know (Litman, 2005; Lauriola et al., 2015). In digital learning environments, this motivation is especially relevant because meaningful participation frequently requires learners to move beyond readily available information. They may need to search for additional sources, compare competing explanations, investigate unfamiliar concepts, experiment with digital tools, and persist when information is incomplete or difficult to interpret. Epistemic curiosity can therefore be understood as a motivational condition that directs learners toward the kinds of exploratory activities through which digital learning may occur.

This role is supported by research showing that epistemic curiosity is associated with information seeking, self-regulation, and engagement in technology-supported learning. Lauriola et al. (2015) demonstrated that epistemic curiosity is related to different patterns of self-regulation and knowledge seeking, indicating that the desire to know can shape how individuals approach unresolved intellectual problems. In immersive virtual reality learning, Lee et al. (2022) found that epistemic curiosity was associated with students' emotional engagement, although its educational effects depended partly on the learning conditions provided. Cheng (2023) similarly showed that learning experiences designed to evoke epistemic curiosity can influence engagement and attitudinal learning in immersive environments. These findings suggest that curiosity becomes educationally consequential not simply because learners experience a desire to know, but because that desire can orient attention and action toward further exploration.

Importantly, epistemic curiosity should not be treated solely as a stable individual characteristic. Nakamura et al. (2022) showed that classroom experiences and instructional conditions can function as antecedents of epistemic curiosity, suggesting that curiosity may emerge through interactions between learners and their learning environments. This is particularly important for digital education because instructional design can influence whether uncertainty stimulates productive inquiry or simply produces disengagement. Tasks that introduce meaningful information gaps, unfamiliar problems, competing sources, or opportunities for exploration may stimulate curiosity, but the resulting learning experience will also depend on whether learners have sufficient guidance, feedback, and resources to act on that curiosity productively.

The findings reported by Ma et al. (2025) extend this perspective to digital literacy among international students in China. Their study showed that both interest-type and deprivation-type epistemic curiosity were positively associated with self-reported digital literacy and with perceptions of the usefulness and ease of use of digital technologies. These results provide evidence that epistemic curiosity is meaningfully related to how learners perceive and report their engagement with digital environments. However, because the study was cross-sectional, these statistical associations should not be interpreted as evidence that curiosity temporally produces digital competence. Rather, they indicate theoretically relevant relationships that invite further examination of the processes connecting curiosity with digital learning outcomes.

From this perspective, the educational significance of epistemic curiosity lies in its potential to initiate purposeful activity. A curious learner may formulate questions, seek additional information, test alternative explanations, explore unfamiliar digital resources, or persist in resolving uncertainty. Yet curiosity alone does not ensure that these activities will be effective, critical, or sustained. The same motivational state may lead to productive exploration in one context but fragmented searching, frustration, or premature disengagement in another. Its consequences are therefore likely to depend on task characteristics, prior knowledge, self-regulatory resources, feedback, and instructional support.

This distinction is central to the argument developed in this commentary. Epistemic curiosity is best understood as a motivational starting condition rather than as digital capability itself. It can prompt learners to approach information, tools, and problems, but the development of digital capability requires opportunities to transform that motivation into purposeful and sustained learning activity. The critical question is therefore not only whether curious learners report higher levels of digital literacy, but also what they subsequently do when curiosity is activated. This question directs attention toward purposeful digital engagement as the proposed mechanism through which curiosity and favorable technology perceptions may create opportunities for capability development.

FROM TECHNOLOGY PERCEPTIONS TO DIGITAL CAPABILITY

The Technology Acceptance Model provides a well-established explanation of why individuals may be willing to adopt and use particular technologies. Its core constructs, perceived usefulness and perceived ease of use, capture beliefs about whether a technology can enhance performance and whether it can be used with relatively little effort (Davis et al., 1989). Subsequent extensions have demonstrated the continuing relevance of these perceptions across different technology-use contexts (Venkatesh et al., 2003; Granić & Marangunić, 2019). Within this explanatory boundary, Ma et al. (2025) make a useful contribution by positioning epistemic curiosity as a cognitive antecedent and examining its statistical relationships with technology perceptions and self-reported digital literacy.

