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Is AI flattening the curve of critical thinkers leaving behind a cognitive cap for learners?

David Scibelli, *Winthrop University, scibellid@winthrop.edu*
Brian Stevens, *Elizabethtown College, stevensbj@etown.edu*

Abstract

This study investigates the notion of unforeseen impacts from Artificial Intelligence as a disruptor force shifting into human analytical and problem-solving space, where the deeper human cognitive exertion for those tasks becomes obsolete for humans. The conception of this tradeoff is believed to be unparallel to other computing advancements, where millions of data points and algorithms are concurrently processed producing timely profound results, thereby exceeding the human counterpart competencies in many areas. Identified are three areas of cognitive nature believed to be impacted in the human to machine transition. This research highlighted human motivation, cognitive analysis and problem solving, and maintaining the body of knowledge in the transference of implicit and explicit understanding of rationale and subject matter content. This work recommends further examination in these areas as AI systems evolve as high yielding reliable information systems of the Modern Era's Fourth Industrial Revolution.

Keywords: information systems, knowledge transfer, artificial intelligence, human motivation, cognitive adaptation

Introduction

The advancement of information systems over the decades has etched at the foundation of Artificial Intelligence (AI), where from its inception, the visions of creating systems to further advance human existence crafting a sustainable world with a euphoric life for its inhabitants. The concept of artificial intelligence dates back to the 1950s, when programmers attempted to build computers capable of performing tasks that required human intelligence; machines that could understand languages, recognize objects, solve problems, act intelligently, play strategy games like chess, and even teach students. Ever since, programmers, engineers, and educators have been attempting to create and adapt these emerging technologies to both the classroom and everyday life. (Brown, Collins, & Harris, 1978)

Given the human tendency to embrace new technology, there are opposing camps that believe there could be tradeoffs in the adoption of innovative technology with detrimental impacts to society. This research will investigate the adoption of AI as disruptor technology, in an evolutionary race between human and machine where the coexisting relationship between the two have not yet established precedence or dominance. Although, this is not a competition between the two entities of human and machine, the reliance of both counterparts in this modern era is critical based on the systems and technology in place pumping the lifeblood of our world. Furthermore, the notion of human-machine is mentioned throughout our existence. This expected convergence is inevitable and solidifies Weiner's perspectives on this relationship. (Wiener, 1961). With this prophetic marriage of human and machine, this study will undertake the impact

of humans as we lean deeper into the fourth industrial revolution (Davis, 2016), as we transition from the once unique role of thinkers to sitting in the passenger seat of autonomous vehicles.

This research investigates the impact of artificial intelligence as it shifts into the deeper cognitive space of humans, where thinking tasks once considered tedious and cumbersome could be handled by the machine. There is a perspective that this shift will offload the human cognitive process to advance to more significant roles; however, will this be an inclusive transition, or inspire a select few in the progressive journey of humankind. Furthermore, with the transition to machine processing of once human intelligent tasks, this study hangs the focus on impact to humans, where artificial intelligence is slated to do those tasks dissolving the unforeseen benefits of encapsulated cognitive psychology for this work. This transition opens the door for further human advancement; however, the clarity of the next phase is still blurred at this early beginning of the process. The next section will discuss human learning methods, aspiration and motivation characteristics of cognitive learning, how critical thinking and reasoning is shaped, and how artificial intelligence became the forefront of our technology revolution.

The purpose of this study is to investigate the impact of information systems advancement with artificial intelligence as a disruptor technology force, offloading the cognitive dispensation of human thinking, thereby arresting further cognitive development and growth in that area for an individual and the knowledge will be lost or no longer developed.

The scope of the study will hinge on specific areas of this notion aforementioned in the purpose, where the research will open the perspective of what is inside this trade-off of cognitive practice from human to machine.

Q1: *Does the desire of humans to do the hard work behind analytical problems diminish with the use of AI tools?*

Q2: *Are human cognitive reasoning advancements being hindered by AI produced results?*

Q3: *Are humans at risk of losing a body of knowledge by eliminating the human need to perform the task?*

Background & Literature Review

Humans have studied how other humans learn since the dawn of time, making observations of how others interacted, performed simple to complex tasks, and everything in between. These observations have been chronicled on everything from paintings on cave walls to articles posted to Internet walls. As our Information Systems progressed from the primitive to the sophisticated hyper-processed predictive systems, is there a human trade-off with the progression of our future advancements?

This section will explore areas of plausible impact where the Literature Review is categorized into four areas that will frame the perspective of this study. The focus point hinges on the following: Human Cognitive Adaptation (how humans learn); Aspiration for Learning (why humans want to learn); Critical Thinking (rationale behind human decisions); and artificial intelligence (what is replacing the cognitive process).

Human Cognitive Adaptation

Human cognitive capabilities have transitioned our world on numerous landscapes throughout our existence. As one marvels at the countless systems and engineering breakthroughs humans have created based on thick cognitive processing embracing ambitious, endless work flourishing us further as we leverage the tools we had once built creating the platforms of the future. In the investigation of human learning, this section will examine the human brain function, then focus on cognitive processing.

