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Epistemologies of Authentic Assessments Amidst the AI Advancement: An Evaluation of the Divergence Between Traditional and AI-Generated Scientific Illustrations

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ABSTRACT

As artificial intelligence (AI) continues to advance and improve its capacity to provide detailed explanations, a critical question emerges: Can students still cultivate a deep and meaningful understanding of educational material? This question underscores the need to reassess and innovate the methods that researchers use to evaluate student comprehension in this rapidly evolving technological landscape. This study focuses on exploring the significant differences between traditional scientific illustrations, crafted by students and those generated by AI tools. A diverse group of 267 students from the University of Venda in South Africa participated in the evaluation process, which used a comprehensive assessment tool designed to allocate a maximum of 10 marks based on various criteria, such as clarity, accuracy, and relevance of the illustrations. To assess the capabilities of different AI tools, the researchers specifically instructed the selected students to use the AI system to generate an illustration of the root cap structure of the buttercup plant. Through this approach, students were empowered to effectively monitor and reflect on their own learning processes and outcomes. The findings from this study suggest that educational instructors should emphasise the importance of critical evaluation when students engage with AI-generated content. In particular, educators and lecturers should guide students to assess AI responses by scrutinising factors such as accuracy, potential biases inherent in AI algorithms, and the degree of simplification presented in the illustrations. By promoting an active engagement with technology, students are encouraged to become discerning users of AI tools, rather than passive consumers of content. State the contribution of this study to scholarship.

Keywords: Active learning, Artificial Intelligence, Balance, practical application, digital competence, critical thinking, self-supervised learning.

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INTRODUCTION

Illustrations are vital in the sciences, particularly in biological fields, as they effectively communicate complex information that words alone often struggle to convey. This notion is encapsulated in the well-known proverb, "A picture is worth a thousand words," which underscores the essential role of visual

aids in scientific research and education.[1] In the realm of science, education is fundamentally anchored in the systematic collection, analysis, and recording of data. Visual representations such as diagrams, charts, and illustrations serve not only to clarify intricate concepts but also to enhance engagement and retention for learners.[2] For instance, in biology, detailed illustrations of cellular structures or ecological systems can provide students with a clearer understanding of these topics than written descriptions alone could achieve.

The creation of illustrations is one of the oldest and most effective methods for documenting scientific findings and observations. Historically, scientists like Leonardo da Vinci and Ernst Haeckel used illustrations to capture and share their discoveries, paving the way for modern scientific communication.[3] Thus, integrating illustrations into science education not only enriches the learning experience but also fosters a deeper appreciation for the natural world, making it an indispensable tool in both teaching and research. A study conducted by Quillin and Thomas emphasises the significant challenges faced in the teaching, learning, and conducting of biological research when visual representations are not utilised.[4] Their findings reveal that visual aids are not merely enhancements; they are essential instruments that clarify complex concepts and expose phenomena that would otherwise remain invisible. By converting intricate processes into accessible visual formats, these illustrations facilitate improved understanding and retention of scientific knowledge.

Furthermore, employing drawings and illustrations is especially beneficial for scientists as it allows them to develop critical skills essential for mastering complicated processes, such as cellular respiration (illustrated in Figure 1a) and meiosis (illustrated in Figure 1b). These drawings do not just serve as representations; they become instrumental in the cognitive process of learning and understanding. Each illustration contributes to the development of a deeper comprehension of biological principles, fostering a more profound engagement with the subject matter. Thus, cultivating the skill of illustration in science education is not only an artistic endeavour but also a vital component of scientific mastery.

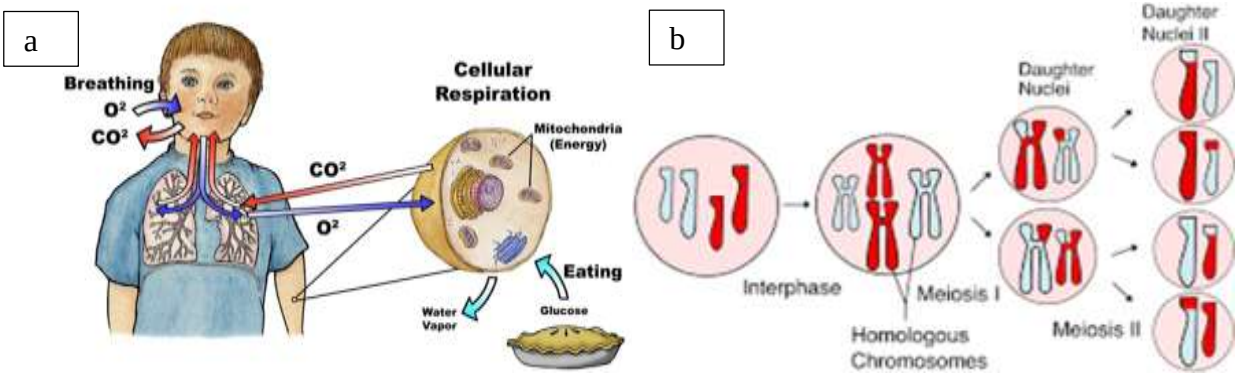

Figure 1: Biological drawings that foster understanding of the complex processes.

The application of drawing in science education is not only an essential skill but also serves as a valuable assessment tool for educators. This process typically involves instructing students in the specific rules and conventions of biological drawing, which are crucial for creating accurate and informative illustrations. Mastering these rules allows students to effectively annotate their drawings, providing deeper insights into the biological concepts depicted.

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[1] Sarah E Holmes, "An Exploration of Online Christian Faith Nurture for Children, Using UK Churches as a Case Study," *International Journal of Christianity & Education* 25, no. 2 (2021): 169–83.

