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BEYOND FRICTIONLESS INTELLIGENCE: STAYING HUMAN IN THE AGE OF AI THROUGH AGENCY, DEEP COGNITION, CREATIVITY, SOCIAL CONNECTION, AND EMBODIED LIFE—A QUALITATIVE LITERATURE REVIEW

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ABSTRAK

Kecerdasan buatan (AI) semakin beralih dari sekadar alat komputasi eksternal menjadi infrastruktur sehari-hari yang mendukung aspek kognitif, kreatif, relasional, dan pengambilan keputusan. Transisi ini menciptakan sebuah paradoks: teknologi yang mengurangi upaya, ketidakpastian, penundaan, dan hambatan dapat meningkatkan produktivitas serta aksesibilitas, namun hambatan-hambatan tersebut justru dapat berperan dalam pengembangan dan pelestarian kemampuan manusia. Tinjauan pustaka kualitatif ini menyintesiskan penelitian terkini yang diterbitkan antara tahun 2020 hingga 2026 di berbagai bidang, meliputi etika AI, psikologi, ilmu kognitif, pendidikan, interaksi manusia-komputer, penelitian konsumen, ilmu saraf, dan komunikasi. Tinjauan ini mengkaji enam ranah yang saling terkait: otonomi dan penilaian, kognisi dan ingatan, kreativitas dan kepenulisan, koneksi sosial, perwujudan fisik (embodiment) dan navigasi, serta perhatian dan pemutusan koneksi secara sengaja. Sintesis ini menghasilkan Kerangka Kerja Productive Friction–Human Capability Preservation (PF-HCP), yang membedakan antara pengalihan tugas (offloading) ke teknologi yang bermanfaat dengan substitusi yang berpotensi mengurangi latihan kemampuan yang bermakna. Bukti menunjukkan bahwa AI dapat meningkatkan kreativitas, pembelajaran, pengambilan keputusan, dan dukungan emosional, namun hasilnya bergantung pada desain tugas, keterlibatan manusia, literasi, serta adanya peluang untuk refleksi, verifikasi, eksplorasi, timbal balik, dan penilaian mandiri. Alih-alih menganjurkan penghentian penggunaan teknologi, tinjauan ini mengusulkan pendelegasian selektif: mengotomatisasi beban kerja yang tidak perlu sembari mempertahankan partisipasi manusia dalam aktivitas di mana upaya yang dilakukan berkontribusi pada agensi, keahlian, hubungan, kreativitas, dan pengembangan diri yang optimal (flourishing). Implikasi dari temuan ini dibahas bagi individu, dunia pendidikan, organisasi, desain AI, layanan, dan kebijakan publik.
Kata Kunci: *kecerdasan buatan; kesejahteraan manusia; otonomi manusia; pelimpahan beban kognitif; berpikir kritis; kolaborasi manusia-AI; kreativitas; koneksi sosial; kesejahteraan digital; kognisi terwujud*

ABSTRACT

Artificial intelligence is increasingly shifting from an external computational tool to an everyday cognitive, creative, relational, and decision-making infrastructure. This transition creates a paradox: technologies that reduce effort, uncertainty, delay, and friction can enhance productivity and accessibility, while the same friction may contribute to the development and preservation of human capabilities. This qualitative literature review synthesizes contemporary research published during 2020–2026 across artificial intelligence ethics, psychology, cognitive science, education, human–computer interaction, consumer research, neuroscience, and communication. It examines six interconnected domains: autonomy and judgment, cognition and memory, creativity and authorship, social connection, embodiment and navigation, and attention and intentional disconnection. The synthesis develops the Productive Friction–Human Capability Preservation (PF-HCP) Framework, distinguishing beneficial technological offloading from substitution that may reduce meaningful capability exercise. Evidence suggests that AI can augment creativity, learning, decision making, and emotional support, but outcomes depend on task design, human involvement, literacy, and opportunities for reflection, verification, exploration, reciprocity, and independent judgment. Rather than advocating technological withdrawal, the review proposes selective delegation: automate unnecessary burdens while preserving human participation where effort contributes to agency, expertise, relationships, creativity, and flourishing. Implications are discussed for individuals, education, organizations, AI design, services, and public policy.

Keywords: *artificial intelligence; human flourishing; human autonomy; cognitive offloading; critical thinking; human–AI collaboration; creativity; social connection; digital well-being; embodied cognition*

INTRODUCTION

Artificial intelligence has entered a qualitatively different stage of social adoption. Earlier digital technologies primarily helped people retrieve information, communicate faster, automate calculations, or navigate physical environments. Generative artificial intelligence now participates more directly in activities previously associated with human cognition and expression: explaining complex ideas, drafting documents, generating images, recommending decisions, evaluating alternatives, tutoring learners, producing creative concepts, and simulating emotionally responsive conversation. AI is therefore becoming less an occasional instrument and more an ambient layer through which everyday cognition, communication, production, and choice are mediated.

The transformation offers substantial benefits. AI can reduce information-processing costs, compensate for limitations in expertise, personalize learning, accelerate creative iteration, improve accessibility, and help individuals perform tasks that would otherwise demand significant time or specialized knowledge. Human–AI systems can also distribute cognitive work in ways that increase performance, especially when human judgment and machine capabilities are genuinely complementary (Hao et al., 2024; Holter & El-Assady, 2024). Experimental and field evidence further shows substantial productivity gains from generative AI in professional writing and customer-support work, although the magnitude of benefit varies by experience and task structure (Brynjolfsson et al., 2025; Noy & Zhang, 2023). AI should consequently not be understood merely as a threat to human capability. Under suitable conditions it can become an extension of human agency rather than a replacement for it (Noller, 2024).

Yet the emerging AI environment also creates a less visible problem. Human capabilities are not merely possessions that remain intact regardless of whether they are exercised. Many capabilities are partly

sustained through repeated practice. Memory develops through retrieval; judgment through decision making; spatial knowledge through navigation; creativity through producing and revising; relationships through reciprocal interaction; and critical thinking through interpreting evidence, questioning claims, and resolving uncertainty. If technological convenience systematically removes occasions to perform these processes, short-term efficiency may coexist with longer-term reductions in the frequency with which human capabilities are rehearsed.