Human learning can be affected by multiple different factors. The human desire to learn can be impacted by gender (Causarano, 2010), socioeconomic status (Li, et al 2020), geography (Lewis & Kim, 2008), subject matter (Wistoft, 2013), and in some cases, occupation (Jensen, 2007). As AI dances with the natural human cognitive processing, does this alleviate the need for rational and understanding of problem solutions? As humans continue to advance, will this be inclusive of all, or will this flirt with the notion of natural selection in cognitive processing, thereby leaving some behind as others move forward, as discussed in the writing of Heyes (2012)? All the works performed through humankind, thus surpassing its predecessors and other species are funneled through a very simple, yet complex vector of cognitive process. This is demonstrated in Figure 1, as represented by the Atkinson and Shiffrin's Multi-Store Memory Model, there is the notion of restrictive measures to which humans obtain information, rationale, and processing of the problems and situational tasks in their life situation, where this work has been brought to the forefront through the scholarly works of Wixted (2024). Plancher & Barrouillet (2019) confirmed with their research that the Atkinson-Shiffrin model was still valid after almost 50 years. In addition to this model, there are several others that carry forward varying perspectives of this work and have contributed augmentation of this Atkinson and Shiffrin's abstract concept (Potts, 1975) Nevertheless, there are numerous viewpoints within these models, it remains that there is a cognitive framework within the human learning process. As we look closer to the AI relationship with this process as a touch point with human cognitive function in no longer grasping concepts and tasks through the lower-level function of learning and memorizing in processing the mapping of reason and data.

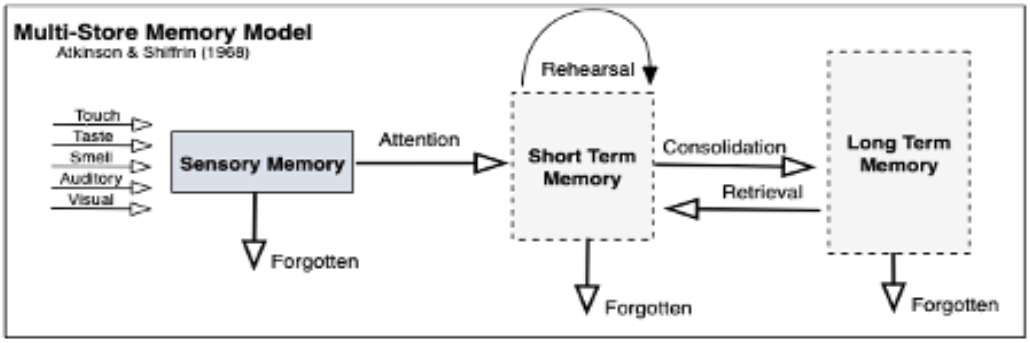

Figure 1: The Multi-Store Memory Model by Atkinson and Schiffrin (1968) demonstrates human memory construct.

Applying the external learning process to the integral brain function aforementioned in this section, are the several factors in the cognitive process as highlighted by Butler (1977), in their works on educational learning. Further investigating the cognitive process for human learning, Stern (2017) identified the function of cognitive process utilizing the human information processing model developed with Dr. Lennart Schalk. The cognitive process stated in this work included remembering, understanding, applying, analyzing, evaluating, and creating. In addition, they highlighted how important long-term memory is as the keeper of learned entities which encompass language processing, scripting, algorithmic, visual graphic and music. Considering the basis of cognitive process and the potential of artificial intelligence impedance

on this process, the next area of impact to study is motivation of learners to engage in deep repetitive learning in their pursuit of knowledge.

Aspiration for Learning

There are several characteristics behind the motivation of learning (Strobel, Strobel, Preckel, & Steinmayr, 2024). As artificial intelligence systems further perform the more difficult and consuming analysis work previously performed by humans, will the individual appetites and desires to thrive advance humans to yet the next level of evolution, as to build further from the body of knowledge extrapolated from AI, be our new launch point?

When writing about her first-grade students' desire to learn, Lara Hansen (2001) combined the definitions of three different authors into a cohesive definition stating that, intrinsic motivation is "enjoying what one does for its own sake" (Kohn, 1993, p. 68), where intrinsically motivated people pursue challenges, are more innovative, and perform better when challenged (Lashaway-Bokina, 2000). People who are intrinsically motivated feel interest and enjoyment in what they are doing, feeling a sense of capability and determination. They do not feel tension, stress, and anxiety (Deci, 1985).

From a non-pedagogical perspective looking into the evolution and human motivation through the works of Bernard, Mills, Swenson, & Walsh (2005), presenting a theory on human motivation, where one would make an interesting link with what motivates humans based on differing adaptive pressures. Motivation has been a driving force behind human evolutionary advancements since our inception. Further extrapolation of human aspiration for knowledge encroaches the instinctive behaviors of curiosity, where this fed motivation driven by stimuli and environmental constructs and comprised of "inquiring, learning, and exploring in the absence of external or reward and punishment," as stated by Silva (2012, p. 178). In addition, concluded in Silva's research, "curiosity does seem to be an important mechanism in the development of knowledge and competence" (p. 163). In understanding in more depth about human reasoning and thinking function, further analysis follows with focus on critical thinking concepts.

Critical Thinking

While critical thinking has been widely studied, there is no consensus definition for the term. Lewis and Smith (1993) stated that the root of critical thinking comes from two disciplines: philosophy and psychology. Conversely, researchers at the University of Louisville combined 12 different theories into the statement:

> "Critical thinking has been described as an ability to question; to acknowledge and test previously held assumptions; to recognize ambiguity; to examine, interpret, evaluate, reason, and reflect; to make informed judgments and decisions; and to clarify, articulate, and justify positions." (University of Louisville Ideas to Action, *n.d.*)

When it comes to the overall concept of critical thinking, are we to take the stance of Supreme Court Justice Potter Stewart and simply "know it when we see it"?