The issue raised here is therefore not a limitation of TAM itself. TAM was not designed as a theory of competence development. Rather, the findings of Ma et al. (2025) create an opportunity to ask an educational question that extends beyond technology acceptance: what happens after learners regard digital technologies as useful and manageable? Favorable technology perceptions may reduce barriers to participation and encourage learners to interact with digital resources, but they do not specify the learning activities through which digital knowledge, skills, and judgment are practiced and developed.

This distinction becomes important because the digital literacy measure used by Ma et al. (2025) captures respondents' self-reported abilities across domains including information and data literacy, digital communication and collaboration, content creation, security, and problem solving. Such judgments provide meaningful information about how learners perceive their own digital competence. Perceived competence should not be dismissed as measurement error because beliefs about one's capabilities may influence confidence, persistence, willingness to attempt challenging tasks, and continued participation in digital environments. Nevertheless, perceived competence and demonstrated capability address different aspects of digital learning. The former concerns what learners believe they can do, whereas the latter concerns what they can actually demonstrate when performing authentic digital tasks.

Evidence from performance-based research supports maintaining this distinction. Porat et al. (2018), for example, identified discrepancies between students' perceived digital competencies and their actual performance on digital tasks. Their population and educational context differed from those examined by Ma et al. (2025), so these findings should not be transferred directly to international students in China. They nevertheless demonstrate why self-reported digital literacy should not automatically be interpreted as demonstrated digital capability.

For this commentary, digital capability therefore refers specifically to the observable enactment of digital knowledge, skills, and judgment in context. It includes the ability to evaluate information, create and revise digital content, protect data, resolve technological problems, make responsible decisions, and transfer digital strategies to unfamiliar tasks. This usage does not replace the broader concept of digital literacy. Instead, it identifies its performance-oriented dimension, which becomes particularly important when the educational concern shifts from technology perceptions and perceived competence toward what learners can demonstrably accomplish with digital technologies.

This distinction leaves an important explanatory space between favorable technology perceptions and demonstrated capability. We propose that purposeful digital engagement provides one plausible bridge across this space.

PURPOSEFUL DIGITAL ENGAGEMENT AS THE PROPOSED BRIDGE

Digital engagement is often described broadly as participation in technology-supported environments. Such a definition, however, is insufficient for explaining how digital capability may develop. Access to digital technology, frequency of use, or time spent online does not necessarily indicate that learners are participating in activities that strengthen transferable digital knowledge and skills. In this commentary, purposeful digital engagement refers to task-grounded behavioral, cognitive, and affective participation in digitally mediated learning activities through which learners actively work with information, technological tools, problems, feedback, and other people.

The behavioral dimension concerns observable participation, such as searching for information, using unfamiliar applications, producing digital artifacts, seeking assistance, and persisting with difficult tasks. The cognitive dimension concerns the intellectual processes accompanying that participation, including comparing information, evaluating source credibility, selecting strategies, diagnosing errors, monitoring understanding, and revising solutions. The affective dimension concerns motivational and emotional experiences that may sustain or disrupt engagement, including interest, enjoyment, uncertainty, frustration, and persistence. Although analytically distinguishable, these dimensions are likely to interact during authentic digital learning.

Several specific activities illustrate how purposeful engagement may create opportunities for capability development. Deliberate practice allows learners to repeat and refine digital procedures rather than merely encounter them. Source verification requires learners to compare information, evaluate credibility, and justify why particular sources should be trusted. Iterative problem solving involves testing solutions, identifying errors, modifying strategies, and trying alternative approaches. Feedback seeking and response allow learners to identify weaknesses in their performance and revise their work. Digital content creation requires the integration of technical operations with communication, judgment, creativity, and responsible information use. Finally, transfer across tasks requires learners to adapt previously acquired knowledge and strategies when confronting unfamiliar digital problems. These activities align closely with contemporary descriptions of digital competence as involving knowledge, skills, judgment, and responsible participation (Vuorikari et al., 2022).

Research on educational technology and student engagement provides a basis for this proposition while also illustrating why engagement should not be assumed to occur automatically. Bond et al. (2020) showed that educational technologies can be associated with multiple dimensions of student engagement, but these relationships depend substantially on how technology is embedded within learning activities. Tu and Lee (2025) likewise situated epistemic curiosity, interest, and engagement within an interconnected learning process, suggesting that curiosity becomes educationally meaningful when learners act upon it. Technology can therefore provide opportunities for participation, but the educational quality of that participation depends on what learners are required and supported to do.