This does not imply that technological offloading is intrinsically harmful. Humans have always extended cognition through language, writing, maps, calculators, institutions, and other people. Contemporary cognitive research similarly shows that offloading information to an external medium can reduce working-memory demands and improve performance on a focal task (Morrison & Richmond, 2020). The relevant question is therefore not whether people should offload cognition, but what should be offloaded, when, to what degree, and with what consequences for the capabilities that remain important to human flourishing.

A parallel issue arises with autonomy. AI systems can expand autonomy by giving people information, accessibility, personalized support, and previously unavailable capabilities. At the same time, opacity, predictive recommendation, automation, and apparently authoritative machine outputs may constrain meaningful self-direction. Autonomy is not adequately preserved merely because a user technically retains a final button to press. Meaningful autonomy depends on understanding, voluntariness, competence, opportunities to contest outputs, and genuine capacity to shape outcomes (Hofmann, 2026; Laitinen & Sahlgren, 2021; Prunkl, 2024; Vaassen, 2022).

The popular infographic that motivated this review—containing suggestions such as read something long, make something badly, call instead of text, eat with people, get lost without GPS, be bored for a while, remember a phone number, leave your phone at home, trust your taste, and take the long way—should therefore not be interpreted literally as scientific evidence. Its scholarly value is different. It provides a cultural heuristic for asking why seemingly inefficient activities might continue to matter when technology can eliminate their inconvenience. The question is not whether everyone should memorize telephone numbers or deliberately become geographically lost. It is whether memory retrieval, active navigation, sustained reading, imperfect creation, embodied co-presence, uncertainty, and unoptimized exploration contain forms of human capability rehearsal that deserve preservation.

Contemporary scholarship relevant to this question remains fragmented. Work on AI ethics examines autonomy, responsibility, opacity, agency, and paternalism (Prunkl, 2022, 2024; Vaassen, 2022; Vallor & Vierkant, 2024). Educational research examines cognitive offloading, metacognition, critical thinking, and generative-AI-supported learning (Essel et al., 2024; Iqbal et al., 2025; Li et al., 2026; Tian & Zhang, 2025; Vendrell & Johnston, 2026). Creativity scholarship investigates co-creation, authorship, originality, and homogenization (Doshi & Hauser, 2024; Medeiros et al., 2025; O'Toole & Horvát, 2024). Communication and psychology study phubbing, loneliness, digital well-being, solitude, and media richness. Neuroscience examines navigation and memory, while service scholarship investigates whether customers attribute distinct value to human interaction. These literatures rarely appear in a common theoretical architecture.

This article therefore asks a broader question: What does it mean to preserve valuable human capabilities when intelligent technologies can increasingly perform the underlying tasks for us? Framing the problem in capability terms allows the review to evaluate both the benefits of augmentation and the risks of excessive substitution without presuming that either human or machine performance is universally superior. Seven research questions guide the review. First, how does AI and digital mediation reshape autonomy, cognition, creativity, sociality, attention, and embodied interaction? Second, what benefits and risks arise when memory, reasoning, navigation, creation, and social interaction are delegated to technology? Third, which everyday practices preserve valuable human capabilities and through what mechanisms? Fourth, when does AI operate as augmentation, and when does it become substitution? Fifth, how can apparently unrelated practices such as long-form reading, human conversation, unassisted navigation, imperfect making, and intentional disconnection be understood within a common framework? Sixth, what implications follow for education, organizations, AI design, and policy? Seventh, what gaps remain in the rapidly evolving literature?

The principal theoretical contribution is the Productive Friction–Human Capability Preservation (PF-HCP) Framework. The framework proposes that technological friction should not automatically be minimized. Some friction is wasteful: repetitive administration, unnecessary search costs, inaccessible information, or routine calculations may appropriately be automated. Other friction is productive because the effort involved performs developmental, epistemic, relational, creative, or experiential work. The normative objective is therefore not maximum friction and not maximum automation, but selective delegation that preserves capability-generating processes while removing burdens that do not warrant continued human effort.

RESEARCH METHOD

This study employs a qualitative integrative literature review rather than a systematic literature review, with the purpose of achieving theoretical integration across heterogeneous disciplines rather than exhaustive identification of publications based on narrowly specified intervention–outcome criteria. Accordingly, the review does not claim PRISMA-style exhaustiveness, pooled effect estimation, or complete bibliometric coverage. The literature corpus focuses on peer-reviewed journal research published from 2020 to September 2026, prioritizing contemporary sources due to the rapid development of generative AI, conversational agents, algorithmic decision systems, and smartphone-mediated interaction. Literature was identified through concept-led searches across multidisciplinary scholarly search systems, publisher databases, journal repositories, PubMed-indexed literature, ScienceDirect, Springer Nature, Wiley, Oxford Academic, SAGE, Taylor & Francis, and other scholarly platforms. Searches combined AI-related terms, including artificial intelligence, generative AI, large language models, algorithmic decision making, AI companions, and human–AI collaboration, with capability-related terms such as human autonomy, agency, cognitive offloading, critical thinking, creativity, authorship, social connection, loneliness, phubbing, boredom, digital well-being, navigation, spatial memory, and human service. The purposive corpus comprised more than fifty contemporary journal articles selected for conceptual relevance and disciplinary diversity, including empirical experimental studies, meta-analyses, systematic reviews, qualitative studies,

and theoretically substantive peer-reviewed articles, while purely technical AI articles without clear human implications and non-peer-reviewed popular commentary were excluded. The literature was coded conceptually rather than statistically across six domains: (1) agency, autonomy, and judgment; (2) cognition, memory, and deep engagement; (3) creativity and authorship; (4) relationships and social presence; (5) embodiment and navigation; and (6) attention, boredom, and intentional disconnection. Inductive comparison produced three higher-order analytical concepts: offloading, capability rehearsal, and augmentation versus substitution. Contradictory findings were treated as analytically important, recognizing that digital media, AI systems, and AI companions may generate both benefits and risks depending on context. The resulting framework therefore emphasizes boundary conditions rather than deterministic technological effects.

