Generative AI and the Development of Critical Thinking Skills

MOSES MWANGI THIGA
Kabarak University

Abstract- Generative AI continues to grow in its ability to generate content that is largely accurate and believable. While these capabilities have their clear benefits and advantages there are also growing concerns on the increase in its misuse in many contexts. A key worrying trend in these misuse scenarios is the lack of a critical evaluation of Generative AI content with some users using it 'as is' without giving much thought to its accuracy, logic, practicality, completeness and ethical soundness. This study examined the relationship between Generative AI and the development of critical thinking. This work established that Generative AI can be both a danger as well as an enabler of critical thinking. It also established that Critical Thinking is required for the development and user of Generative AI. It further established that Critical Thinking skills can be developed using Generative AI through systematic and in-depth questioning of the outputs of the tools in use. The idea of questioning is premised on the knowledge and acceptance that GenAI outputs are prone to inaccuracy, hallucinations and bias among other challenges that make them unsuitable for acceptance without questioning.

Indexed Terms- Generative AI, Critical Thinking, Foundation Models, Hallucination, Bias, Questioning, Evaluation

I. CRITICAL AND NON-CRITICAL THINKING

Critical thinking is a kind of thinking in which one questions**,** analyses**,** interprets**,** evaluates **and** makes a judgment about what they have read, heard, said, or written. The term *critical has its origins* from the Greek word *kritikos* meaning "able to judge or discern". (Monash University, 2024). It has also been defined as "*the intellectually disciplined process of actively and skillfully conceptualizing, applying, analyzing, synthesizing, and/or evaluating information gathered from, or generated by, observation, experience, reflection, reasoning, or communication, as a guide to belief and action.*" (Scriven & Paul, 2003).

Critical thinking requires one to clarify the purpose and context of their thoughts, to question the sources of the information they receive, to identify and evaluate the arguments of others, and to be able to formulate their own logical arguments. (Monash University, 2024). On the converse, non-critical thinking is characterized by a passive acceptance of information (without questioning the source, validity, or potential biases), emotional decision making (relying on feeling and instinct rather than evidence), confirmation bias (selecting information that reinforces as opposed to disrupting prior beliefs) and appeal to authority (accepting sources simply because they sound authoritative). The consequences of non-critical thinking are dire; the reliance on unreliable sources, susceptibility to misinformation, narrow mindedness, and a distorted view of reality among others (Believe In Mind, 2023).

II. DEVELOPMENT OF CRITICAL THINKING SKILLS

Critical thinking is manifested when an individual is able to demonstrate a core set of skills that comprise interpretation, analysis, evaluation, inference, explanation and self-regulation according to Facione (1990). According to the Learning Development Center at the University of Plymouth (2006), these skills can be developed by engaging in a series of self directed or guided questioning process. The process, presented in Figure 1 comprises three key steps; description, analysis and evaluation that contain guiding questions around a topic or an issue.

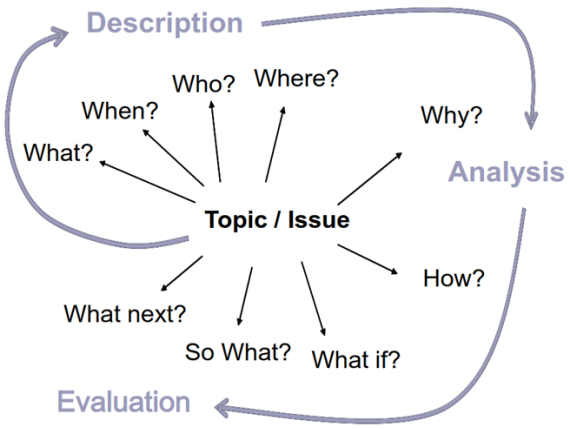

Figure 1: Model to Generate Critical Thinking (Learning Development, 2006).

The what, when who and where questions in the description step lead to an understanding of the background and context of the topic or issue. The why, how and 'what if' questions at the analysis step facilitate an exploration of the relationship between the parts and the whole of the topic or issue as well as identifies problems and alternative view points. The 'so what' and 'what next' questions in the evaluation stage facilitate the identification of solutions, conclusions and recommendations around the topic or issue at hand (Learning Development, 2006). These steps lead to a through examination of the topic or issue at hand whether it presents as a problem or an inquiry for knowledge.