As for how Critical Thinking (CT) works, Facione (2015) separated Critical Thinking down into six segments: Interpretation; Inference; Self-Regulation; Evaluation; Explanation; and Analysis. These cognitive skills are the basic tenets of thought, and therefore thinking critically. Metacognition is a converging component of critical thinking, where it encompasses Flavell's framework on how CT initiates, processes, and reflectively analyzes the information during the cognitive process (Flavell, 1979).

Nevertheless, this notion of a metacognition processes dovetailing into critical thinking, whereas Saiz's model of the components of critical thinking demonstrate metacognition process as a factor in the decision process shown in Figure 2. (Rivas, Saiz, Ossa, 2022). Revas, Saiz, and Ossa continue, suggesting that thinking and reasoning are adjoined, thereby identifying inference and judgment are integral to the thinking process. Azevedo stated that metacognitive influencers are necessary for learners in complex technical environments, whereas these tools would be used to augment the learning process (2005). Lajoie & Derry (1993) further elaborate on the need for four types of tools to enhance memory and metacognitive process, process lower cognitive skills while allowing the higher level of thinking, learners embrace other cognitive activities, keep the learners engaged in the problem activity.

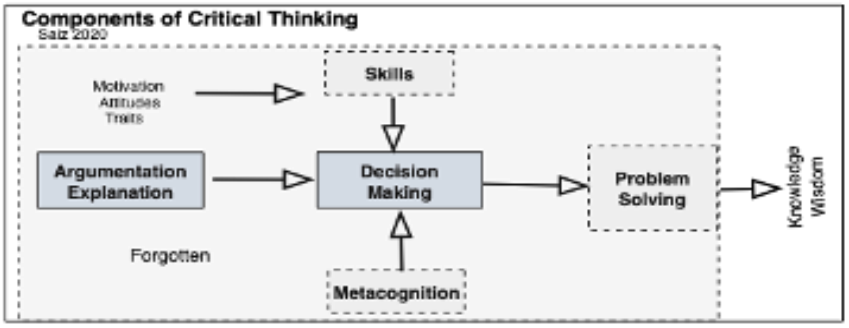

Figure 2: The components of critical thinking with the meta cognition processes integrated into this construct (Saiz, 2020).

Artificial Intelligence

Within the construct of Information Systems, the vision of powerful autonomous generative computing systems stems back to the mid-1950, where this concept of artificial intelligence was brought to forefront through the works of Newell and Simons at Dartmouth as discussed by Anyoha (2017). To best define artificial intelligence, a populous view through the lens of an AI publishing and market research company *Emergj* defines framing an expectation of what artificial intelligence is:

> "Artificial intelligence is an entity (or collective set of cooperative entities), able to receive inputs from the environment, interpret and learn from such inputs, and exhibit related and flexible behaviors and actions that help the entity achieve a particular goal or objective over a period of time." (Emerj, 2018)

AI lagged a slow growth early on, but dramatically increased in growth more recently, as our computing capabilities, sophisticated algorithms, and transition to automated systems has landed artificial intelligence technology at the doorstep of our modern civilization. The systems were once conceptualized and now in the toddler age and advancing through correction and training. However, unlike a plethora of dystopian science fiction plots, artificial intelligence has heretofore been used for helpful purposes. A recent study looked at how AI could be used to alleviate the impact of learning disabilities on learning (Bressane, et al, 2024). AI and Machine Learning (ML) are being used more routinely to create, manage, and observe the results of clinical trials for the pharmaceutical industry (Bhatt, 2021).

With sportsbook gambling legalized across the United States six years ago (Liptak & Draper, 2018), athletes, coaches, and officials are under more scrutiny to maintain integrity and not throw games and

matches to the benefit of bettors. Sportsradar used AI to monitor close to 850,000 events across 70 sports in 2023, finding oddities in 0.21% of those events, or one in about every 467 matches (Fisher, 2024).

On the other hand, there are a myriad of instances where AI has replaced different aspects of humans learning specific tasks. For example, in the 1970s and 80s, television commercials aired on every channel for the Time Life book series, *Home Repair and Improvement*, a 36-book series for Do-It-Yourselfers of that generation. Technology changed that, as one Redditor summarized the paradigm shift:

> *"Are the 1980 Time Life Home Repair and Improvement books still good? Moving and want to declutter. My husband got these from his dad when we bought our current home. Sort of like, 'you're a homeowner, now, kid. You're gonna need to learn how to do this.' We've never used them. Any repairs, my husband just went on YouTube." (Reddit, n.d.)*

In that same digital vein, Rob Kenney created a YouTube channel for people who grew up in a fatherless house as he did, to teach useful tips and tricks for around the house (Swartyagher, 2023). This channel falls on both sides of the argument, providing learning for those who may not have experienced it firsthand, while also creating another avenue to not feel the need to acquire the knowledge before it was absolutely necessary.

Adaptation of AI can be vocation dependent. The construction industry is slow to adapt AI into its existing methods and tactics, with different parts of the world accepting the technology faster than others (Phaladi, Mashwama, Thwala, & Aigbavboa, 2022). A major negotiation point of the 2023 Writers' Guild of America strike was over the involvement of AI in the Hollywood screen-writing process (Lee & James, 2023). On the other hand, while digital natives are more apt to use technology, fostering their desire to learn how technology works (i.e. programming) is an entirely different challenge (Husin, Judi, Hanawi, & Amin, 2020).