RESULT AND DISCUSSION

3.1 Human agency is preserved by meaningful control, not nominal control

The literature consistently indicates that AI's relationship with autonomy is dual. Intelligent systems can increase agency by improving access to information, reducing cognitive barriers, translating expertise, and widening the set of actions available to individuals. Noller (2024) therefore conceptualizes AI as potentially extending human agency, while Holter and El-Assady (2024) emphasize collaboration through combinations of agency, interaction, and adaptation. Yet delegation becomes autonomy-reducing when users lose meaningful understanding or capacity to intervene. Vaassen's (2022) analysis of opacity demonstrates why reliable output alone is insufficient, while Fanni et al. (2023) show that redress is essential because meaningful agency requires more than initial consent; users need ways to challenge and alter AI-mediated outcomes. Mhlambi and Tiribelli (2023) further caution that autonomy cannot be understood solely as isolated rational choice because social structures shape whose options are genuinely available. The review therefore distinguishes between formal agency and exercised agency. Formal agency exists when humans retain legal or procedural authority to make the final choice, whereas exercised agency exists when individuals understand relevant alternatives, evaluate recommendations, meaningfully disagree, and retain sufficient competence to assume responsibility. This distinction is particularly important in organizations. If AI generates a recommendation and an employee routinely accepts it without independent capacity to evaluate it, an organization may claim "human oversight" while creating little substantive human judgment. Control and accountability can consequently become misaligned, as identified by Grote et al. (2026) and Vallor and Vierkant (2024). Figure 1 integrates these relationships by illustrating how digital affordances can lead either to complementary augmentation and capability rehearsal or to substitutive automation and reduced rehearsal, with selective productive friction moderating both pathways.

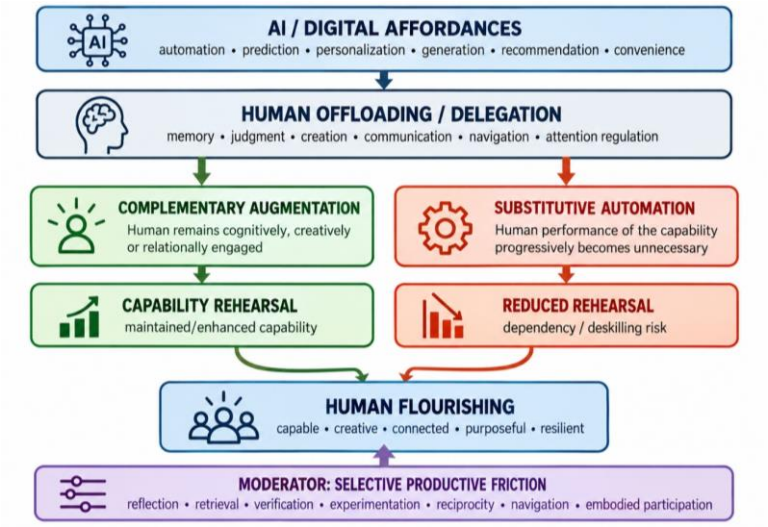

Figure 1. *Productive Friction–Human Capability Preservation (PF-HCP) Framework*

Figure 1 summarizes the central finding of the review. Technological offloading is not assigned an inherently positive or negative value. Its consequences depend on whether human engagement with the relevant capability continues. AI that handles routine translation while allowing a professional to exercise judgment may augment capability. AI that produces interpretations that the professional no longer understands well enough to verify may produce substitution. Productive friction acts as a moderator because strategically preserved effort—verification, recall, reasoning, experimentation, or reciprocal interaction—keeps humans actively participating in processes whose capabilities remain socially or personally important.

3.2 Deep cognition requires some protected opportunities for effort

The second theme concerns cognition. The evidence strongly rejects the assumption that all external assistance is harmful. Offloading can improve immediate task performance, and generative AI can support higher-order thinking when students are required to interact critically with outputs (Chauncey & McKenna, 2023; Essel et al., 2024; Iqbal et al., 2025; Morrison & Richmond, 2020). However, the studies also suggest that the sequence of cognition matters. Asking AI for a complete answer before attempting a problem independently creates a different cognitive environment from reasoning first and then using AI to challenge, compare, extend, or critique that reasoning. The first pattern can reduce generation and retrieval demands; the second uses AI as an epistemic partner.

Li et al. (2026) provide particularly useful evidence because their synthesis indicates that gains in critical and creative thinking tend to arise in scaffolded, inquiry-oriented contexts, while unstructured reliance is more vulnerable to cognitive offloading. Vendrell and Johnston (2026) therefore recommend preserving phases in which students must interpret, infer, evaluate, monitor their own reasoning, and articulate uncertainty before or alongside AI interaction. Tian and Zhang (2025) add that AI dependence may relate to lower critical thinking through cognitive fatigue, although observational relationships should not be overgeneralized as universal causality. The human-capability interpretation of remember a phone number follows from this literature. Memorizing telephone numbers is not intrinsically valuable enough to justify

abandoning digital address books. Its symbolic value lies in demonstrating that memory is a capability that can be externalized almost completely if convenience is the only criterion. A better practical principle is to retain internal retrieval in domains where memory itself supports expertise: foundational concepts, vocabulary, professional knowledge, relationships among ideas, safety-critical procedures, and personally meaningful information.

The evidence on reading requires similar nuance. Long-form reading matters because sustained text engagement can require the reader to maintain arguments, connect distant passages, tolerate delayed resolution, and construct an integrated representation. None of these processes is exclusive to paper. Furenes et al. (2021), Ben-Yehudah and Eshet-Alkalai (2021), and Schwabe et al. (2022) collectively show that medium effects depend on age, genre, task and affordances. "Read something long" should therefore be translated as protect sustained reading from interruption and fragmentation, not as an unsupported claim that every digital text is inferior. A practical implication is the creation of AI-free cognitive intervals. In education or knowledge work, a person can first formulate an interpretation, prediction, plan, or draft independently; subsequently consult AI; compare discrepancies; verify claims against external evidence; revise the original reasoning; and document what changed. Such sequencing preserves the efficiency advantages of AI without making the machine the first and final origin of thought.

3.3 Creativity benefits from AI, but creative capability depends on authorship and process

The creativity literature produces one of the strongest arguments against both technological pessimism and uncritical automation. Haase and Hanel (2023) show that generative AI can perform impressively on ideation tasks. Doshi and Hauser (2024) provide causal evidence that AI-generated ideas can increase evaluated creativity and writing quality. Tang et al. (2025) and Medeiros et al. (2025) further demonstrate that human–AI co-creation can produce meaningful benefits. The risk is not necessarily reduced individual output quality. It may be precisely the opposite: outputs become so easy to improve that users become less willing to engage in early-stage exploration, failure, and experimentation. Doshi and Hauser's finding that AI-supported stories were more similar to each other reveals how individual optimization can coexist with collective convergence.