III. ICT CHALLENGES TO THE DEVELOPMENT OF CRITICAL THINKING SKILLS

The development of critical thinking skills is not without challenges in the contemporary context that is characterized by significant advances in Information and Communication Technologies (ICTs). Some of these challenges include;

i. Information Overload - Information overload is defined as a situation where one receives too much information at one time and cannot process it in a clear way (Cambridge Dictionary, 2024). This information can come from sources such as radio, television, print media, websites, e-mail, mobile telephony and RSS feeds among others (Okolo, 2021). This overload can make it difficult to undertake the in-depth analysis and evaluation required for critical thinking.
ii. Attention Economy - The Attention economy refers to the range of economic activities that are premised on the idea that people's attention is a scarce resource that needs to be captured and maintained (Dictionary.com, 2022b). This competition for attention leads to a superficial engagement with information and hinders the development of critical thinking skills that require deeper cognitive processing (Atchley & Lane, 2014)
iii. Filter Bubbles - Filter bubbles are a type of echo chamber (a bounded, enclosed media space that magnifies messages delivered to it and insulates participants from 'external' or messages inconsistent with that space), that is created by personalization algorithms online. These algorithms create a unique universe of information for us by showing more of what we like and less of what we don't (Arguedas et al., 2022). This has the net effect of limiting a person from diverse perspectives required for the development of critical thinking skills.
iv. Misinformation and Disinformation - Misinformation is false or misleading information. Disinformation is false information that is deliberately intended to mislead its recipients (Dictionary.com, 2022a). It's emotive and confirmation bias appeal is further hampering the development of critical thinking skills.
v. AI Generated Content - AI-generated content refers to any content, such as text, images, audio, or video, that is created with the assistance of artificial intelligence (AI) technologies (Wu, Gan, Chen, Wan, & Lin, 2023). The relative ease with which AI can generate high quality and believable content has led to over-reliance and a lack of critical thinking.

IV. GENERATIVE ARTIFICIAL INTELLIGENCE

Generative Artificial Intelligence (GenAI) refers to a class of deep learning models that can generate high quality text, images, video, music, speech, software and designs (Gartner, 2024). Its relationship with the broader field of Artificial Intelligence is depicted in **Error! Reference source not found.**

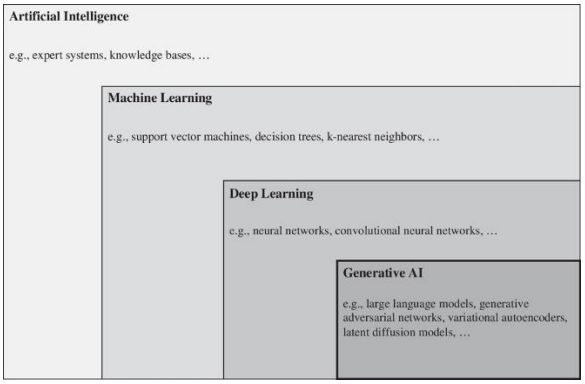

Figure 2: Generative Artificial Intelligence (Banh & Strobel, 2023)

GenAI is powered by large-scale AI models known as foundation models that are trained unsupervised or semi-supervised on vast amounts of unlabeled data. They typically employ deep neural networks with millions or billions of parameters and require significant computing resources during training. Their large size and complexity enables them to capture complex patterns and relationships in data. This in turn enables them to excel in generating text, language translation, and creative content (XenonStack, 2024).