ChatGPT and Grammarly are two of the most famous examples of current AI programs. With X's (Twitter) Grok joining the fray in November 2023; a humor generating AI Bot. Bernard Marr (2023) penned a full list of AI tools for Forbes, that included ChatGPT as well as 13 other "must use" sources to help with branding a business (Looka), create educational or business videos (Lumen5), animating old personal photos (Deep Nostalgia), among others.

Regardless of the application, the human brain still functions better than the artificial one. When analyzed at a neurological level, research has shown that biological learning outperforms AI generated algorithms (Uzan, et al., 2019).

The future of AI is blurred. As aforementioned, students, working adults, and others want to rely on different AI functions and programs, very few digital natives want to learn how to program it going forward (Husin, Judi, Hanawi, & Amin, 2020).

Researchers have been concerned with the interaction of human intelligence and artificial intelligence for almost 50 years. McDermott (1976) discussed how difficult it was to write programming for AI processes, as the human brain can understand implied terms, phrases, or intent based on context; while AI needs explicit terminology to compute and execute a command. Fast forwarding to now, Reddit is selling user information to 'train' artificial intelligence software at a price tag of $60 million per year. The transaction did not go unnoticed, with the Federal Trade Commission keeping a close eye on what transpired following the sale (Dave, 2004).

The threat of AI replacing human workers is both fantasy and reality, depending on the occupation. A recent workplace study yielded results showing that careers believed to be threatened by AI such as writing and language translation have little impact on job removal, while positions involving supply chain optimization have a high likelihood of being replaced by AI. (Cawley, 2024)

Beyond the trends of exacerbated AI commercialization discussion and the opposition more so grounding the hysteria, therefore shadowing it's not yet proven long reached capabilities. As discussed in this section, industry and implementation of AI systems are in present time and expected to progress. This contrasts the past decades of a once sleeping technology.

Methodology

The methodology of this study is a meta-analysis using various models and theories to review articles and previous research already performed on this topic, combining this research into a cohesive discussion on the present and future of AI and how it affects human cognition processes. This methodological approach contains a literature review of the notion of how AI parallels the human task domain. These domains included cognitive processing in humans, human incentive to process learned tasks, critical thinking and reasoning, and artificial intelligence's role in human activities. Furthermore, in this research, the Multi-Store Memory Model created by Atkinson and Shiffrin was used as the foundation of cognitive processing.

Discussion

As examined in this study, an investigation of cognitive adaptation, motivation, continuous critical thinking development, and grounded usable AI systems was conducted to explore the impact to the more analytical work done by humans, which would transition to machines. Noteworthy to mention, this is not an alarmist perspective of terrorizing AI systems destroying humankind, but more taking a scientific approach to understand the touchpoints into human cognitive processing that will change. It is recognized that the rebirth of AI is rapidly being adopted and implemented as a disrupting automated technology that is earmarked to fold into many market segments with the capability of tirelessly out-performing its predecessors and reducing resource entities within these markets.

The claim in this research approaches the cognitive development divide where many of the analytical threads used in problem solving are shifting to working with results of tasks. One could suggest that the calculator did not preclude scientific development after its prefiltration into our world. The mechanical device in 1642 did advance further into the electric version in 1961 following that, calculator tools were developed with even more capable features reported by Akanegbu (2012). It might be arguable that finite skills may have been lost; however, it is reasonable to consider how the tool has allowed humans to make advancements in many areas with crutching assistance and accuracy. AI could parallel the same channel in doing the most tedious and endless assembly constructing solutions, solving problems, pattern matching, and analyzing data. Specific to human cognitive processing of the things AI has learned to do, artificial intelligence could create programs, and select from the best examples of code and algorithms. Would this be a lost skill for humans? In retrospect, most programmers do not use assembly language, where higher level languages may have simplified the process. Although, one might argue that with programming in higher languages such as Python, there is still reasoning, algorithmic design and problem solving. It would be plausible to believe that a Subject Matter Expert (SME), would be needed to feed or create a script for AI to figure out what is needed in a program; however, one would lean to the thought that reasoning or cognitive designing of the programs would not be necessary. There could be a need to validate the results

of the program; however, that component could possibly be performed through AI. As a plausible outcome consideration, would these human analytical skills no longer be necessary and possibly not carried forward for the future?

Another area of AI intrusion on human cognitive development is in language association, where artificial intelligence performs excellent language generation, where it could construct intelligible reports, articles, and papers that are selected from the most renowned artifacts collected over centuries of humankind development. Certainly, a SME is needed to nurture the AI system, until the point of AI refinement is reached. The perceived downside to AI taking over the language and writing tasks is the need for humans to map out and construct ideas to streams of communication formulating thought and ideas. It is not said that the SME will not proofread or edit the AI works sometimes making it sensical, but the inception of ideas and intricate formulation of language will not be necessary. What happens at the cognitive level as the aforementioned in Figure 1 at the cognitive level?

One could make similar arguments in other domains, where AI analysis and problem-solving solutions in the role of helping us, assisting medical diagnosis for symptoms, treatments, and radiographic discovery. One cannot argue against the potentials of this technology, but with the reliance of the systems, the intricate articulation of the experts in the field and further development of their cognitive process will be intertwined with working with results not integrated into the problem-solving cognitive process of discovery.