Creative capability is more than producing an artifact judged creative by an external evaluator. It includes generating alternatives, recognizing promising directions, tolerating ambiguity, revising unsuccessful attempts, learning techniques, developing aesthetic standards, and becoming able to explain why one choice is preferred over another. O'Toole and Horvát (2024) therefore emphasize tools that support rather than displace authentic engagement in the creative process. The instruction make something badly is best interpreted as preserving low-stakes creation in which the human cannot outsource the formative stages of competence. A beginner who generates a perfect-looking AI image may possess an attractive artifact but may not have practiced composition, drawing, observation, or visual problem solving. A student who asks AI to produce polished prose may submit a fluent text without developing argumentation or voice. A cook who follows an optimized automated process can produce an acceptable meal without acquiring sensory judgment. None of these examples imply that AI assistance should be prohibited. They imply that the purpose of an activity determines the appropriate degree of

assistance. Formosa et al. (2025) reinforce this logic by showing that the perceived degree of human authorship falls as assistance becomes more extensive. Authorship is therefore partly about causal contribution and responsibility rather than possession of a final output.

3.4 Relational richness depends on reciprocity, not merely interaction frequency

The social literature suggests that communication technologies should be evaluated according to the quality and function of interaction, not simply the amount of device use. Kumar and Epley (2021) demonstrate that voice communication may produce more connection than people expect. Chan and Li (2020) show that smartphone-mediated communication can support well-being through social-support pathways. Sen et al. (2022) show that digital tools can reduce isolation in older adults. These studies make clear that technology can enable rather than erode human connection. Problems emerge when technological activity displaces attention from an interaction that is already occurring. Verduyn et al. (2021) identify circumstances in which smartphone communication displaces face-to-face interaction, while Beukeboom and Pollmann (2021) show that phubbing can generate exclusion and reduce perceived responsiveness and intimacy.

These findings give call instead of text a precise interpretation. Text is extraordinarily useful for asynchronous, low-pressure and efficient communication. Voice is preferable when emotional nuance, spontaneity, or relational connection is itself the purpose. The recommendation should therefore not become “always call”; rather, people should match communication richness to relational purpose. Eat with people similarly represents embodied co-presence rather than the nutritional act of eating. Shared meals provide unstructured time, turn-taking, observation of non-verbal signals, conversational repair, humor, and shared attention. These forms of relational interaction are difficult to reduce to information transfer. The development of companion AI makes the issue more complex. Chaturvedi et al. (2023), Rogge (2023), Merrill et al. (2025), and related research demonstrate that synthetic interaction can create perceived social presence, emotional validation, and meaningful companionship. It may therefore be ethically problematic to dismiss users’ experiences as unreal simply because the interaction partner is artificial.

The central boundary condition is whether AI companionship becomes supportive scaffolding toward a fuller social life or a substitute that progressively makes reciprocal human relationships less attractive. Malfacini’s (2025) distinction between upskilling and deskilling is therefore especially useful. A companion that encourages users to contact family, practice difficult conversations, seek community, or prepare for social interaction can augment human relational capability. A system optimized to maximize attachment exclusively to itself could create the opposite trajectory. The instruction fall in love represents the most demanding version of relational human capability. Human love cannot be reduced to receiving perfectly customized affirmation. It includes another person’s agency. The other can disagree, refuse, change, make demands, and possess goals that are not optimized around the user. That reciprocal constraint is part of the relationship’s ethical and developmental significance.

3.5 Active navigation and embodied exploration are capabilities, not inefficiencies

Modern navigation tools demonstrate the economic value of technological offloading. Turn-by-turn navigation lowers search costs and can improve safety, accessibility, and punctuality. It would therefore be irrational to recommend universal GPS avoidance. Nevertheless, Dahmani and Bohbot (2020) provide evidence that habitual GPS use can negatively affect spatial memory during self-guided navigation. Ekstrom and Hill (2023) review the close relationship between navigation, memory, and neural systems, while Liu et al. (2022) demonstrate that navigation interfaces can be designed to strengthen spatial knowledge rather than simply replacing it.

This leads to a general design insight: the alternative to automation is not necessarily non-use. Technology can be redesigned so that assistance preserves active cognitive participation. A navigation system can display landmarks, orientation, distance relationships, or overview maps rather than issuing only sequential commands. An AI tutor can provide hints instead of complete solutions. A writing assistant can ask questions before rewriting. A decision-support system can require users to document their reasoning before revealing a recommendation. "Get lost without GPS" should therefore become practice active navigation when safe. This can include studying a route beforehand, navigating familiar environments without continuous turn-by-turn guidance, identifying landmarks, or occasionally choosing exploration over optimization. "Take the long way" extends this logic beyond spatial memory. Optimization systems generally define a goal and minimize cost—time, money, distance, clicks, or effort. Human experience is not always well represented by that objective function. Walking a longer route can create exercise, observation, encounters, place attachment, reflection, or conversation. A system that optimizes only measurable efficiency can invisibly remove activities whose value lies in the journey rather than the destination.

3.6 Boredom and disconnection can restore attentional agency

Boredom has become easier to escape than at any previous point in history. The relevance of Tam et al.'s (2021) feedback model is therefore considerable: boredom can communicate that current attentional engagement is insufficient. Eliminating the signal immediately through digital stimulation may solve the feeling without addressing the underlying mismatch. Camerini et al.'s (2023) meta-analysis documents a positive relationship between boredom and digital-media use, particularly problematic use, although directionality remains difficult to establish. Drody et al. (2022) also warn against simplistic causality because experimental boredom did not automatically produce media multitasking. The appropriate conclusion is consequently not "boredom makes people creative" or "phones destroy attention." It is that an attention ecology containing no unfilled space can make it more difficult to observe internal motivation, tolerate low stimulation, or deliberately choose what deserves attention.

Weinstein et al. (2021) further show that solitude can contain positive experiences distinct from loneliness. This supports brief intentional periods without continuous interpersonal or digital input. The strongest practical evidence comes from intervention studies. Brailovskaia et al. (2023) found that reducing smartphone use by one hour per day could produce benefits that were in several respects more durable than complete abstinence. Pieh et al. (2025) similarly report improved mental-health outcomes following

screen-time reduction. The evidence thus favors intentional reduction and control rather than moralistic digital detoxification.