Foundation models can be categorized into three types;

i. Large Language Models (LLMs): These models are designed to process and understand natural language in order to perform tasks such as content generation, language translation and localization, answering questions, search and recommendation, code generation, market research classification and generating text (Haritonova, 2024). Popular LLMs include the Bidirectional Encoder Representations from Transformers (BERT), Generative Pre-Trained Transformers (GPTs) and the Text-to-Text Transfer Transformer (T5) (XenonStack, 2024). Examples of LLM tools include ChatGPT (OpenAI, 2024) and Gemini (Google, 2024).
ii. Computer Vision Models: These models are designed to process and understand visual data so that they can perform tasks like image classification, object detection and image segmentation. Examples of these models include ResNet, EfficientNet and YOLO (You Only Look Once) (Pathak, 2023). Other models include the Vision Transformer (ViT) (Dosovitskiy et al., 2021), Grounding DINO (Ikomia, 2024), Segment Anything (SAM) (Kirillov et al., 2023) and CLIP (Radford et al., 2021). Computer vision has been applied in diverse ways such as in self driving cars, road condition monitoring, X-ray analysis, digital pathology, defect inspection in manufacturing, crop yield monitoring, and pest and disease detection among others (XenonStack, 2023).
iii. Multimodal Models: These models integrate multiple data types such as images, text and audio and can perform tasks such as image captioning, text to image generation, sign language recognition, emotion recognition and video processing. Examples of these multimodal models include Visual ChatGPT, MM-REACT, Frozenm LlaMA-Adapter, BLIP-2, MiniGPT-4, LlaVA, PICa, PNP-VQA and Img2LLM (Wu, Gan, Chen, Wan, & Yu, 2023). Examples of Multimodal AI tools include ChatGPT (OpenAI, 2024), Gen-2 (Runway Research, 2024), ImageBind (Meta AI, 2024), Inworld (Inworld AI, 2024), Objective (Objective, Inc, 2024) and Gemini (Google, 2024)

Foundation models face a number of challenges nevertheless. (i) They can be biased on account of the data provided to them during training, (ii) they can lack domain specificity if not trained on relevant data, (iii) they can suffer interpretability challenges given that they are build on deep learning architectures that are generally complex, (iv) they require high computation resources at the training stages and (v) they may also lack an understanding of subtle yet important things such as context, humor, sarcasm, or cultural references during the generation of outputs (XenonStack, 2024).

GenAI applications built on top of these foundation models too have their fair share of challenges.

i. Bias - GenAI is prone to both data and algorithmic biases. Data biases originate from the data provided to models during the training phase of the model development. Algorithmic biases are introduced during the inference phase of model development largely from how the algorithms are designed and tuned (Banh & Strobel, 2023).
ii. Intellectual Property - GenAI applications are built on foundation models that are trained on data that is the intellectual property of other people and organizations. When it is utilized to generate new content then the owners of the IP may object

(Smits & Borghuis, 2022). The issue extends to claims for copyrights by people who use GenAI applications to generate works, can they claim ownership of such works? (European Union Agency for Criminal Justice Cooperation, 2023)

iii. Transparency - The core architecture of GenAI is deep neural networks. These networks are inherently complex and very difficult to explain how they arrive at the outputs they provide. This is made even more difficult by the closed-source nature of some of these models (Banh & Strobel, 2023).
iv. Hallucinations – GenAI is prone to generating outputs that seem plausible but are either incorrect or unreasonable with respect to the source of information. Though still under investigation, it is thought that this is caused by the presence of incorrect, contradictory or fictional information in the training data for the foundation models (Banh & Strobel, 2023).
v. Misuse – GenAI is prone to uses cases that are malicious or unacceptable from an ethical or legal standpoint. For instance it can be used to create deep fakes to spread mis-information and influence people unduly (Banh & Strobel, 2023). In education students can use LLM's to generate responses to assessments which is unacceptable in academic circles where originality is expected (Shmueli et al., 2023). In employment settings employees are increasingly turning to GenAI to perform their tasks often times without the knowledge and approval of their employers (World Economic Forum, 2024).

V. GENERATIVE AI AND CRITICAL THINKING

Generative AI as a Danger to Critical Thinking

According to Bhosale (2023), over-reliance on GenAI can lead to a reduction in critical thinking by researchers. Farrokhnia et al (2023) established that the use of GenAI tools by teachers and students can lead to a decline in high-order cognitive skills such as critical and analytical thinking. On the part of students the use of GenAI tools makes it easy to obtain solutions and reduces the motivation to conduct independent research, exploration and analysis in order to arrive at their own findings and conclusions. On the part of teachers, the ease with which GenAI tools can generate lesson plans and assessments can lead to a reliance on the tools leading to a reduction in their mastery of the subject matter.