Based on accepting there is a trade-off with human cognitive process to the AI machine process, the suggestion is humans may be losing the deeper cognitive development involving reasoning, problem-solving, and assembly skills, where in specific areas they are awaiting results from the system and not performing the deep analysis and creating rationale for specific tasks as demonstrated in Figure 3.

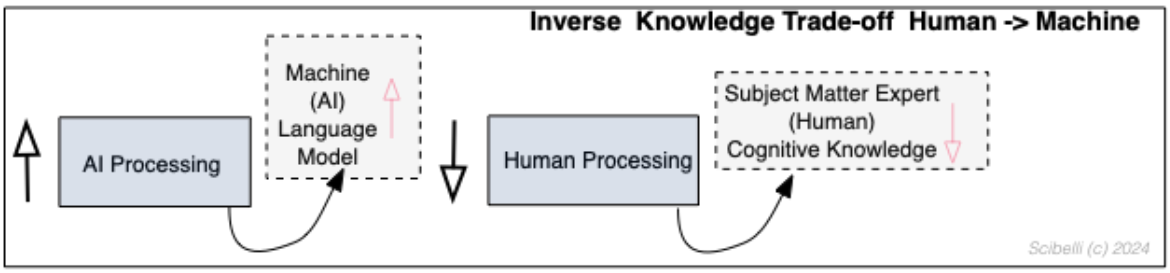

Figure 3: Represents the trade-off of human cognitive tasks processing as AI adopts those tasks updating pattern recognition and advancing predictive analysis within the AI system.

Whereas pre-AI cognitive tasks involved human thinking and processing to determine the rationale and thought to construct results and outcomes from their inner-brain action which is identified in Figure 4. As AI technologies advance into a convergence of human-machine integration for the heavy processing of more analytical and problem-solving tasks, there is a cybernetic connection with an inter-reliance between the two, capitulating the human's need for the results and the machine's need to be validated and corrected if needed, thereby being smarter next time. Figure 5 shows this coupling effect of the partnership and indirect sharing of their cognitive process; however, the human is blind to the methods and rationale processed by the machine where the machine will be taught by the human.

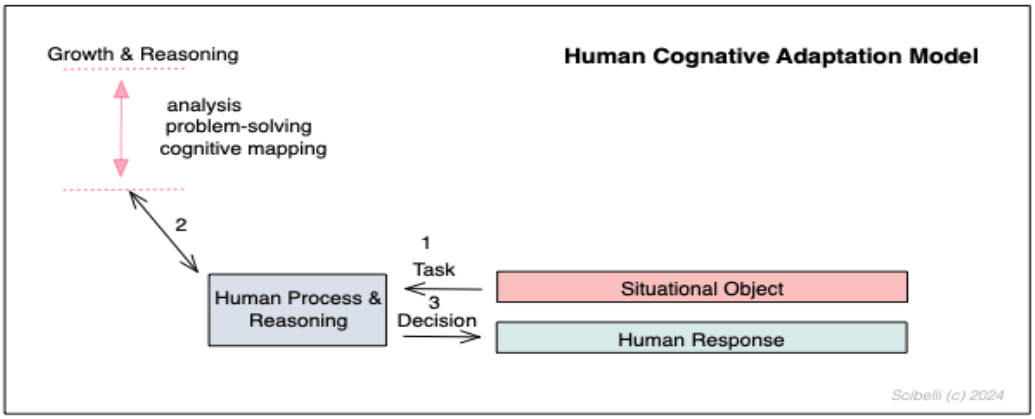

Figure 4: Level 0 illustration demonstrates human cognitive processing of an analytical task.

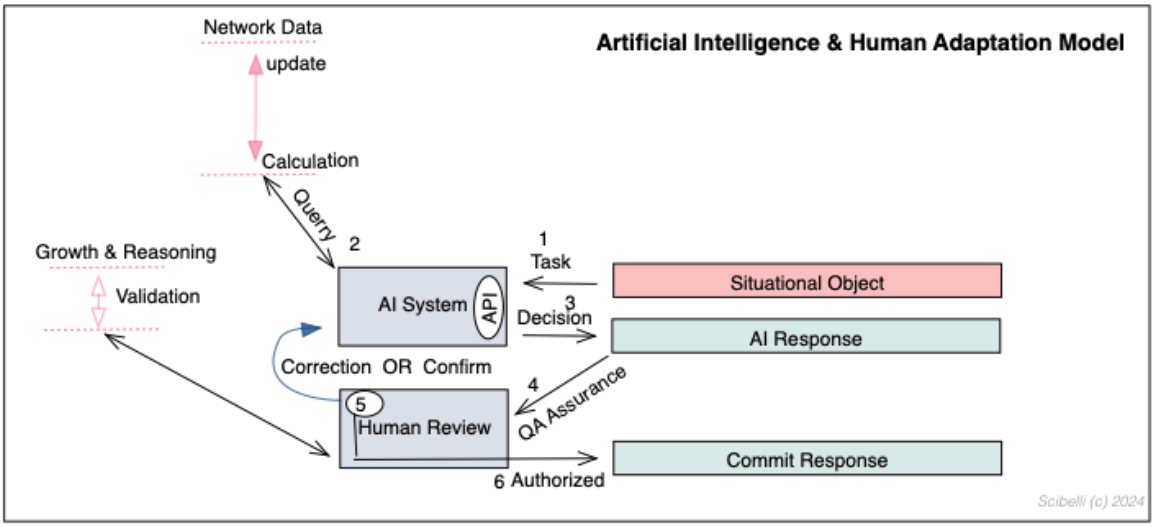

Figure 5.: Exhibits a shared mode adaptation model of both human and AI in the processing of cognitive tasks, where the human oversees and corrects the work of AI during this growth phase.