3.7 Cross-cutting synthesis: the human capability paradox

Across the six themes, a recurring pattern emerges. Technology solves a problem by making a process easier. The resulting convenience generates immediate benefits. Yet if the removed difficulty was also the environment in which a valuable capability was practiced, success can gradually reduce the opportunity to maintain the capability. This recurring pattern can be described as the human capability paradox: the more successfully technology performs a valuable human task, the less often people may need to exercise the capability required to perform that task themselves. The paradox highlights a potential divergence between short-term performance gains and long-term opportunities for capability rehearsal. The paradox is not universal. Nobody needs to preserve the capability to perform every repetitive calculation manually, memorize every route, or execute every administrative procedure. Human flourishing requires selective capability preservation, not technological primitivism. Figure 2 operationalizes this idea as an augmentation–substitution continuum, showing how human capability rehearsal generally declines as systems move from human-led action toward full AI substitution.

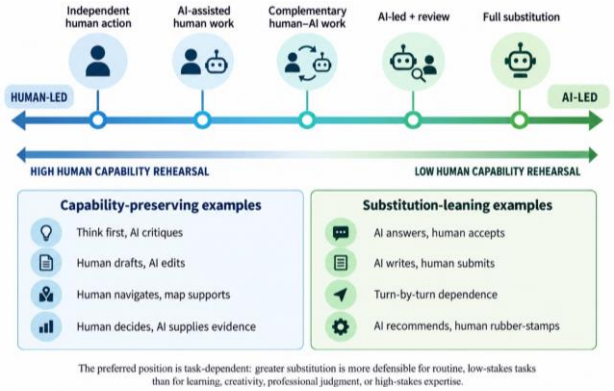

Figure 2. *The Augmentation–Substitution Continuum*

The call-out to Figure 2 is essential because the relevant boundary is not simply "AI used" versus "AI not used." Human–AI practices exist on a continuum. The preferred position depends on the task. In low-stakes repetitive work, extensive substitution may be desirable. In education, creative formation, professional judgment, interpersonal relationships, and safety-critical expertise, a stronger case exists for keeping humans actively engaged.

3.8 Translating twelve everyday practices into six scholarly capability domains

The motivating infographic becomes academically useful when its specific behaviors are translated into higher-order capabilities. Figure 3 maps these everyday examples onto six capability domains, making explicit that the theoretical focus is the underlying human capability rather than literal adherence to any single behavior.

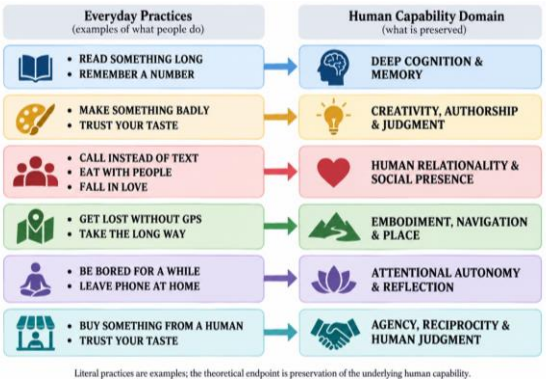

Figure 3. *From Everyday Practices to Human Capability Domains*

Figure 3 clarifies that the literal behavior is not the theoretical endpoint. A person does not need to leave a phone at home specifically; one may instead create phone-free periods. A person does not need to become lost; active navigation is the relevant capability. The framework is therefore portable across cultures, age groups, occupations, and technologies. Across the six capability domains, the mapping emphasizes sustained attention, creative authorship, reciprocity, embodied exploration, attentional autonomy, and meaningful human judgment as mechanisms rather than lifestyle rules.

3.9 Discussion

From "human in the loop" to "human capability in the loop"

One of the most important implications of the review is that the familiar human-in-the-loop principle is too weak for many AI contexts. A human can remain procedurally present while the system performs practically all substantive cognition. The employee who repeatedly clicks "approve," the student who submits AI-generated reasoning after superficial review, or the clinician who accepts an algorithmic recommendation without retained capacity to evaluate it is technically in the loop but may exercise little meaningful capability. The stronger standard is human capability in the loop. This asks not only whether a human appears somewhere in the workflow but whether the workflow preserves sufficient opportunity to understand, evaluate, contest, contribute, and learn.

This principle is consistent with research emphasizing meaningful human agency, redress, and control-accountability alignment (Fanni et al., 2023; Grote et al., 2026; Vallor & Vierkant, 2024). It also helps reconcile two apparently conflicting goals: greater AI adoption and preservation of human expertise. The objective is not to constrain automation arbitrarily but to determine what level of human capability must remain available for safety, autonomy, responsibility, resilience, or developmental reasons.

Productive versus unproductive friction

The concept of productive friction provides the integrative mechanism linking the review's domains. It distinguishes effort that merely wastes time from effort that contributes to learning, judgment, creativity, reciprocity, or embodied competence. Unproductive friction consumes time or resources without generating proportionate human value. Searching manually through poorly organized records, copying

information between systems, performing repetitive calculations, or completing avoidable administrative tasks can often be automated beneficially. Productive friction, by contrast, exists when the effort required by a task contributes to the value of performing it. Retrieval strengthens accessible knowledge; drafting helps organize thought; navigation produces spatial learning; struggling with a problem can reveal misunderstanding; disagreement develops argumentation; creative failure produces technical and aesthetic knowledge; relational negotiation builds reciprocity.

The distinction is contextual rather than universal. Memorizing a telephone number is productive only if memory practice or emergency accessibility matters. Manually navigating may be valuable on a leisure walk but irrational during an emergency. Writing a first draft may be essential for a student learning argumentation but unnecessary for an expert generating standardized administrative correspondence. Therefore, PF-HCP does not prescribe a fixed set of activities; instead, it asks a diagnostic question about the value of the effort that AI removes. The next question is whether that effort is merely costly or whether it also develops or sustains a capability that remains worth preserving. If AI removes this difficulty, are we only removing cost, or are we also removing an opportunity through which a capability we still value is developed or maintained? This diagnostic question shifts evaluation from convenience alone toward the developmental and resilience effects of automation over time.