In workplace settings GenAI capabilities are now increasingly being integrated into productivity tools. They are able to assist users with tasks such as writing email, drafting reports, and in developing concepts and proposals. While these are well intended they have the overall impact of reducing users ability to think through and critique their writing. With time, over reliance can lead to the loss of creativity and critical thinking skills (Benard, 2023). In this regard, Korolov (2023), recommends that employers constantly help their employees to develop critical thinking skills in order to use these tools effectively.

GenAI tools are also increasingly in use for code development though auto-complete features, natural language input and direct interaction through a chat interface. From the perspective of the tool developers the generated code should be inspected before being put into production but this is not always the case. In this regard, these GenAI tools that generate code can also lead to diminishing coding and critical thinking skills among programmers (SonarSource SA, 2024)

Generative AI as an Enabler of Critical Thinking

GenAI has been found to play a role in influencing the development of critical thinking skills. In a study by conducted among undergraduate students in Ghana by Essel et al (2024) the use of ChatGPT was found to influence the development of the students' critical, reflective, and creative thinking skills and their dimensions discernibly. The use of GenAI in teaching programming was explored by Yilmaz and Yilmaz (2023) with a group of students. Students who used the GenAI tool, ChatGPT, were found to perform better on the computational thinking scale, computer programming self-efficacy scale, and learning motivation in computer programming courses scale.

According to Risvold et al (2024) GenAI can play the role of a non-judgmental collaborator who can patiently and objectively entertain all manner of questions. This can help learners explore their ideas through questioning and reflecting on the variety of responses provided by a GenAI tool. A similar argument is advanced by Gigster (2023) who describe

the potential value of GenAI in a medical setting where healthcare students and professionals can exercise critical thinking in a virtual environment thereby limiting exposure of actual patients to 'experiments'.

An approach to integrate AI into a teaching and learning experience for learning critical thinking skills was proposed by Aithal and Silver (2023). Their approach comprises of three steps, understand and analyze ideas and arguments, evaluate ideas and arguments and then apply the knowledge gained to solve problems and make decisions. The first two are conducted collaboratively with an AI chatbot through a Q & A session.

Developing Critical Thinking Skills with Generative AI

Critical thinking is also a key skill for the development and use of GenAI. Carruci (2024) notes that fact checking, source and other critical thinking skills are crucial for the proper training of AI models as well as in using the applications derived from them. According to the MIT Horizion (2023), continuous learning to grow one's body of knowledge on a subject, cross checking the accuracy of the information in the outputs, and reflecting on the output to establish if it is what was desired and if there are any missing or inadequate aspects are important skills for GenAI users (MIT Horizon, 2023).

VI. REFLECTIONS AND WAY FORWARD

The key question of this study was "*How can Generative AI contribute to the development of Critical Thinking Skills*?"

The working definition of critical thinking for the purposes of this discussion is "a kind of thinking in which one questions**,** analyses**,** interprets**,** evaluates and makes a judgment about what they have read, heard, said, or written". (Monash University, 2024).
In this regard this paper makes the following proposal for the development of critical thinking skills whilst using GenAI tools.

Step 1: Consider GenAI as a helper, not a replacement

The first critical step towards developing critical thinking skills is acknowledging the place of GenAI in the tasks at hand. The tools are not designed to replace human involvement or input in the tasks that are assigned to them. Rather they are very powerful assistants who are also known to be wrong, biased and out-rightly unethical at times. Their human masters must therefore be at hand to assess and enhance their outputs before making use of them.

Step 2: Question the outputs

The assessment of the outputs of GenAI is undertaken through as process of questioning. This is informed by the perspective that GenAI outputs cannot be taken at face value but must be examined critically before acceptance and use. 4

The following questions are proposed;

1. Truth - Is the output true or factual?
2. Completeness - Is the output comprehensive?
3. Logical - Does the output make sense?
4. Practicality - Are the recommendations practical?
5. Ethical - Do the outputs violate any ethical principles?