[2] Nimet Akben, "Effects of the Problem-Posing Approach on Students' Problem Solving Skills and Metacognitive Awareness in Science Education," *Research in Science Education* 50, no. 3 (2020): 1143–65.

[3] L. Floridi and J. Cowls, "A Unified Framework of Five Principles for AI in Education," *Philosophy & Technology* 32 (2019): 687–703.

[4] Kim Quillin and Stephen Thomas, "Drawing-to-Learn: A Framework for Using Drawings to Promote Model-Based Reasoning in Biology," *CBE—Life Sciences Education* 14, no. 1 (2015): es2.

In the contemporary educational landscape, the use of Artificial Intelligence (AI) tools in the instruction of biological drawing has gained increasing prominence. The integration of these tools significantly enhances the learning experience and deepens students' understanding of biological concepts. The recent advancements in machine learning technologies have generated heightened interest in research related to AI's potential applications in education.[5]

This study aims to explore the practice of biological drawing by combining traditional artistic guidelines with innovative AI tools. Through both convenience and purposive sampling techniques, students from the University of Venda were selected with a focus on first-year students to evaluate the effectiveness and coherence of students' drawings. The study aims to assist educators in assessing students' understanding of biological concepts and their illustrative abilities. Additionally, it seeks to enhance drawing skills through personalised and adaptive learning experiences.

LITERATURE REVIEW

In recent years, there has been a notable surge in interest surrounding the integration of artificial intelligence (AI) technologies in education. This growing interest can be attributed to several key factors, including remarkable advancements in technology, an increasing reliance on digital tools, and an urgent need for innovative pedagogical approaches that address the unique challenges of modern learning environments.[6]

Many researchers have underscored the transformative potential of AI tools, highlighting their ability to create personalised and adaptive learning experiences tailored to individual students' needs. These technologies offer educators the resources to customise instruction, facilitating a more inclusive educational process that recognises and accommodates diverse learning styles and paces. For instance, AI can analyse student performance data to identify strengths and weaknesses, enabling targeted interventions and support strategies to enhance learning outcomes.

Furthermore, AI systems provide valuable intellectual support to both students and teachers throughout the educational journey. By delivering real-time feedback, recommending resources, and offering insights based on data analysis, AI enhances the learning experience.[7] For example, platforms powered by AI can suggest supplementary materials tailored to a student's specific challenges, thereby fostering a deeper understanding of the subject matter.[8]

As educational institutions endeavour to harness these innovations, it is crucial to consider not only the technological capabilities of AI but also the broader implications for pedagogy, assessment methods, and overall educational effectiveness. This includes examining how AI can reshape traditional teaching practices, influence the role of educators, and impact student engagement and learning outcomes. By thoughtfully integrating AI into educational frameworks, researchers can pave the way for a more dynamic and responsive learning environment that meets the needs of all learners.

THEORETICAL FRAMEWORK

The Diffusion of Innovation theory, developed by Everett Rogers in 1962, provides a robust framework for understanding how innovative ideas and technologies spread within a population. This theory is a widely used social science theory that explains how, why, and at what rate innovative ideas and technologies spread through populations. Rogers identified five key attributes of innovations that influence their rate of adoption, which encompass relative advantages, compatibility, complexity, trialability, and observability. The theory articulates that the degree to which an innovation is perceived as better than the idea it supersedes. Applying this theory to the adoption of Artificial Intelligence (AI) in teaching and learning can offer valuable insights into the dynamics of its transition. AI itself

[5] Eva Cetinic and James She, "Understanding and Creating Art with AI: Review and Outlook," *ACM Transactions on Multimedia Computing, Communications, and Applications* 18, no. 2 (May 31, 2022): 1–22, https://doi.org/10.1145/3475799.

[6] Helen; Sharpe Beetham, Helen Beetham, and Rhona Sharpe, *Rethinking Pedagogy for a Digital Age* (routledge London, 2007); Holmes, "An Exploration of Online Christian Faith Nurture for Children, Using UK Churches as a Case Study."

[7] Innocent Zitha, Georgina Mokganya, and Orifha Sinthumule, "Innovative Strategies for Fostering Student Engagement and Collaborative Learning among Extended Curriculum Programme Students," *Education Sciences* 13, no. 12 (2023): 1196.

[8] Rose Luckin and Wayne Holmes, "Intelligence Unleashed: An Argument for AI in Education," 2016; National Center for Education Statistics (NCES), *The Condition of Education 2020* (U.S. Department of Education, 2020).

represents a significant innovation, characterised by its relative advantages, compatibility, complexity, trialability, and observability. Relative Advantage: This refers to the extent to which AI is regarded as superior to the solution it replaces, such as AI-powered automation compared to manual processes. Compatibility: This describes how well AI aligns with the existing values, past experiences, and needs of potential users. Complexity: This indicates how challenging AI is perceived to be in terms of understanding and usage. Trialability: This reflects the capability to test AI on a limited scale before full adoption. Observability: This pertains to how visible the results of AI are to others, enhancing its perceived value and effectiveness.

Addressing Barriers to Adoption

Complexity and compatibility are significant barriers to AI adoption. Simplifying AI interfaces, providing training, and ensuring compatibility with existing systems can mitigate these barriers. Trialability, allowing potential adopters to test AI on a small scale, can also increase adoption rates. Using diverse communication channels, including mass media, digital platforms, and interpersonal networks, can enhance AI awareness and understanding. Highlighting AI's relative advantages and observable benefits can further drive adoption. Engaging opinion leaders and building supportive social networks can foster positive attitudes towards AI. Addressing ethical concerns and ensuring equitable access to AI technologies can promote broader acceptance. The diffusion of AI also depends on the policy and regulatory frameworks. The Diffusion of Innovation theory offers an important framework for understanding the complexities involved in the transition to AI. By examining the characteristics of AI as an innovation, using effective and dynamic operations, acknowledging the role of time, and recognising the influence of social systems, stakeholders can create strategies that promote responsible and equitable adoption of AI. The recognition of this theory will enable students to have unlimited self-supervised learning when AI is incorporated with the traditional principles of biological drawings to mitigate the points of divergence and establish an innovative and dynamic model for application.