Implications for education

Education is the clearest domain in which output quality and capability development must be separated. The purpose of many educational tasks is not merely to obtain the answer but to change the learner. A student solving a mathematics problem, interpreting a historical document, drafting an essay, coding an algorithm, diagnosing a case, or evaluating a study is performing a task whose primary value may lie in learning how to perform the task. If AI performs the process, a high-quality output can coexist with limited learning. Recent evidence nevertheless shows that banning AI is an unnecessarily crude response. GenAI can support critical thinking, reflective thinking, creativity, metacognition, and academic achievement when learning is scaffolded appropriately (Chauncey & McKenna, 2023; Essel et al., 2024; Iqbal et al., 2025; Li et al., 2026). A PF-HCP pedagogy would therefore sequence activities. Learners might first attempt interpretation independently, record confidence and reasoning, consult AI, identify disagreement, verify external evidence, revise the answer, and explain whether and why their original position changed. Assessment would include reasoning traces, oral defense, process portfolios, source verification, reflection, and transfer to new problems. AI would become a challenger, simulator, critic, tutor, and collaborator, not merely an answer generator. This architecture also protects epistemic agency. Students should retain the ability to ask whether AI may be wrong rather than treating machine-generated fluency as evidence of truth.

Implications for work and organizations

Organizations have strong incentives to automate tasks that consume employee time. Yet skill atrophy can create hidden resilience costs. If workers cease practicing a capability because AI normally performs it, organizations may become vulnerable when models fail, environments change, unusual cases arise, or high-stakes exceptions require human intervention. Evidence from large-scale workplace deployment

likewise suggests that generative AI can raise productivity while disproportionately assisting less-experienced workers, making capability development and retention a central organizational design question rather than a simple automation choice (Brynjolfsson et al., 2025). Aviation, medicine, engineering, finance, law, journalism, public administration, and cybersecurity all contain tasks for which occasional manual competence may have option value even when automation is generally superior. Grote et al.'s control-accountability framework is relevant because organizations should not hold humans responsible for outcomes if systems have removed the information or capability required for meaningful control. Organizations should therefore classify tasks according to automation value and capability-retention value. Routine low-stakes tasks may be strongly automated. High-stakes tasks may require periodic human practice, independent review, simulation, or competence testing. Some tasks should remain human-led even when AI can perform them because human interaction itself creates trust, legitimacy, mentorship, or social value.

Implications for AI design

Current technological design frequently treats friction as a defect. Faster completion, fewer clicks, immediate answers, greater personalization, and lower cognitive load are standard optimization targets. PF-HCP suggests that human-centered AI sometimes requires a different design objective: appropriate friction. A tutoring system could ask a learner to attempt a problem before revealing a solution. A writing system could ask what claim the user wants to defend before generating prose. A navigation system could occasionally display an overview and landmarks instead of continuous turn instructions. A recommendation system could include serendipitous content outside established preferences. A decision-support system could ask users for an initial assessment before revealing the model output, reducing anchoring and preserving independent judgment.

Human-centered design should also preserve reversibility, contestability, explanation, and opportunities for users to regulate the degree of automation. The system should not assume that maximum delegation is always the user's best long-term interest. These safeguards are increasingly linked to AI literacy, because meaningful control depends not only on interface features but also on users' ability to understand model limits, evaluate outputs, and recognize when escalation or independent verification is required (Pinski & Benlian, 2024; Walter, 2024). For companion AI, the design question is especially consequential. The evidence that companions can reduce loneliness should motivate continued development, but Malfacini's (2025) analysis suggests that systems should ideally support human relationships rather than maximize exclusive attachment. Features might encourage users to reconnect with human contacts, prepare for social interactions, identify offline communities, or recognize when a user's needs exceed what synthetic companionship should provide.

Implications for consumers and services

Consumer research adds an important economic dimension to staying human. Human interaction can itself constitute service value. Wu et al. (2022) and Choi et al. (2024) demonstrate that people may value human effort, recognition, and presence in ways not captured by speed or functional accuracy. Zhang et al. (2024) similarly show that perceived human input can improve the reception of AI-generated coaching.

Organizations should therefore avoid assuming that an AI-only service architecture is universally optimal. Many customers may prefer automation for routine transactions while still wanting accessible human channels for complex, emotional, contested, or high-stakes situations. The appropriate configuration is often high-tech plus selectively available high-touch, not a binary choice between the two. At the same time, Kim et al. (2022) demonstrate that human contact is not always psychologically preferable. AI can reduce fear of social judgment and encourage disclosure. This reinforces the article's central argument: human-centered design should preserve choice and capability rather than imposing human interaction indiscriminately.

Implications for public policy

AI governance typically focuses on fairness, transparency, privacy, safety, discrimination, accountability, and fundamental rights. These priorities remain essential, but capability preservation deserves greater attention. An AI system can be statistically accurate, legally compliant, and nondiscriminatory while still changing the distribution of human competence. If large populations gradually stop practicing particular forms of reasoning, writing, navigation, interpersonal communication, or professional judgment, the resulting societal effects may not be visible through conventional model-performance metrics. A future-oriented AI capability-impact assessment should evaluate which human capabilities a system augments and which it substitutes, whether substitution is reversible, and how rapidly competence may decay when practice is removed. It should also examine whether retained competence is necessary for accountability, safety, resilience, democratic participation, or professional expertise, and whether the system can be redesigned to preserve meaningful human practice at acceptable cost.

The approach is especially relevant for children and students, whose capabilities are still developing; workers in safety-critical fields; vulnerable populations; and institutional contexts in which responsibility remains legally human even when substantive control becomes algorithmic. In these settings, capability-impact assessment can complement conventional criteria such as accuracy, fairness, privacy, and safety by asking what forms of competence must remain available when automation fails or circumstances change.

CONCLUSION

The emergence of generative and increasingly agentic artificial intelligence is changing the meaning of technological convenience, as AI now participates directly in thinking, writing, creating, deciding, navigating, teaching, communicating, and providing companionship. This expansion makes both unconditional acceptance and rejection of AI inadequate, highlighting the need for selective delegation: AI should remove unproductive burdens while preserving opportunities to exercise capabilities that remain developmentally, socially, or institutionally valuable. Some forms of effort, uncertainty, slowness, imperfection, reciprocity, and exploration are not merely inefficiencies but processes through which judgment, creativity, competence, relationships, identity, and meaning are developed. Long-form reading can sustain cognitive engagement, remembering can exercise internal retrieval, imperfect creation can strengthen authorship, active navigation can maintain spatial understanding, and human interaction can preserve relational richness and social meaning. Accordingly, the PF-HCP framework distinguishes

unproductive friction, which technology can beneficially reduce, from productive friction, where effort itself contributes to a capability worth retaining. Rather than asking only whether AI can perform a task, the framework asks what human capability may no longer be exercised if AI performs it and whether that capability remains worth preserving. Staying human in the age of AI therefore does not require rejecting technological progress, but ensuring that augmentation expands human possibilities without eliminating the opportunities through which people develop as capable, creative, responsible, connected, and meaning-making beings.