The implication thereof is that the average GenAI user must possess significant knowledge in the subject matter that they seek assistance on from GenAI. That background knowledge must be sufficient enough to help them ask the right questions in the right way. It must be sufficient to help them evaluate the outputs of seemingly new content for accuracy in the light of prior knowledge. This is helpful in order to help them identify departures from established principles and schools of thought.

Grounding in logic is critical when it comes to evaluating the sequence of ideas presented in the output. A user must be conversant with what is a logical vs illogical argument, and how an argument must proceed to a logical conclusion. This will help in assessing whether any conclusions presented by GenAI have valid premises.

An ethical antennae is also very important for a GenAI user. The outputs of these tools have been found to perpetuate biases in subtle ways that may not be obvious to an untrained eye. It is therefore important that GenAI users examine the outputs from the perspectives of fairness, bias, and fair representation among other ethical considerations.

Step 3: Make a judgment

With the facts at hand one must make a determination on whether or not to utilize the outputs of the GenAI tool in whole or in part. This ought not to be a passive step but rather one that is informed by the outcomes of the questioning process. Ideally a positive indication from all the five questions ought to be the benchmark for proceeding to utilize the GenAI output.

CONCLUSION

Generative AI is technological advancement that has had significant impact in the area of content generation. It is now relatively easy to develop text, images, video and audio that is of high quality and very believable by most human standards. However, the technology has been found to have some fundamental challenges that relate to the accuracy of the content, bias, intellectual property infringement, transparency and misuse.

Additionally concerns have been raised on it's impact on the role of users in the generation of the content from an intellectual, legal and ethical perspective. There are questions regarding the implications of utilizing GenAI solutions on human creativity and critical thinking among other 21st Century skills. There are legal issues around the use of peoples Intellectual Property by foundation models as well as ownership of derived works. From an ethical perspective there are discussions on the legitimacy of assessments and documents generated by GenAI tools in academic and work setups.

As has been the case with many technological advancements before GenAI, a period of uncertainty, rejection and denial always precedes acceptance as the technologies and support systems develop and mature. In the case of GenAI the healthy debates around its challenges are serving to improve the technology as well as the requisite support structures for its effective utilization. A key support structure is the availability of clear and concise guidelines for everyday users on how to critically assess the outputs of GenAI tools.

This work first and foremost established that Generative AI can be both a danger as well as an enabler of critical thinking. It also established that Critical Thinking is required for the development and user of Generative AI. It further established that Critical Thinking skills can be developed using Generative AI through systematic and in-depth questioning of the outputs of the tools in use. The idea of questioning is premised on the knowledge and acceptance that GenAI outputs are prone to inaccuracy, hallucinations and bias among other challenges that make them unsuitable for acceptance without questioning.

REFERENCES

[1] Arguedas, A. R., Robertson, C. T., Fletcher, R., & Nielsen, R. K. (2022). *Echo chambers, filter bubbles, and polarisation: A literature review*. https://reutersinstitute.politics.ox.ac.uk/echo-chambers-filter-bubbles-and-polarisation-literature-review

[2] Atchley, P., & Lane, S. (2014). Cognition in the Attention Economy. In B. H. Ross (Ed.), *Psychology of Learning and Motivation* (Vol. 61, pp. 133–177). Academic Press. https://doi.org/10.1016/B978-0-12-800283-4.00004-6

[3] Banh, L., & Strobel, G. (2023). Generative artificial intelligence. *Electronic Markets*, *33*(1), 63. https://doi.org/10.1007/s12525-023-00680-1

[4] Believe In Mind. (2023, May 7). *Critical Thinking and Non-Critical Thinking: Key Differences*. https://www.believeinmind.com/self-growth/critical-thinking-and-non-critical-thinking-key-differences/

[5] Benard, J.-L. (2023, September 11). *A Double-Edged Sword: The Risks of Using Generative AI in Employee Communication*. Sociabble. https://www.sociabble.com/blog/ai/risks-generative-ai/

[6] Bhosale, U. (2023, July 17). Responsible Use of Generative AI. *Enago Academy*. https://www.enago.com/academy/responsible-use-of-generative-ai/

[7] Cambridge Dictionary. (2024, February 28). *Information Overload*. https://dictionary.cambridge.org/dictionary/english/information-overload