METHODOLOGY

The researchers employed a sampling method that considered participant availability, the study's objectives, the characteristics of the population, and the required level of precision. In convenience sampling, participants are chosen based on their accessibility. In purposive sampling, participants are selected based on specific criteria that align with the research goals. This study utilised both convenience and purposive sampling techniques to select the University of Venda as a rural-based institution, focusing on first-year students. These students were chosen because they are transitioning into higher education. Thus, the participants in this study are first-level students who are navigating this transition.

Research Design

This study adhered to the research design established by Creswell and Creswell, incorporating both qualitative and quantitative approaches.[9] The qualitative approach was utilised to explore students' experiences, while the quantitative approach focused on analysing the grades achieved by students and the number of students who selected a particular AI tool. In that manner, the research was conducted in five phases, outlined as follows:

Phase 1 (Lesson on biological drawing guidelines)

This stage involves a series of lectures focused on the guidelines for biological drawing. Over the course of five days, participants engaged in discussions about the key principles and techniques required for accurate representation of biological structures. At the end of this intensive session, the group reached a consensus on the date for the assessment, as well as the specific topics and criteria that would be included in the evaluation. This collaborative approach ensured that everyone was on the same page and prepared for the upcoming assessment.

[9] John W Creswell and J David Creswell, *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches* (Sage publications, 2017).

Phase 2 (Facilitation of a gradable assessment for the selection of participants of phase 3)
The assessment tool was valued at 10 marks, with a total of 267 students participating. The grading process allowed for the selection of 80 students to advance to phase 3. These 80 students were those who scored less than 5 out of 10 on the written assessment.

Phase 3 (Extra lesson on biological drawing guidelines)
Additional lessons were arranged and conducted with selected students to clarify and outline the guidelines for biological drawing. These lessons concluded with an assessment worth ten points.

Phase 4 (Selection of an AI tool and drawing of a specific biological drawing)
This phase examined the differences between traditional biological drawings and those generated by AI. Students had the opportunity to choose any AI tool to explore the structure of the root cap of the buttercup plant. To focus their exploration, they followed these steps:
1. The chosen AI tool was instructed to draw the structure of the root cap of the buttercup plant.
2. The AI tool was instructed to adhere to the biological drawing guidelines when creating the drawing.
3. Finally, the AI tool was provided with a list of guidelines that are typically followed in biological illustration.

Phase 5 (Students' experiences and opinions)
In this particular phase of the study, an explanatory sequential approach, as outlined by Mokganya and Zitha and Creswell, was implemented.[10] This involved gathering responses through a free listing technique to explore user experiences with the AI tool. The specific questions posed to participants were:
1. Did the AI tool successfully generate the content or responses that you requested?
2. If your answer to the first question is no, could you elaborate on the reasons for this outcome? We are particularly interested in understanding any limitations or issues that may have influenced the tool's performance.
By framing our inquiry this way, we aim to gain deeper insights into the functionality of the AI tool and identify areas for improvement based on user feedback.
3. What is your overall perspective on using AI tools for biological drawings?

Ethical Considerations
The research project was submitted to the Research Ethics Committee at the University of Venda to ensure compliance with ethical standards and to safeguard the rights of participants. The ethical certificate issued by the University serves as formal confirmation that the study adheres to these guidelines throughout its duration. Prior to participation, all individuals were required to sign an informed consent form. This document clearly outlined the purpose of the research, the procedures involved, and any potential risks. Participants were explicitly informed that their involvement in the study was entirely voluntary and that they could withdraw from the study at any time without facing any negative consequences. This process was designed to promote transparency and uphold the autonomy of all participants involved in the research.

PRESENTATION OF FINDINGS

Biographical profile of the participants
The participating cohort consisted of 74% males and 26% females (see Figure 2), illustrating a predominantly male representation. The participants' ages ranged from 18 to 25 years, demonstrating a youthful demographic. Notably, 53 students were classified within the 21-25 age group (refer to Figure 3). This significant representation of individuals in the 21-25 age category can be attributed to a range

[10] Mokgaetji Georginah Mokganya and Innocent Zitha, "Assessment of First-Year Students' Prior Knowledge as a Pathway to Student Success: A Biology Based Case," in *Proceedings of The Focus Conference (TFC 2022)*, vol. 732 (Paris: Atlantis Press SARL, 2023), 233–46, https://doi.org/10.2991/978-2-38476-006-0_19; J. W. Creswell, *Education Research: Planning, Conducting, and Evaluating Quantitative and Qualitative Research* (Upper Saddle River, NJ: Prentice Hall, 2012).

of factors. Many students opted for gap years, allowing them to gain work experience or travel prior to pursuing their academic goals. Additionally, some initially engaged in other educational pursuits, such as obtaining qualifications in mechanical engineering at various Technical and Vocational Education and Training (TVET) institutions, before transitioning to their current studies. These factors contribute to the diverse age range observed within the participating cohort.