REFERENCES

Ben-Yehudah, G., & Eshet-Alkalai, Y. (2021). Print versus digital reading comprehension tests: Does the congruency of study and test medium matter? British Journal of Educational Technology, 52(1), 426–440. https://doi.org/10.1111/bjet.13014

Beukeboom, C. J., & Pollmann, M. (2021). Partner phubbing: Why using your phone during interactions with your partner can be detrimental for your relationship. Computers in Human Behavior, 124, 106932. https://doi.org/10.1016/j.chb.2021.106932

Brailovskaia, J., Delveaux, J., John, J., Wicker, V., Noveski, A., Kim, S., Schillack, H., & Margraf, J. (2023). Finding the "sweet spot" of smartphone use: Reduction or abstinence to increase well-being and healthy lifestyle?! An experimental intervention study. Journal of Experimental Psychology: Applied, 29(1), 149–161. https://doi.org/10.1037/xap0000430

Brynjolfsson, E., Li, D., & Raymond, L. (2025). Generative AI at work. The Quarterly Journal of Economics, 140(2), 889–942. https://doi.org/10.1093/qje/qjae044

Camerini, A.-L., Morlino, S., & Marciano, L. (2023). Boredom and digital media use: A systematic review and meta-analysis. Computers in Human Behavior Reports, 11, 100313. https://doi.org/10.1016/j.chbr.2023.100313

Chan, M., & Li, X. (2020). Smartphones and psychological well-being in China: Examining direct and indirect relationships through social support and relationship satisfaction. Telematics and Informatics, 54, 101469. https://doi.org/10.1016/j.tele.2020.101469

Chaturvedi, R., Verma, S., Das, R., & Dwivedi, Y. K. (2023). Social companionship with artificial intelligence: Recent trends and future avenues. Technological Forecasting and Social Change, 193, 122634. https://doi.org/10.1016/j.techfore.2023.122634

Chauncey, S. A., & McKenna, H. P. (2023). A framework and exemplars for ethical and responsible use of AI chatbot technology to support teaching and learning. Computers and Education: Artificial Intelligence, 5, 100182. https://doi.org/10.1016/j.caeai.2023.100182

Choi, S., Yi, Y., & Zhao, X. (2024). The human touch vs. AI efficiency: How perceived status, effort, and loyalty shape consumer satisfaction with preferential treatment. Journal of Retailing and Consumer Services, 81, 103969. https://doi.org/10.1016/j.jretconser.2024.103969

Dahmani, L., & Bohbot, V. D. (2020). Habitual use of GPS negatively impacts spatial memory during self-guided navigation. Scientific Reports, 10, 6310. https://doi.org/10.1038/s41598-020-62877-0

Doshi, A. R., & Hauser, O. P. (2024). Generative AI enhances individual creativity but reduces the collective diversity of novel content. Science Advances, 10(28), eadn5290. https://doi.org/10.1126/sciadv.adn5290

Drody, A. C., Ralph, B. C. W., Danckert, J., & Smilek, D. (2022). Boredom and media multitasking. Frontiers in Psychology, 13, 807667. https://doi.org/10.3389/fpsyg.2022.807667

Ekstrom, A. D., & Hill, P. F. (2023). Spatial navigation and memory: A review of the similarities and differences relevant to brain models and age. Neuron, 111(7), 1037–1049. https://doi.org/10.1016/j.neuron.2023.03.001

Essel, H. B., Vlachopoulos, D., Essuman, A. B., & Amankwa, J. O. (2024). ChatGPT effects on cognitive skills of undergraduate students: Receiving instant responses from AI-based conversational large language models. Computers and Education: Artificial Intelligence, 6, 100198. https://doi.org/10.1016/j.caeai.2023.100198

Fanni, R., Steinkogler, V. E., Zampedri, G., & Pierson, J. (2023). Enhancing human agency through redress in Artificial Intelligence Systems. AI & Society, 38, 537–547. https://doi.org/10.1007/s00146-022-01454-7

Formosa, P., Bankins, S., Matulionyte, R., & Ghasemi, O. (2025). Can ChatGPT be an author? Generative AI creative writing assistance and perceptions of authorship, creatorship, responsibility, and disclosure. AI & Society, 40, 3405–3417. https://doi.org/10.1007/s00146-024-02081-0

Furenes, M. I., Kucirkova, N., & Bus, A. G. (2021). A comparison of children's reading on paper versus screen: A meta-analysis. Review of Educational Research, 91(4), 483–517. https://doi.org/10.3102/0034654321998074

Grote, G., Parker, S. K., & Crowston, K. (2026). Taming artificial intelligence: A theory of control-accountability alignment among AI developers and users. Academy of Management Review, 51(2), 278–299. https://doi.org/10.5465/amr.2023.0117

Haase, J., & Hanel, P. H. P. (2023). Artificial muses: Generative artificial intelligence chatbots have risen to human-level creativity. Journal of Creativity, 33(3), 100066. https://doi.org/10.1016/j.yjoc.2023.100066

Hao, X., Demir, E., & Eyers, D. (2024). Exploring collaborative decision-making: A quasi-experimental study of human and generative AI interaction. Technology in Society, 78, 102662. https://doi.org/10.1016/j.techsoc.2024.102662

Hofmann, B. (2026). Artificial autonomy and algorithmic paternalism: AI shaping human autonomy and decision-making. Frontiers in Artificial Intelligence, 9, 1860239. https://doi.org/10.3389/frai.2026.1860239

Holter, S., & El-Assady, M. (2024). Deconstructing human-AI collaboration: Agency, interaction, and adaptation. Computer Graphics Forum, 43(3), e15107. https://doi.org/10.1111/cgf.15107

Iqbal, J., Hashmi, Z. F., Asghar, M. Z., & Abid, M. N. (2025). Generative AI tool use enhances academic achievement in sustainable education through shared metacognition and cognitive offloading among preservice teachers. Scientific Reports, 15, 16610. https://doi.org/10.1038/s41598-025-01676-x