[8] Carucci, R. (2024). *In The Age Of AI, Critical Thinking Is More Needed Than Ever*. Forbes. https://www.forbes.com/sites/roncarucci/2024/02/06/in-the-age-of-ai-critical-thinking-is-more-needed-than-ever/

[9] Dictionary.com. (2022a, August 15). "Misinformation" vs. "Disinformation." *Dictionary.Com*. https://www.dictionary.com/e/misinformation-vs-disinformation-get-informed-on-the-difference/

[10] Dictionary.com. (2022b, October 6). What Is "Attention Economy"? *Dictionary.Com*. https://www.dictionary.com/e/politics/attention-economy/

[11] Dosovitskiy, A., Beyer, L., Kolesnikov, A., Weissenborn, D., Zhai, X., Unterthiner, T., Dehghani, M., Minderer, M., Heigold, G., Gelly, S., Uszkoreit, J., & Houlsby, N. (2021). *An Image is Worth 16x16 Words: Transformers for Image Recognition at Scale* (arXiv:2010.11929). arXiv. https://doi.org/10.48550/arXiv.2010.11929

[12] 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 (LLMs). *Computers and Education: Artificial Intelligence*, *6*, 100198. https://doi.org/10.1016/j.caeai.2023.100198

[13] European Union Agency for Criminal Justice Cooperation. (2023). *Generative Artificial Intelligence—The impact on intellectual property crimes*. https://www.eurojust.europa.eu/publication/generative-artificial-intelligence-impact-intellectual-property-crimes

[14] Facione, P. A. (1990). *Critical Thinking: A Statement of Expert Consensus for Purposes of Educational Assessment and Instruction. Research Findings and Recommendations*. https://eric.ed.gov/?id=ED315423

[15] Farrokhnia, M., Banihashem, S. K., Noroozi, O., & Wals, A. (2023). A SWOT analysis of ChatGPT: Implications for educational practice and research. *Innovations in Education and Teaching International*, *0*(0), 1–15. https://doi.org/10.1080/14703297.2023.2195846

[16] Gartner. (2024). *Generative AI: What Is It, Tools, Models, Applications and Use Cases*. https://www.gartner.com/en/topics/generative-ai

[17] Gigster. (2023, September 1). How AI Shapes the Future of Critical Thinking. *Gigster*. https://gigster.com/blog/ai-critical-thinking/

[18] Google. (2024). *Gemini—Chat to supercharge your ideas*. https://gemini.google.com

[19] Haritonova, A. (2024). *Top 10 Real-Life Applications of Large Language Models*. PixelPlex. https://pixelplex.io/blog/llm-applications/

[20] Ikomia. (2024). *Grounding DINO: Revolutionizing AI with Zero-Shot Detection*. https://www.ikomia.ai/blog/grounding-dino-zero-shot-detection-explained

[21] Inworld AI. (2024). *Inworld*. https://inworld.ai/

[22] Kirillov, A., Mintun, E., Ravi, N., Mao, H., Rolland, C., Gustafson, L., Xiao, T., Whitehead, S., Berg, A. C., Lo, W.-Y., Dollár, P., & Girshick, R. (2023). *Segment Anything* (arXiv:2304.02643). arXiv. https://doi.org/10.48550/arXiv.2304.02643

[23] Korolov, M. (2023, September 5). *GenAI in productivity apps: What could possibly go wrong?* Computerworld. https://www.computerworld.com/article/3705429/generative-ai-productivity-apps-problems-solutions.html

[24] Learning Development. (2006). *Model to Generate Critical Thinking*. University of Plymouth. https://archive.learnhigher.ac.uk/resources/files/Critical%20thinking/8%20Critical%20Thinking.pdf

[25] Meta AI. (2024). *ImageBind*. https://imagebind.metademolab.com/

[26] MIT Horizon. (2023). *Critical Thinking in the Age of AI*. https://horizon.mit.edu/insights/critical-thinking-in-the-age-of-ai

[27] Monash University. (2024). *What is critical thinking?* Student Academic Success. https://www.monash.edu/student-academic-

success/enhance-your-thinking/critical-thinking/what-is-critical-thinking

[28] Objective, Inc. (2024). *AI-Native Search for Every Website and Application*. https://www.objective.inc/