Building on these observations, this commentary proposes a conceptual progression in which epistemic curiosity provides an initial motivational condition, favorable technology perceptions facilitate participation, purposeful digital engagement provides opportunities for active learning, and digital capability represents a potential performance-oriented outcome.

This progression should not be interpreted as an empirically validated causal or temporal model. Ma et al. (2025) provide statistical evidence for relationships among epistemic curiosity, perceived usefulness, perceived ease of use, and self-reported digital literacy. Their study did not directly measure purposeful digital engagement as defined here, nor did it assess digital capability through performance-based tasks. The relationships involving purposeful engagement and demonstrated capability therefore remain conceptual propositions requiring empirical testing.

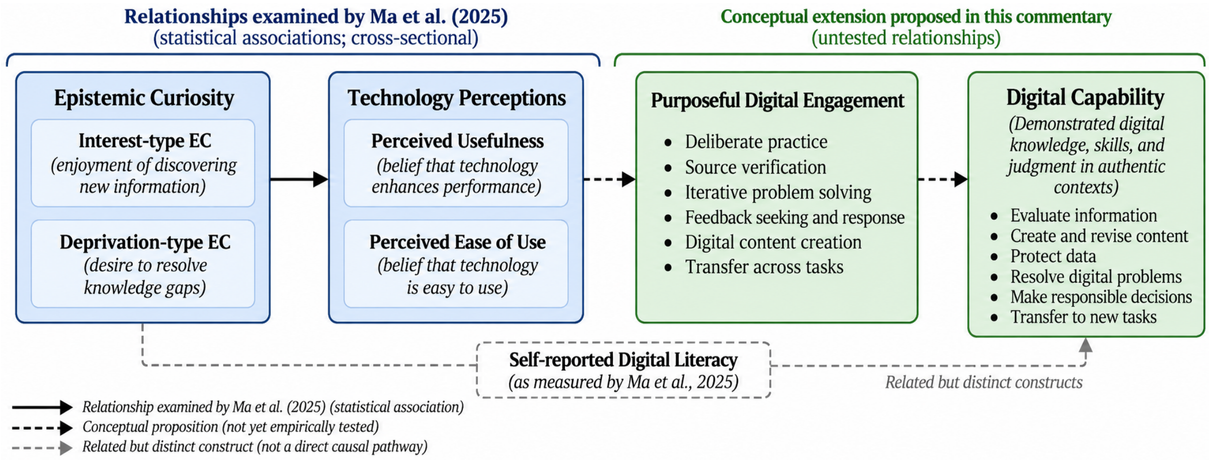

Figure 1. Proposed conceptual model of epistemic curiosity, technology perceptions, purposeful digital engagement, and digital capability

The proposed bridge also clarifies why favorable technology perceptions may be educationally important without being sufficient for capability development. Perceived usefulness may encourage learners to invest attention and effort because a digital resource appears relevant to their goals. Perceived ease of use may lower perceived barriers to initial or continued participation. Capability, however, is more likely to develop when these perceptions are followed by sustained activities requiring learners to evaluate, create, verify, solve, revise, and transfer. The emphasis therefore shifts from technology exposure or acceptance toward the quality of learners' interaction with digital information and tools.

This proposition generates several empirically testable questions. Future studies could examine whether perceived usefulness and perceived ease of use predict the quality of purposeful digital engagement, whether particular engagement activities predict subsequent performance, and whether engagement accounts for longitudinal changes in digital capability. The proposed progression should consequently be treated as a research agenda rather than as evidence that a developmental mechanism has already been established.

DIFFERENT FORMS OF CURIOSITY MAY GENERATE DIFFERENT ENGAGEMENT PATHWAYS

A further implication concerns the distinction between interest-type epistemic curiosity (I-type EC) and deprivation-type epistemic curiosity (D-type EC). Treating epistemic curiosity as a single and uniformly beneficial learner characteristic may conceal important differences in why learners seek information and how they respond to digital challenges. I-type curiosity is generally associated with the enjoyment of discovering unfamiliar information and expanding existing knowledge, whereas D-type curiosity arises more strongly from the desire to resolve a perceived knowledge gap (Litman, 2005; Lauriola et al., 2015).