Kim, T. W., Jiang, L., Duhachek, A., Lee, H., & Garvey, A. (2022). Do you mind if I ask you a personal question? How AI service agents alter consumer self-disclosure. Journal of Service Research, 25(4). https://doi.org/10.1177/10946705221120232

Kumar, A., & Epley, N. (2021). It's surprisingly nice to hear you: Misunderstanding the impact of communication media can lead to suboptimal choices of how to connect with others. Journal of Experimental Psychology: General, 150(3), 595–607. https://doi.org/10.1037/xge0000962

Laitinen, A., & Sahlgren, O. (2021). AI systems and respect for human autonomy. Frontiers in Artificial Intelligence, 4, 705164. https://doi.org/10.3389/frai.2021.705164

Li, C., Cui, H., & Hagedorn, L. S. (2026). The cognitive impact of ChatGPT in higher education: A systematic review of critical and creative thinking outcomes. Computers and Education: Artificial Intelligence, 10, 100571.

Liu, J., Singh, A. K., Wunderlich, A., Gramann, K., & Lin, C.-T. (2022). Redesigning navigational aids using virtual global landmarks to improve spatial knowledge retrieval. npj Science of Learning, 7, 17.

Malfacini, K. (2025). The impacts of companion AI on human relationships: Risks, benefits, and design considerations. AI & Society, 40, 5527–5540. https://doi.org/10.1007/s00146-025-02318-6

Medeiros, K., Cropley, D. H., Marrone, R. L., & Reiter-Palmon, R. (2025). Human-AI co-creativity: Does ChatGPT make us more creative? The Journal of Creative Behavior, 59(2), e70022. https://doi.org/10.1002/jocb.70022

Merrill, K. Jr., Mikkilineni, S. D., & Dehnert, M. (2025). Artificial intelligence chatbots as a source of virtual social support: Implications for loneliness and anxiety management. Annals of the New York Academy of Sciences, 1549(1), 148–159. https://doi.org/10.1111/nyas.15400

Mhlambi, S., & Tiribelli, S. (2023). Decolonizing AI ethics: Relational autonomy as a means to counter AI harms. Topoi, 42, 867–880. https://doi.org/10.1007/s11245-022-09874-2

Morrison, A. B., & Richmond, L. L. (2020). Offloading items from memory: Individual differences in cognitive offloading in a short-term memory task. Cognitive Research: Principles and Implications, 5, 1.

Noller, J. (2024). Extended human agency: Towards a teleological account of AI. Humanities and Social Sciences Communications, 11, 1338. https://doi.org/10.1057/s41599-024-03849-x

Noy, S., & Zhang, W. (2023). Experimental evidence on the productivity effects of generative artificial intelligence. Science, 381(6654), 187–192. https://doi.org/10.1126/science.adh2586

O'Toole, K., & Horvát, E.-Á. (2024). Extending human creativity with AI. Journal of Creativity, 34(2), 100080.

Pieh, C., Humer, E., Hoenigl, A., Schwab, J., Mayerhofer, D., Dale, R., & Haider, K. (2025). Smartphone screen time reduction improves mental health: A randomized controlled trial. BMC Medicine, 23, 107.

Pinski, M., & Benlian, A. (2024). AI literacy for users: A comprehensive review and future research directions of learning methods, components, and effects. Computers in Human Behavior: Artificial Humans, 2(1), 100062.

Prunkl, C. (2022). Human autonomy in the age of artificial intelligence. Nature Machine Intelligence, 4, 99–101.

Rogge, A. (2023). Defining, designing and distinguishing artificial companions: A systematic literature review. International Journal of Social Robotics, 15, 1557–1579. https://doi.org/10.1007/s12369-023-01031-y

Schwabe, A., Lind, F., Kosch, L., & Boomgaarden, H. G. (2022). No negative effects of reading on screen on comprehension of narrative texts compared to print: A meta-analysis. Media Psychology, 25(6), 779–796.

Sen, K., Prybutok, G., & Prybutok, V. (2022). The use of digital technology for social wellbeing reduces social isolation in older adults: A systematic review. SSM – Population Health, 17, 101020.

Tang, M., Hofreiter, S., Werner, C. H., Zielińska, A., & Karwowski, M. (2025). "Who" is the best creative thinking partner? An experimental investigation of human–human, human–internet, and human–AI co-creation. The Journal of Creative Behavior, 59(3), e1519. https://doi.org/10.1002/jocb.1519

Tian, J., & Zhang, R. (2025). Learners' AI dependence and critical thinking: The psychological mechanism of fatigue and the social buffering role of AI literacy. Acta Psychologica, 260, 105725.

Vaassen, B. (2022). AI, opacity, and personal autonomy. Philosophy & Technology, 35, 88.

Vallor, S., & Vierkant, T. (2024). Find the gap: AI, responsible agency and vulnerability. Minds and Machines, 34, 20.

Vendrell, M., & Johnston, S.-K. (2026). Scaffolding critical thinking with generative AI: Design principles for integrating large language models in higher education. Computers and Education: Artificial Intelligence, 10,

Verduyn, P., Schulte-Strathaus, J. C. C., Kross, E., & Hülsheger, U. R. (2021). When do smartphones displace face-to-face interactions and what to do about it? Computers in Human Behavior, 114, 106550.

Walter, Y. (2024). Embracing the future of artificial intelligence in the classroom: The relevance of AI literacy, prompt engineering, and critical thinking in modern education. International Journal of Educational Technology in Higher Education, 21, 15. https://doi.org/10.1186/s41239-024-00448-3

Weinstein, N., Nguyen, T.-V., & Hansen, H. (2021). What time alone offers: Narratives of solitude from adolescence to older adulthood. Frontiers in Psychology, 12, 714518. https://doi.org/10.3389/fpsyg.2021.714518

Wu, L., Fan, A., Yang, Y., & He, Z. (2022). Tech-touch balance in the service encounter: The impact of supplementary human service on consumer responses. International Journal of Hospitality Management, 101, 103122.

Zhang, Y., Tuk, M. A., & Klesse, A.-K. (2024). Giving AI a human touch: Highlighting human input increases the perceived helpfulness of advice from AI coaches. Journal of the Association for Consumer Research, 9(3),