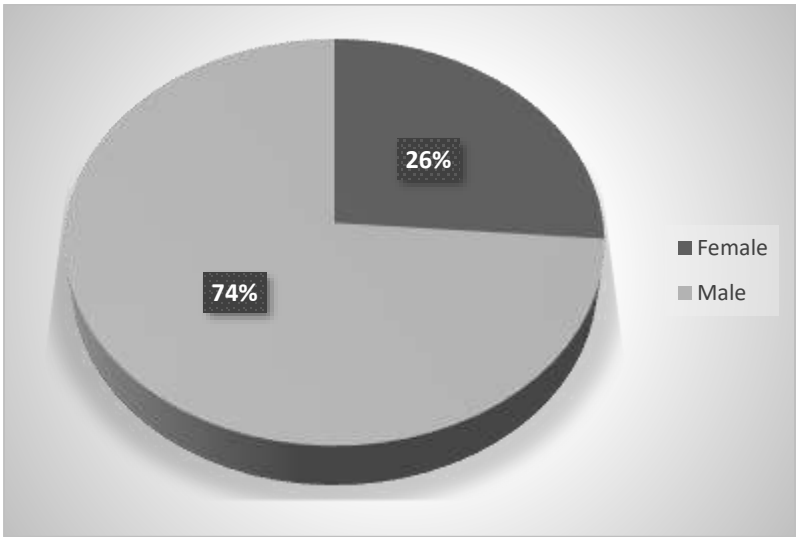

Figure 2: Gender of the participants.

Figure 2 illustrates the distribution of gender among the sampled participants, revealing that males constitute the majority of the group. Despite their numerical predominance, the analysis indicates that female participants have consistently outperformed their male counterparts in the project. This finding suggests that, irrespective of a smaller representation, females display superior skills or abilities in this context. Further investigation into the factors contributing to this disparity could provide valuable insights into the dynamics at play within the study.

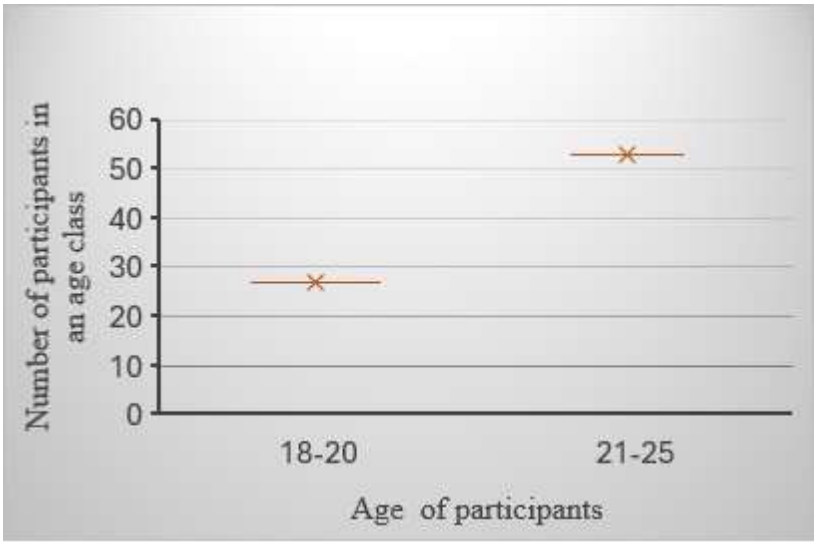

Figure 3: Age group of the participants.

In Figure 3, the data provides a detailed breakdown of the age distribution among participants, categorised into two age groups. The first group consists of individuals aged 18 to 20 years, while the second group encompasses those between 21 and 25 years old. This classification allows for a better understanding of the demographic characteristics of our participants, offering insights into the perspectives and experiences unique to these age ranges.

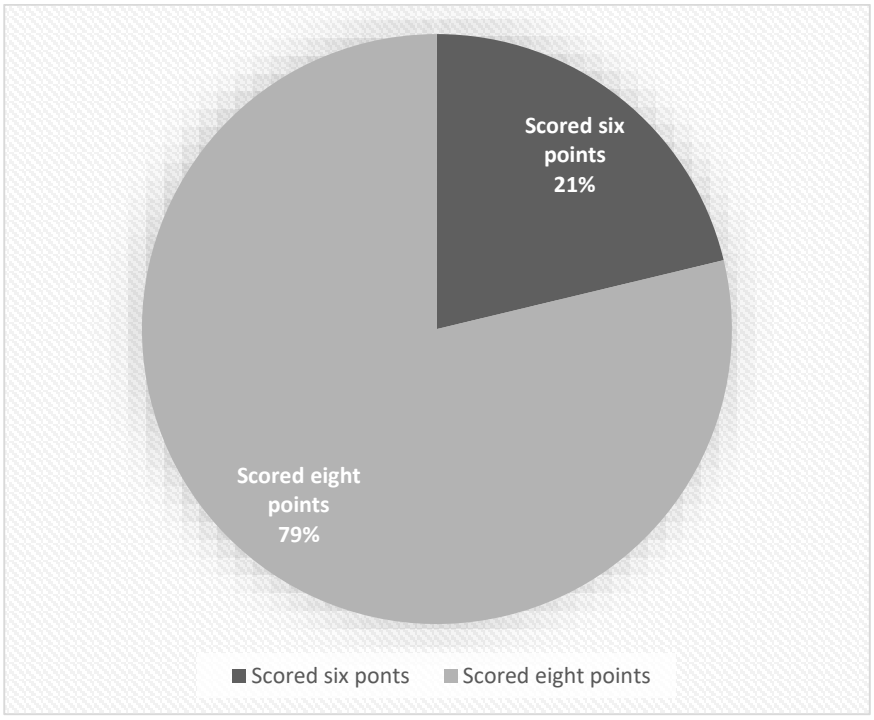

Figure 4: AI and Traditional generated illustrations.