The findings reported by Ma et al. (2025) support maintaining this distinction. Both forms were positively associated with self-reported digital literacy, although the magnitude of their relationships differed. The reported direct association with digital literacy was stronger for I-type EC ($\beta = .472$) than for D-type EC ($\beta = .393$). A similar descriptive pattern appeared in the indirect relationships through perceived usefulness, with coefficients of .254 for I-type EC and .213 for D-type EC, and through perceived ease of use, with coefficients of .139 and .101, respectively. These differences should be interpreted cautiously. They describe relative statistical associations within the study sample and do not demonstrate that I-type curiosity is inherently superior or that the two forms necessarily operate through different causal pathways.

A more useful interpretation is that the two forms of curiosity may encourage different qualities of engagement. I-type curiosity may be particularly compatible with exploratory behavior because encountering new knowledge is experienced as intrinsically rewarding. Learners may voluntarily investigate unfamiliar applications, search beyond required materials, experiment with alternative approaches, or create digital products because the process of discovery itself is interesting. Such activity may support breadth of exploration, experimentation, and autonomous learning.

D-type curiosity may produce a different but potentially equally valuable pattern. When learners recognize a knowledge gap or confront a problem that remains unresolved, the desire for resolution may focus attention and sustain effort. In digital learning, this could involve repeatedly testing a technological solution, searching for more precise information, debugging errors, comparing conflicting evidence, or continuing an investigation until an inconsistency is resolved. Such behaviors may support depth, persistence, and systematic problem solving.

The productive consequences of D-type curiosity, however, may be particularly sensitive to regulatory and instructional conditions. Unresolved uncertainty can stimulate sustained problem solving, but it may also lead to frustration when task difficulty exceeds available knowledge, strategies, or support. Research on epistemic curiosity and self-regulation suggests that different forms of curiosity may be accompanied by different patterns of information seeking and regulatory behavior (Lauriola et al., 2015). Self-regulatory resources, prior knowledge, feedback, task difficulty, and instructional scaffolding may therefore influence whether uncertainty results in productive persistence or ineffective effort.

The educational implication is not that one type of curiosity should be maximized while the other is minimized. Instead, instructional design should consider how different curiosity states can be translated into productive activity. Learners experiencing interest-type curiosity may benefit from autonomy, opportunities for open exploration, optional resources, and space to pursue emerging questions. Learners confronting unresolved knowledge gaps may benefit more from structured hints, staged problems, accessible feedback, and support for monitoring and revising strategies. In both cases, curiosity becomes educationally consequential when it is translated into purposeful engagement rather than remaining solely a motivational state.

IMPLICATIONS FOR RESEARCH AND EDUCATIONAL PRACTICE

The proposed conceptual extension has several implications for research. The first concerns measurement. Studies examining digital literacy development should distinguish between perceived digital competence and demonstrated digital capability rather than treating either as a complete substitute for the other. Self-report measures remain valuable because they capture how learners evaluate their own abilities, confidence, and experiences. Performance-based assessments answer a complementary question by examining whether those abilities can be enacted in authentic situations. Future studies could therefore combine questionnaires with tasks requiring source verification, digital content creation, privacy or security decisions, technological problem solving, and transfer of strategies to unfamiliar contexts. Behavioral traces and learning analytics may provide additional evidence regarding how learners search, revise, persist, seek feedback, and respond to difficulties.

A second implication concerns temporal evidence. Cross-sectional structural models can identify meaningful statistical relationships, but statistical mediation does not establish the chronological sequence required for a developmental mechanism. Longitudinal studies could test whether changes in epistemic curiosity and technology perceptions precede changes in purposeful digital engagement and whether sustained engagement predicts subsequent improvements in performance. Experimental studies could manipulate curiosity-evoking task features, instructional scaffolding, feedback, or opportunities for deliberate practice and assess their effects on both engagement and digital capability. Such approaches would provide stronger evidence for evaluating the developmental propositions advanced in this commentary.

A third priority is to identify the conditions under which engagement becomes productive. Prior digital experience, self-efficacy, technological anxiety, task difficulty, feedback quality, and self-regulatory resources may influence whether curiosity results in sustained and effective digital activity. The proposed pathway is therefore unlikely to operate identically across learners, tasks, or educational settings. Future research should examine moderators as well as mediating processes and should avoid assuming that higher curiosity, easier technology, or greater frequency of technology use will necessarily produce stronger digital capability.