Further analysis of the concept of an Artificial Intelligence & Human Adaptation Model in Figure 5, specific questions rise to the forefront. In this observation being in shared mode human-AI, one could see evolution of the machine for these tasks and become independent, thus alleviating the need of the human component for the specific mission. Considering the forward-thinking assertion, the first question looks at the human drive and motivation behind the AI partnership.

Q1: Does the desire of humans to do the hard work behind analytical problems diminish with the use of AI tools?

There are significant factors from primitive to situational. Without deeper investigation and experimentation it would be speculative to affirm an absolute position, nevertheless it would be plausible to believe that no longer having self-initiative and discovery as a precursor to achieving outcomes, may reshape the found need for motivation of individuals. In addition to the notion of a somewhat flattened human motivational curve, would it be acceptable to consider human cognitive processing impacts. The next question,

Q2: Are human cognitive reasoning advancements being hindered by AI produced results?

Looks at the disrupted cognitive process where critical thinking occurs as shown in Figure 2. Artificial intelligence is performing the assembly of components for solving a problem, and the human observes the result outcome, where validation checks are made, similar to an engineering test plan for a product. With this continuous offloading of deeper cognitive association of analysis, one could suspect there may be a degradation of specific cognitive function in that area, thereby the knowledge is no longer needed. This perspective dovetails into the third question,

Q3: Are humans at risk of losing a body of inherent knowledge by eliminating the human need to perform or solve the task?

As claimed in this discussion, there may be impact to SME knowledge in various analytical and problem-solving segments. As the machines improve their AI duties, the need or motivation for SME to advance and attain foreknowledge in that area could reasonably diminish where it would not be necessary. While those coming newly into the field, replacing the old with minimal or no implicit or explicit knowledge to transfer? The machine will be the holder through millions of data points and complex algorithms. It is plausible to parallel this metaphorically with the fall of the Roman Empire, where the buildings stood strong, but the receipt for concrete was lost.

Results

This study explored the insertion of artificial intelligence into deeper analytical and problem-solving tasks into the human cognitive space. The focus examined a shared model of co-generative cognitive function of both human and machine, and the impacts to humans from a cognitive perspective, where the need for their reasoning and critical thinking was reduced for that task, allowing AI to process for human validation. Results suggested from this work indicate that there is a plausible transition of human analysis, problem-solving, and pattern association that will be processed by artificial intelligence.

The complexity of understanding the impact to human motivation being results driven and not discovery will require a deeper dive and observation. One would suspect that there may be a negative outcome; but that would need to be further studied. As well, this research recognizes that humans no longer involved in the discovery and exploring the rationale behind the problem-solving, may lose the cognitive expertise, and the suggestion is further research to correlate the relationship. The last point brings forth the notion that knowledge transfer gaps and AI systems with unfettered oversight may contribute to loss of inherent knowledge, where both implicit and explicit transference may be diminished.

The results of this study that were brought forward are the three focused areas believed important to further examine, what is believed to be the unforeseen consequences of an advanced AI technology coexisting with human-machine managed and standalone machine managed analytical information systems. The areas to further advance the study are: decrease in human motivation resulting from a passive role in information discovery and analysis, a decrease in cognitive development advancements with AI replaced analysis, and eroding the body of knowledge with future reliance on artificial intelligence systems without transference of implicit and explicit knowledge.

Conclusion

Recognized is the existence of a feasible artificial intelligence platform rising from decades of advancements and setbacks. The capability of AI is fueled by an infinite caliber of datasets populated from

millions of users, transactions, devices, and sensors throughout our globe. The aggregate of the data or information that is beyond human comprehension, and processing of it by natural human means is unattainable based on performance and time constraints for response. This positions AI as being dominant in that domain based on performance and time. It would be daunting for humans to supersede knowledge or completely understand the inner-workings and associations of each entity of the AI system; however, the new human role of being the Overseer for AI will be to assure the correct results and data integrity of the systems. A recent study (Ng, 2024) reflected trust with humans toward Conversational AI, and as the reliability of AI continues to advance, it is possible the human role as caretakers of AI will diminish, where the concern is keeping humans motivated and wanting to learn, not losing their cognitive reasoning in understanding their domain of knowledge, and finally to assure that humankind does not lose or create gaps the body of knowledge, thereby humans will thrive and still aspire yet strong innovative instincts to move forward.

The next step in this research is to carry forward the cognitive loss, motivation loss, and knowledge transference loss in humans post AI adoption as standalone systems, using a longitudinal research model with a metrics-based analysis. With the expected adoption of AI as a disruptor technology force, the area of impact spans across numerous domains where human roles will change. This opens the door for scholarly investigation of how the adoption of Artificial Intelligence affects the human role(s) at home, in the workplace, with others, and with the technology itself. Thereby, additional research is necessary to catalog our future as human participants in a human-machine world.