In Figure 4, a comprehensive comparison is provided between illustrations created by artificial intelligence (AI) and those generated through traditional artistic techniques. This illustration delineates the distinct characteristics inherent to each approach, highlighting variances in style, execution, and overall visual representation. AI-generated illustrations tend to demonstrate exceptional precision and innovative design elements, whereas traditional illustrations may offer a unique emotional resonance and delicate touch, reflective of the artist's individual creativity and skill. This examination not only clarifies the differences between these methodologies but also emphasises the value of both in their respective applications across various disciplines. Based on the analysis of illustrations of AI and traditionally generated drawings, AI scored six points while traditionally generated illustrations scored eight points.

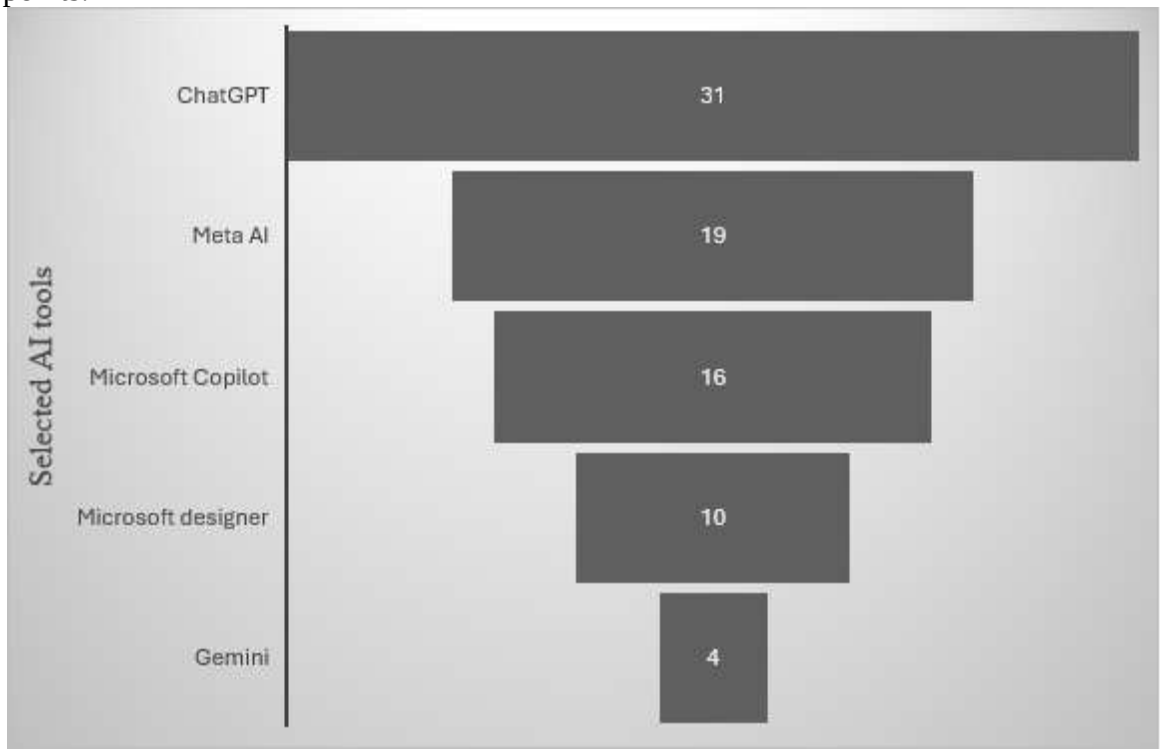

Figure 5: Different AI tools selected by the participants

Figure 5, presented above, illustrates the comparative differences among several AI tools used for generating biological drawings. The tools examined include Gemini, Microsoft Copilot, Meta AI, and ChatGPT. Notably, a significant majority of participants reported using ChatGPT more frequently than any of the other AI options available. This preference may reflect ChatGPT's user-friendly interface and its ability to produce detailed and accurate representations, making it a popular choice among users seeking to create biological illustrations. The varying features and performance of each tool can provide insights into their effectiveness in specific contexts related to biological drawing.

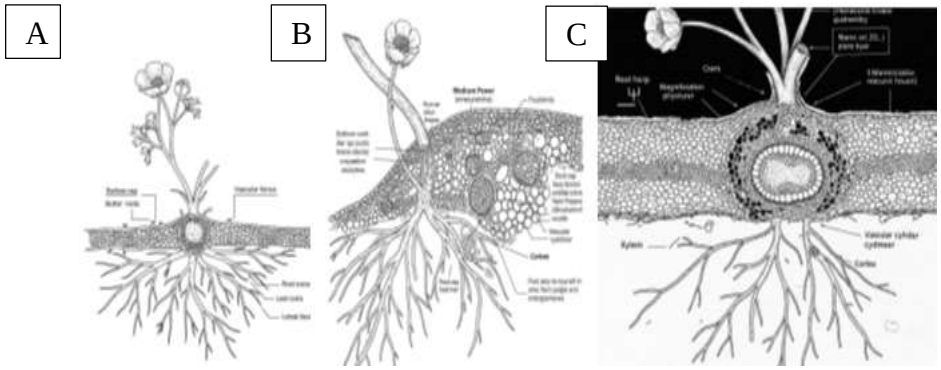

Figure 6: Drawings created by the AI tool Microsoft Copilot from the instructions 1, 2, and 3, respectively.