The international-student context examined by Ma et al. (2025) makes these boundary conditions particularly important. Participants differed in educational level, disciplinary background, duration of residence in China, and length of Chinese-language study. Such diversity increases the relevance of the study to international education but does not demonstrate that relationships among curiosity, technology perceptions, engagement, and digital literacy operate equivalently across cultural or linguistic groups. Cross-cultural participation should therefore not be treated as evidence of cross-cultural generalizability.

For international students, digital learning occurs alongside adaptation to new linguistic, academic, and sociocultural environments. Language proficiency may affect learners' ability to formulate effective search queries, evaluate nuanced information, interpret digital instructions, participate in online discussions, or seek assistance. Academic conventions may shape expectations regarding acceptable sources, authorship, collaboration, citation, and communication with instructors. Prior exposure to specific technologies may influence both perceived ease of use and the strategies available when technical difficulties arise. Help-seeking practices and willingness to express uncertainty may likewise differ across educational and cultural environments. These factors constitute plausible boundary conditions for the proposed pathway rather than characteristics that can be assumed to operate uniformly.

Future cross-cultural research should therefore examine whether measurement structures and relationships among epistemic curiosity, technology perceptions, purposeful engagement, and digital capability are comparable across cultural settings, language groups, educational levels, and disciplines. Measurement invariance testing would be particularly valuable before interpreting observed differences between groups as substantive rather than measurement-related.

For educational practice, the central implication is that strengthening digital learning requires more than making technologies attractive, useful, or easy to operate. These characteristics are important because they can facilitate participation, but instructional environments must also provide meaningful opportunities through which learners practice digital judgment and problem solving. Educators can design tasks requiring students to compare competing digital sources, verify claims, generate and revise digital products, solve authentic technological problems, justify their decisions, seek and use feedback, and apply learned strategies in unfamiliar situations.

Instructional support should also respond to the form of uncertainty learners experience. Open-ended exploration may provide productive opportunities for interest-type curiosity, whereas difficult unresolved problems may require scaffolding that prevents persistence from becoming frustration without progress. In multilingual and international learning environments, such scaffolding may additionally involve accessible language, explicit explanation of academic digital practices, multiple pathways for help seeking, and sensitivity to differences in previous technological experience.

Culturally responsive digital education, from this perspective, does not require assigning fixed characteristics to learners based on cultural background. Rather, it requires recognizing that students enter digital environments with different linguistic resources, educational histories, technological experiences, and expectations about participation. Providing multiple opportunities for exploration, feedback, collaboration, and problem resolution may allow curiosity to be expressed and supported without assuming that all learners engage with digital technologies in the same way.

CONCLUSION

This commentary advances the argument that understanding digital development requires attention to what occurs after learners become curious and develop favorable perceptions of technology. Technology acceptance can facilitate participation, but it does not by itself explain how learners develop the knowledge, skills, and judgment needed to perform effectively in digital environments.

Purposeful digital engagement is proposed as a plausible bridge between motivational and perceptual conditions and the development of digital capability. Deliberate practice, source verification, iterative problem solving, feedback seeking, content creation, and transfer across tasks provide concrete examples of the activities through which learners may transform motivation and willingness to use technology into demonstrable digital performance.

The distinction between interest-type and deprivation-type epistemic curiosity further suggests that curiosity may support digital learning through different motivational experiences rather than through a single uniform process. Exploratory interest may encourage breadth and experimentation, whereas unresolved knowledge gaps may support focused persistence and problem solving. Neither form should be regarded as inherently superior because their educational consequences depend on task demands, self-regulatory resources, feedback, instructional support, and the broader learning context.

The proposed pathway remains a conceptual proposition rather than an established developmental mechanism. Its value lies in identifying processes that can be examined more directly through longitudinal, experimental, cross-cultural, behavioral, and performance-based research. Such work can clarify when curiosity and favorable technology perceptions translate into productive digital engagement and when that engagement contributes to demonstrable capability.

The central educational question is therefore not simply whether learners are curious, whether they accept technology, or whether they perceive themselves as digitally competent. More important is how these motivational and perceptual conditions are translated into sustained, critical, responsible, and demonstrable digital practice.

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The authors have sufficiently contributed to the study, and have read and agreed to the published version of the manuscript.

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