[29] Okolo, S. (2021). Information Overload: Causes, Symptoms, Consequences and Solutions. *Asian Journal of Information Science and Technology*, *11*, 1–6. https://doi.org/10.51983/ajist-2021.11.2.2887

[30] OpenAI. (2024). *ChatGPT*. https://openai.com/chatgpt

[31] Pathak, P. (2023, April 27). Foundation Models: A step-by-step guide for beginners. *Scribble Data*. https://www.scribbledata.io/blog/foundation-models-101-a-step-by-step-guide-for-beginners/

[32] Radford, A., Kim, J. W., Hallacy, C., Ramesh, A., Goh, G., Agarwal, S., Sastry, G., Askell, A., Mishkin, P., Clark, J., Krueger, G., & Sutskever, I. (2021). *Learning Transferable Visual Models From Natural Language Supervision* (arXiv:2103.00020). arXiv. https://doi.org/10.48550/arXiv.2103.00020

[33] Risvold, W., Stratton, M., & Geddy, M. (2024). *How to Evaluate Critical Thinking in the Age of AI*. https://www.aacsb.edu/insights/articles/2024/02/how-to-evaluate-critical-thinking-in-the-age-of-ai

[34] Runway Research. (2024). *Gen-2*. https://research.runwayml.com/gen2

[35] Scriven, M., & Paul, R. (2003). Defining critical thinking: A statement prepared for the National Council for Excellence in Critical Thinking Instruction. *8th Annual International Conference on Critical Thinking and Education Reform, Summer 1987*.

[36] Shmueli, G., Maria Colosimo, B., Martens, D., Padman, R., Saar-Tsechansky, M., R. Liu Sheng, O., Street, W. N., & Tsui, K.-L. (2023). How Can IJDS Authors, Reviewers, and Editors Use (and Misuse) Generative AI? *INFORMS Journal on Data Science*, *2*(1), 1–9. https://doi.org/10.1287/ijds.2023.0007

[37] Silver, V. A. and J. (2023, March 30). Enhancing critical thinking skills with AI-assisted technology. *World of Better Learning | Cambridge University Press*. https://www.cambridge.org/elt/blog/2023/03/30/enhancing-learners-critical-thinking-skills-with-ai-assisted-technology/

[38] Smits, J., & Borghuis, T. (2022). Generative AI and Intellectual Property Rights. In B. Custers & E. Fosch-Villaronga (Eds.), *Law and Artificial Intelligence: Regulating AI and Applying AI in Legal Practice* (pp. 323–344). T.M.C. Asser Press. https://doi.org/10.1007/978-94-6265-523-2_17

[39] SonarSource SA. (2024). *What is AI Code Generation? Benefits, Tools & Challenges*. https://www.sonarsource.com/learn/ai-code-generation/

[40] World Economic Forum. (2024, January 16). *3 ways companies can mitigate the risk of AI in the workplace*. World Economic Forum. https://www.weforum.org/agenda/2024/01/how-companies-can-mitigate-the-risk-of-ai-in-the-workplace/

[41] Wu, J., Gan, W., Chen, Z., Wan, S., & Lin, H. (2023). *AI-Generated Content (AIGC): A Survey* (arXiv:2304.06632). arXiv. http://arxiv.org/abs/2304.06632

[42] Wu, J., Gan, W., Chen, Z., Wan, S., & Yu, P. S. (2023). *Multimodal Large Language Models: A Survey* (arXiv:2311.13165). arXiv. https://doi.org/10.48550/arXiv.2311.13165

[43] XenonStack. (2023). *Top 6 Computer Vision Applications*. https://www.xenonstack.com/blog/computer-vision-applications

[44] XenonStack. (2024). *Introduction to Foundation Models| A Complete Guide*. https://www.xenonstack.com/blog/foundation-models

[45] Yilmaz, R., & Yilmaz, F. G. K. (2023). The effect of generative artificial intelligence (AI)-based tool use on students' computational thinking skills, programming self-efficacy and motivation. *Computers and Education: Artificial Intelligence*, *4*, 100147. https://doi.org/10.1016/j.caeai.2023.100147