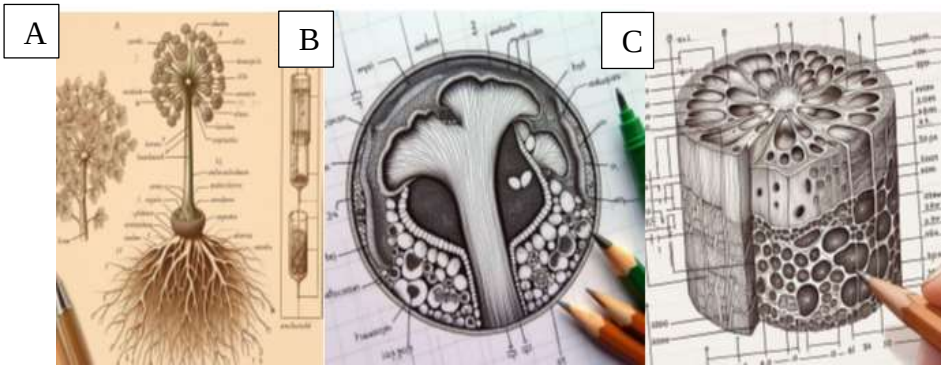

Figure 7: Drawings created by the AI tool Microsoft Designer from the instructions 1,2, and 3, respectively.

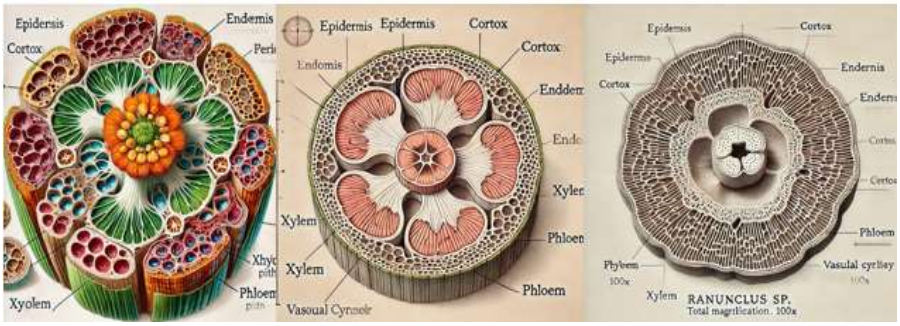

Figure 8: Drawings created by the AI tool ChatGPT from the instructions 1,2, and 3, respectively.

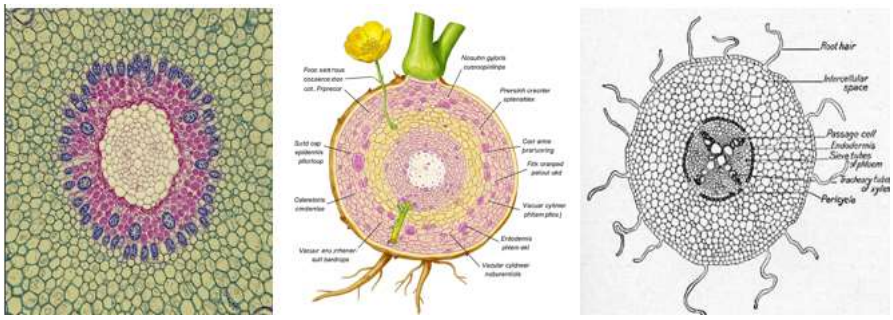

Figure 9: Drawings created by the AI tool Gemini from the instructions 1,2, and 3, respectively.

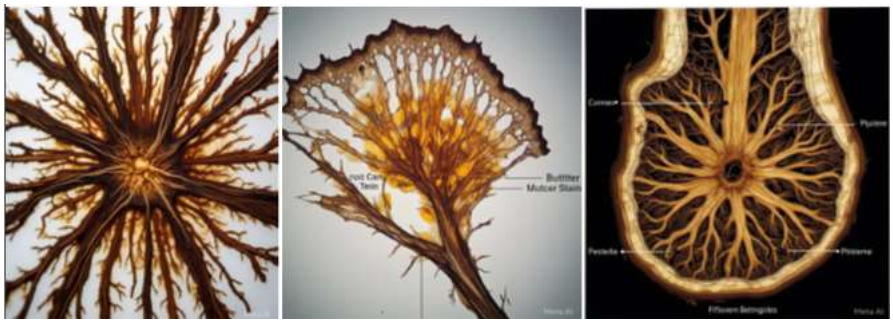

Figure 10: Drawings created by the AI tool Meta AI from the instructions 1,2, and 3, respectively.

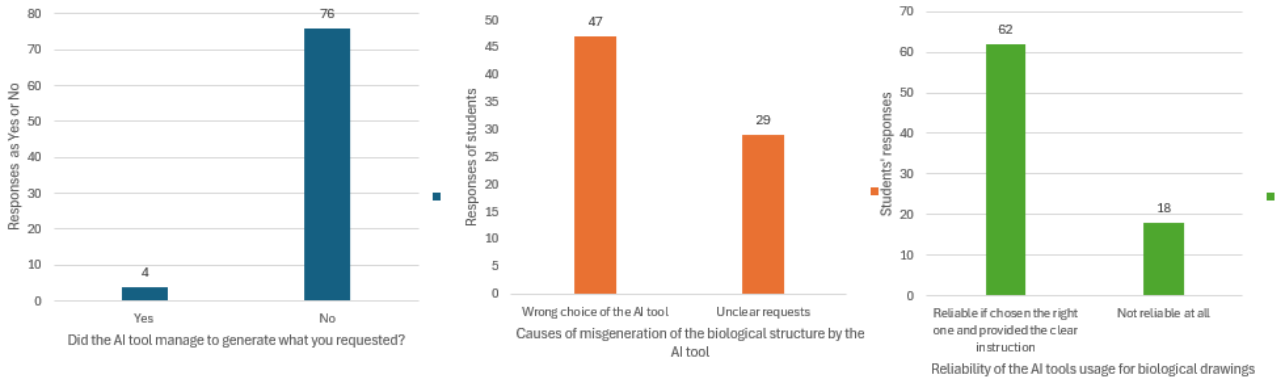

Figure 11 presents a detailed comparison between traditional drawings and AI-generated biological structures. This illustration highlights the distinct characteristics and artistic styles employed in traditional methods, which often focus on manual techniques and the artist's interpretation of biological forms. In contrast, the AI-generated structures showcase a data-driven approach that emphasises precision and complexity, effectively capturing intricate biological features. The juxtaposition of these two methods not only underscores their differing visual styles but also raises important questions about the role of technology in artistic representation and scientific accuracy.