References

Anuli Akanegbu Anuli is a writer and new-media enthusiast who dreams about becoming the sixth Spice Girl. Until then follow her on Google+ or Twitter: @akaanuli. , technology enthusiast. (2023, July 10). *The history of calculators: Evolution of the Calculator (timeline)*. EdTechMagazine. https://edtechmagazine.com/k12/article/2012/11/calculating-firsts-visual-history-calculators

Anyoha, R. (2017, August 28). *The history of Artificial Intelligence*. Science in the News. https://sitn.hms.harvard.edu/flash/2017/history-artificial-intelligence/

Azevedo, R. (2005). Computer Environments as Metacognitive Tools for Enhancing Learning. *Educational Psychologist, 40*(4), 193–197. https://doi.org/10.1207/s15326985ep4004_1

Bernard, L. C., Mills, M., Swenson, L., & Walsh, R. P. (2005). An evolutionary theory of human motivation. *Genetic, Social, and General Psychology Monographs, 131*(2), 129–184. https://doi.org/10.3200/mono.131.2.129-184

Bhatt, Arun. Artificial intelligence in managing clinical trial design and conduct: Man and machine still on the learning curve?. Perspectives in Clinical Research 12(1):p 1-3, Jan–Mar 2021. | DOI: 10.4103/picr.PICR_312_20

Bjerkholt, E., Ørbæk, T., & Kindeberg, T. (2023). An outline of a pedagogical rhetorical interactional methodology – researching teachers' responsibility for supporting students' desire to learn as well as their actual learning. *Teaching in Higher Education, 28*(2), 238–253. https://doi.org/10.1080/13562517.2020.1792876

Bressane, A., Zwirn, D., Essiptchouk, A., Saraiva, A. C., Carvalho, F. L., Formiga, J. K., Medeiros, L. C., & Negri, R. G. (2024). Understanding the role of study strategies and learning disabilities on

student academic performance to enhance educational approaches: A proposal using Artificial Intelligence. *Computers and Education: Artificial Intelligence*, *6*, 100196. https://doi.org/10.1016/j.caeai.2023.100196

Brown, J. S., Collins, A., & Harris, G. (1978). 5 - Artificial Intelligence and Learning Strategies. In Learning Strategies (pp. 107–139). essay, Academic Press.

Butler, F. C. (1977). The Major Factors That Affect Learning: A Cognitive Process Model. *Educational Technology*, *17*(7), 5–12. http://www.jstor.org/stable/44421180

Cawley, C. (2024, February 18). *These are the jobs that AI is actually replacing in 2024*. Tech.co. https://tech.co/news/ai-replacing-jobs#:~:text=Supply%20chain%20optimization%2C%20for%20example,on%20fixed%20assets%20(65%25).

Causarano, N., Pole, J. D., Flicker, S., Flynn, S., Layne, C., Larkin, J., & Salehi, R. (2010). Exposure to and desire for sexual health education among urban youth: Associations with religion and other factors. *Canadian Journal of Human Sexuality*, *19*(4), 169-184.

Dave, P. (2024, March 15). Reddit's sale of user data for AI training draws FTC Inquiry. Wired. https://www.wired.com/story/reddits-sale-user-data-ai-training-draws-ftc-investigation/

Davis, N. (2016, January). What is the fourth industrial revolution. In *World economic forum* (Vol. 19).

Deci, E.L., & Ryan, R.M. (1985). Intrinsic motivation and self-determination in human behavior. New York: Plenum Press.

Facione, P. A. (2015). Critical Thinking: What It Is and Why It Counts . *Insight Assessment*, 1–30.

Faggella, D. (2018, December 21). *What is Artificial Intelligence? an informed definition*. Emerj Artificial Intelligence Research. https://emerj.com/ai-glossary-terms/what-is-artificial-intelligence-an-informed-definition/

Fisher, E. (2024, March 4). *Report: Match Fixing hasn't slowed. What's new: Ai is watching*. Front Office Sports. https://frontofficesports.com/report-match-fixing-hasnt-slowed-whats-new-ai-is-watching-now/

Flavell, J. H. (1979). Metacognition and cognitive monitoring: A new area of cognitive–developmental inquiry. *American Psychologist*, *34*(10), 906–911. https://doi.org/10.1037/0003-066x.34.10.906

Gorges, J., Maehler, D.B., Koch, T. et al. Who likes to learn new things: measuring adult motivation to learn with PIAAC data from 21 countries. Large-scale Assess Educ 4, 9 (2016). https://doi.org/10.1186/s40536-016-0024-4

Hansen, L. (2001). The inherent desire to learn: Intrinsically motivating First Grade Students. Networks: An Online Journal for Teacher Research, 4(2), 39–39. https://doi.org/10.4148/2470-6353.1200

Heyes, C. (2012). New thinking: The evolution of human cognition. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *367*(1599), 2091–2096. https://doi.org/10.1098/rstb.2012.0111

Husin, N. F., Mohamad Judi, H., Hanawi, S. A., & Mohd Amin, H. (2020). Technology integration to promote desire to learn programming in higher education. *International Journal on Advanced Science, Engineering and Information Technology*, *10*(1), 253–259. https://doi.org/10.18517/ijaseit.10.1.10264

Jensen, K. (2007). The desire to learn: An analysis of knowledge-seeking practices among professionals. Oxford Review of Education, 33(4), 489–502. https://doi.org/10.1080/03054980701476055

Kohn, A. (1993). Punished by rewards: The trouble with gold stars, incentive plans, A's, praise, and other bribes. Boston, MA: Houghton Mifflin.