DISCUSSION

To assess the capabilities of different AI tools, the researchers specifically instructed students to select the AI to generate an illustration of the root cap structure of the buttercup plant. This particular choice not only highlights the intricacies of plant biology but also serves as an engaging subject that students can relate to in their studies. Through this approach, students are empowered to effectively monitor and reflect on their own learning processes and outcomes. The findings from this study suggest that educational instructors should emphasise the importance of critical evaluation when students engage with AI-generated content. In particular, educators should guide students to assess AI responses by scrutinising factors such as accuracy, potential biases inherent in AI algorithms, and the degree of

simplification presented in the illustrations. This study aligns with the findings of Akben on the problem posing approach to metacognitive awareness.[11] The researchers delved into the contrasts between traditional biological illustrations and those produced by AI.

Students were encouraged to select any AI tool of their choice to investigate and represent the structure of the root cap of the buttercup plant, a critical part of the plant's anatomy that protects the growing tip of the root. To ensure a thorough and focused exploration, students followed a structured approach comprised of three key steps. Students began by instructing their chosen AI tool to generate a drawing of the root cap structure of the buttercup plant. This involved inputting specific requests related to the desired characteristics and details of the root cap, such as its shape, size, and texture. This study concurs with the findings of Beetham and Sharpe, who advocate for the support of AI in students' learning. [12]

Students ensured that the AI tool adhered to established biological drawing guidelines throughout the illustration process. These guidelines typically emphasise accuracy, proportion, and clarity, enabling the viewer to easily understand anatomical details. Finally, students provided the AI tool with a comprehensive list of standard guidelines commonly followed in biological illustration. This list included instructions on proper labelling, colour usage, and stylistic conventions required for effective scientific communication. Students not only learned how to effectively use AI in the realm of biological illustration but also gained insights into the unique qualities and limitations of both traditional and AI-generated drawings.

To cultivate a richer understanding of their learning processes and enhance metacognitive awareness, students are encouraged to undertake a comprehensive self-reflection that includes posing thoughtful and probing questions. This study resonates with the study of Holmes and Zitha et al on the unlimited access to AI in expanding the instantaneous learning among students.[13] They might explore inquiries such as: Which specific concepts do I grasp fully, and how can I effectively apply this understanding in practical scenarios? What particular topics or ideas do I find perplexing, and what underlying reasons contribute to my confusion, such as a lack of prior knowledge or unclear explanations? This study validates the findings of the study conducted by Florid and Cowls on the use of alternative strategies for expediting learning.[14] Furthermore, they should consider which alternative strategies, such as collaborative learning, visual aids, or different study techniques, they could implement to enhance their comprehension and overall academic performance.

Engaging deeply with these reflective questions, students can uncover valuable insights into their individual learning styles, acknowledge their strengths, and pinpoint specific areas that necessitate focused attention and growth. This reflective practice not only bolsters their present learning endeavours but also empowers them with crucial skills for continuous personal and academic development throughout their lives. This study is consistent with the findings of Darwin et al. on the consideration of critical thinking in the era of AI for rigorous interaction for a comprehensive evaluation of the content's relevance and reliability.[15]

This study offers a comprehensive overview of the intricate interplay between artificial intelligence tools, pedagogical design, digital competencies, and metacognitive skills, highlighting their collective impact on the advancement of students' critical thinking capabilities. It illustrates how these elements are interdependent, with AI tools enhancing pedagogical strategies and fostering digital literacy. This study is congruent with Florid and Cowls on the unified framework for AI in education for the establishment of effective learning.[16]

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[11] Akben, "Effects of the Problem-Posing Approach on Students' Problem Solving Skills and Metacognitive Awareness in Science Education."

[12] Beetham, Beetham, and Sharpe, *Rethinking Pedagogy for a Digital Age*.

[13] Holmes, "An Exploration of Online Christian Faith Nurture for Children, Using UK Churches as a Case Study"; Khulisile Nkuna and Innocent Zitha, "Exploring the Divine: A Deeper Look into Religious Motifs in Siswati Poetry," *International Journal of Research in Business and Social Science (2147- 4478)* 14, no. 1 (February 25, 2025): 112–19, https://doi.org/10.20525/ijrbs.v14i1.3859.

[14] Floridi and Cowls, "A Unified Framework of Five Principles for AI in Education."

[15] Darwin et al., "Critical Thinking in the AI Era: An Exploration of EFL Students' Perceptions, Benefits, and Limitations," *Cogent Education* 11, no. 1 (2024): 2290342.

[16] Floridi and Cowls, "A Unified Framework of Five Principles for AI in Education."

Additionally, this study underscores the pivotal role of formative feedback, which serves as a critical link between cognitive development and digital proficiency, thereby facilitating a holistic educational experience that empowers students to engage thoughtfully and analytically with the material. This study echoes the findings of Heikka and Niemi on rethinking pedagogy for the digital age and AI literacy for thorough engagement with the content provided.[17]

This integrative approach not only supports cognitive growth but also equips students with essential skills for navigating the complexities of the digital age. Students demonstrate a predominantly favourable attitude toward the incorporation of artificial intelligence as a tool for delivering personalised feedback, which serves to enhance their educational experience. A considerable number of students recognise the potential of AI tools to expedite their comprehension of complex concepts, clarify illustrations, and rectify any misconceptions related to the application and guidelines. The researchers hold an unfamiliar perspective than some scholars who view the integration of AI in higher education as leading to inevitable academic dishonesty, as students can generate content to meet assessment demands.

Furthermore, the ability of these AI systems to tailor learning experiences to individual preferences enables students to receive support that aligns with their specific needs. This personalised approach not only facilitates a deeper understanding of the material but also fosters increased engagement and motivation in academic pursuits. Consequently, students perceive the integration of AI in educational settings as a valuable means to improve learning outcomes.

Discussion Summary

Educational institutions should not fear artificial intelligence; instead, they should engage thoughtfully with its development and implementation. Stakeholders can effectively mitigate the risks associated with misinformation and miscommunication. This study focuses on exploring the significant differences between traditional scientific illustrations, crafted by students and those generated by AI tools. To assess the capabilities of different AI tools, the researchers specifically instructed the selected AI to generate an illustration of the root cap structure of the buttercup plant. This particular choice not only highlights the intricacies of plant biology but also serves as an engaging subject that students can relate to in their studies. Through this approach, students are empowered to effectively monitor and reflect on their own learning processes and outcomes.

The findings from this study suggest that educational instructors should emphasise the importance of critical evaluation when students engage with AI-generated content. In particular, educators should guide students to assess AI responses by scrutinising factors such as accuracy, potential biases inherent in AI algorithms, and the degree of simplification presented in the illustrations. Embracing AI has the potential to enhance educational practices, but it requires a commitment to understanding and addressing the diverse needs and learning styles of all students. For instance, consider the following approaches to learning: “Tell me, and I will forget.” This phrase highlights the limitations of passive learning, where merely delivering information often falls short of fostering lasting understanding or application. Education that relies solely on lectures or rote memorisation may lead to short-term retention but does little to encourage critical thinking or problem-solving skills.

“Teach me, and I will remember.” This statement reflects a somewhat more interactive approach to teaching, suggesting that when instructors engage students through demonstrations or discussions, the information is more likely to be retained. However, this method may still not captivate every learner, as it leans on traditional techniques that do not accommodate all learning preferences. “Involve me, and I will learn.” This perspective emphasises the importance of active participation and experiential learning. When students engage in firsthand activities, collaborative projects, or real-world problem-solving, they are more likely to achieve a deeper understanding and stronger retention of knowledge. This approach recognises that learning is most effective when students are actively involved in the process, allowing them to make connections and apply what they have learned in meaningful ways.

[17] T. Heikkilä and H. Niemi, “ AI Literacy in the Classroom: Preparing Future Teachers for Critical Use of Generative AI,” *Education and Information Technologies* 28, no. 5 (2023): 7895–7912.

In the pursuit of education and innovation, waiting for the perfect moment to implement new initiatives can lead to missed opportunities. The educational landscape is continually evolving, and stakeholders must capitalise on the possibilities available today. Embracing current technologies, fostering inclusive learning environments, and promoting actively engaged pedagogy can create impactful and meaningful experiences for all students, equipping them to face the challenges of the future.

RECOMMENDATIONS

To achieve optimal results in a project or training initiative, it is advisable to begin with a single module or assignment. This targeted approach not only simplifies the evaluation process but also enables focused adjustments based on participant feedback and performance. By narrowing the scope initially, this can ensure that participants fully grasp the material before moving on to more complex tasks.

In addition, providing comprehensive training on the various functionalities and applications of different AI tools is crucial. This training should include practical demonstrations and direct exercises that allow participants to explore the tools in a controlled environment. By understanding the strengths and limitations of each tool, participants can make informed decisions when applying them in real-world scenarios.

Furthermore, incorporating collaborative brainstorming sessions is an effective strategy to deepen understanding and foster innovative thinking. During these sessions, participants can share ideas, challenge assumptions, and build upon each other's contributions, leading to creative solutions and enhanced learning outcomes. This collaborative approach not only promotes individual skill development but also nurtures a sense of teamwork and community, essential for achieving long-term success.

Ultimately, by starting with a focused module, providing in-depth training, and facilitating collaborative discussions, this can create an environment that drives both personal and collective advancement, leading to more effective and impactful results. To ensure the sustainable and ethically sound use of AI in education, it is essential to expand pedagogical involvement in designing digital learning systems and to embed AI literacy in foundational curricula.

CONCLUSION

This study has conducted a thorough examination of the fundamental differences between traditional scientific illustrations created by students and those generated through artificial intelligence tools. By analysing a range of critical aspects, including artistic techniques, accuracy, creativity, and their respective impacts on educational outcomes, this research provides significant insights into how each method shapes the understanding of complex scientific concepts.

Moreover, the study delves into additional factors such as the level of detail within the illustrations, user engagement, and the overall effectiveness of communication conveyed through these images. This comprehensive evaluation substantially enhances our understanding of the evolving role of technology in scientific illustration and its broader implications for pedagogical practices.

The findings indicate that educators should emphasise the importance of critical evaluation as students engage with AI-generated content. Specifically, educators are advised to assist students in assessing AI outputs by examining essential elements such as the accuracy of the information presented, the potential biases that may be embedded within AI algorithms, and the degree of simplification applied in the illustrations. While the incorporation of AI technology possesses the potential to significantly enhance educational methodologies, it requires a dedicated commitment to recognising and addressing the diverse needs and learning styles of all students.

This study places a particular focus on exploring the notable distinctions between traditional scientific illustrations crafted by students and those produced by AI tools. To effectively evaluate the capabilities of various AI applications, the researchers directed a selected AI to generate an illustration of the root cap structure of the buttercup plant. This specific choice is particularly relevant, as it not only highlights the intricate complexities associated with plant biology but also serves as a relatable subject for students in their academic pursuits. Through this methodological approach, students are

empowered to actively monitor and reflect on their learning processes, fostering deeper engagement with the subject matter and enhancing their educational outcomes.

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