Lajoie, Susanne P., Derry, Sharon J.. Computer Environments as Cognitive Tools for Enhancing Learning. (1993). In *Computers As Cognitive Tools* (pp. 269–296). Routledge. https://doi.org/10.4324/9780203052594-16

Lashaway-Bokina, N. (2000). Recognizing and nurturing intrinsic motivation: A cautionary tale. Roeper Review, 22. 225-228.

Lee, W., & James, M. (2023, September 25). WGA and the studios reach tentative deal to end writers' strike. Los Angeles Times. https://www.latimes.com/entertainment-arts/business/story/2023-09-24/writers-strike-over-wga-studios-reach-deal-actors

Lewis, A., & Smith, D. (1993). Defining higher order thinking. *Theory into Practice, 32*(3), 131–137.

Lewis, J. L., & Kim, E. (2008). A Desire to Learn: African American Children's Positive Attitudes toward Learning within School Cultures of Low Expectations. Teachers College Record, 110(6), 1304-1329. https://doi.org/10.1177/016146810811000602

Li, H., Peng, M. Y.-P., Yang, M., & Chen, C.-C. (2020). Exploring the influence of learning motivation and socioeconomic status on college students' learning outcomes using self-determination theory. *Frontiers in Psychology*, *11*. https://doi.org/10.3389/fpsyg.2020.00849

Liptak, A., & Draper, K. (2018, May 14). *Supreme Court ruling favors sports betting*. The New York Times. https://www.nytimes.com/2018/05/14/us/politics/supreme-court-sports-betting-new-jersey.html

Marr, B. (2024, February 20). Beyond CHATGPT: 14 mind-blowing AI tools everyone should be trying out now. Forbes. https://www.forbes.com/sites/bernardmarr/2023/02/28/beyond-chatgpt-14-mind-blowing-ai-tools-everyone-should-be-trying-out-now/?sh=708df92a7a1b

McDermott, D. (1976). Artificial Intelligence Meets Natural stupidity. *ACM SIGART Bulletin*, (57), 4–9. https://doi.org/10.1145/1045339.1045340

Ng, Y.-L. (2024a, April 30). *A longitudinal model of continued acceptance of Conversational Artificial Intelligence*. Information Technology & People. https://www.emerald.com/insight/content/doi/10.1108/ITP-06-2023-0577/full/html

Plancher, G., & Barrouillet, P. (2019b, October 22). *On some of the main criticisms of the modal model: Reappraisal from a TBRS perspective - memory & cognition*. SpringerLink. https://link.springer.com/article/10.3758/s13421-019-00982-w

Phaladi, M. G., Mashwama, X. N., Thwala, W. D., & Aigbavboa, C. O. (2022, January 1). *IOPscience*. IOP Conference Series: Materials Science and Engineering. https://iopscience.iop.org/article/10.1088/1757-899X/1218/1/012003/meta

Potts, G. R. (1975). Bringing Order to Cognitive Structures. In *Cognitive Theory* (1st ed., Vol. 1, pp. 247–270). Routledge. https://doi.org/10.4324/9780203781548-16

Rivas SF, Saiz C, Ossa C. Metacognitive Strategies and Development of Critical Thinking in Higher Education. Front Psychol. 2022 Jun 15;13:913219. doi: 10.3389/fpsyg.2022.913219. PMID: 35783800; PMCID: PMC9242397.

R/homeimprovement on reddit: Are the 1980 Time Life "Home Repair and improvement" books still good? moving and want to declutter. (n.d.). https://www.reddit.com/r/HomeImprovement/comments/1314ypb/are_the_1980_time_life_home_repair_and/

Silva, P. J. (2012). Chapter 10 Curiosity and Motivation. In *The Oxford Handbook of Human Motivation* (pp. 157–166). essay, Oxford University Press.

Stern E. Individual differences in the learning potential of human beings. NPJ Sci Learn. 2017 Jan 12;2:2. doi: 10.1038/s41539-016-0003-0. PMID: 30631449; PMCID: PMC6220331

Strobel, A., Strobel, A., Preckel, F., & Steinmayr, R. (2024). On the interplay of motivational characteristics and academic achievement: The role of need for cognition. *AERA Open*, *10*. https://doi.org/10.1177/23328584231218961

Swartvagher, J. (2023, January 21). *Fatherless dad starts YouTube channel to teach basic skills*. Tinybeans. https://tinybeans.com/dad-how-do-i-youtube-videos/

Uzan, H., Sardi, S., Goldental, A. et al. Biological learning curves outperform existing ones in artificial intelligence algorithms. Sci Rep 9, 11558 (2019). https://doi.org/10.1038/s41598-019-48016-4

What is critical thinking?. What is Critical Thinking? - University of Louisville Ideas To Action. (n.d.). https://louisville.edu/ideastoaction/about/criticalthinking/what

Wiener, N. (1961). Cybernetics or Control and Communication In the Animal and the Machine. Massachusetts Institute of Technology.

Wistoft, K. (2013). The desire to learn as a kind of love: gardening, cooking, and passion in outdoor education. *Journal of Adventure Education and Outdoor Learning*, *13*(2), 125–141. https://doi.org/10.1080/14729679.2012.738011

Wixted, J. T. (2024). Atkinson and Shiffrin's (1968) influential model overshadowed their contemporary theory of human memory. *Journal of Memory and Language*, *136*, 104471-https://doi.org/10.1016/j.jml.2023.104471