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Comprehensive AI assessment framework: Enhancing educational evaluation with ethical AI integration

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Highlights

- The Comprehensive AI Assessment Framework (CAIAF) ensures the ethical and effective integration of GenAI tools in education.
- CAIAF guides educators through clear, example-based levels tailored for primary, secondary, undergraduate, and graduate settings.
- CAIAF promotes responsible AI use by emphasizing ethical principles and providing adaptable strategies for diverse educational environments.
- CAIAF facilitates the adoption of GenAI tools in education, moving beyond restrictions to foster innovation and academic integrity.

Abstract

The integration of generative artificial intelligence (GenAI) tools into education has been a game-changer for teaching and assessment practices, bringing new opportunities, but also novel challenges which need to be dealt with. This paper presents the Comprehensive AI Assessment Framework (CAIAF), an evolved version of the AI Assessment Scale (AIAS) by Perkins, Furze, Roe, and MacVaugh, targeted toward the ethical integration of AI into educational assessments. This is where the CAIAF differs, as it incorporates stringent ethical guidelines, with clear distinctions based on educational levels, and advanced AI capabilities of real-time interactions and personalized assistance. The framework developed herein has a very intuitive use, mainly through the use of a color gradient that enhances the user-friendliness of the framework. Methodologically, the framework has been developed through the huge support of a thorough literature review and practical insight into the topic, becoming a dynamic tool to be used in different educational settings. The framework will ensure better learning outcomes, uphold academic integrity, and promote responsible use of AI, hence the need for this framework in modern educational practice.

Article Info: Research Article

Keywords: *Comprehensive AI Framework, AI Assessment, AI Integration, AI Ethics, AI in Education*

1. Introduction

Generative artificial intelligence tools, also known as GenAI tools, have had a transformative impact in numerous domains, including education (Mello et al., 2023). Generation of human-like creative and problem-solving content for users has been made possible by the use of very advanced AI (Yeo, 2023). GenAI tools are a tremendous development in AI technology. These tools autonomously create content that mimics human creative and problem-solving capabilities (Dickey & Bejarano, 2023). Examples include ChatGPT, a language model designed for generating human-like text; conversational agents Gemini and Copilot; vision-language models Midjourney and Dall-E, a transformer whose decoder is conditioned on

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text functioning as a text-to-image generator (Wang et al., 2023). The integration of GenAI tools in education has opened up new possibilities for both students and educators (Bubeck et al., 2023).

GenAI tools have succeeded with all their instances as they all generate something in return: either a human-like conversation or a vision from text (Zhang et al., 2023). Initially, the technology appeared with rule-based approaches and modest datasets in the very early AI systems, limiting their capabilities (Gampala et al., 2020). Technological advancements in deep learning and neural networks have allowed the development of powerful GenAI tools. For instance, ChatGPT generates human-like text through meaningful conversations and creates coherent and contextually relevant conversations (Boscardin, 2024).

GenAI tools have application areas in a wide range of disciplines. In medicine, AI has become prominent with diagnostic tools and wearable technology, both clinical- and patient-facing (Yeo, 2023). The broader impact of AI in medical education can be observed in conversational models such as ChatGPT (Boscardin, 2024). Moreover, GenAI tools has been implemented dramatically in the disciplines of language education and library services, and commercial markets and management (Pack & Maloney, 2024; Gao, 2024). Both domains explore the recent research agenda of AI technology applications for digital transformation. Such applications have been developed to assist in the decision-making process of managerial functions, in the facilitation of operations, or in market competition (Kitsios & Kamariotou, 2021).

In education, AI technologies are used in a variety of beneficial ways. Evidence demonstrates that social science and humanities programs may find AI tools, such as ChatGPT, to be valuable assets in teaching students the skills they need to engage with modern practices (Simms, 2024). But along with the commencement of the use of such tools, a significant domain required to be addressed has emerged.

Ethical considerations will keep playing a crucial role in GenAI tools. Addressing the ethical and pedagogical dimensions and encouraging responsible AI practitioners to uphold ethical standards and best practices are critical (Pack & Maloney, 2024). Such technological tools have fundamentally modified aspects of AI. Through further exploration of AI tools, ethically responsible coordinators will comprehend the GenAI tools and their subsequent impacts on society, the educational aspects of the users, and the surrounding world. (Sullivan et al., 2023). Only in this way can AI be harnessed to make a positive difference and develop technologies for people.

2. Challenges and Opportunities of Gen AI Tools in Education and Assessment

The rapid advancement of second-generation AI tools, such as ChatGPT, Gemini, and Midjourney, has dramatically reshaped educational practices. These tools bring transformative changes to teaching, learning, and assessment, offering unprecedented opportunities for personalized learning and real-time feedback. However, they also raise significant concerns about academic integrity, ethical considerations, and the potential to disrupt traditional educational models. This section will explore the key challenges and opportunities that educators and policymakers face as they navigate the integration of second-gen AI tools in educational contexts.

2.1. Impact on Education and Assessment

GenAI tools have had a significant effect on education, changing how people teach and learn. According to Mahligawati (2023), the course of teaching as a profession may be disrupted by GenAI tools. ChatGPT, Gemini, Dall-E or etc., means of creativity and engagement, may be used to increase student participation beyond lectures in higher education institutions. Opting to teach AI to students of higher education may be preferred compared to other subjects (Adıgüzel et al., 2023). In education, AI can individualize the training, give immediate feedback on assignments, and create an interactive atmosphere for the learners (Kılınç, 2023).

In terms of assessment methods, GenAI tools have changed the way of assessments' performance through automated scoring systems, personalized feedback, and adaptive testing tailored to the needs of each student (Olga et al., 2023). Kamalov & Gurrib (2023) stated that assessment processes may be sped up using AI since it reduces biases while also providing assistance for the deep comprehension of performance levels

amongst pupils. Using these tools, educationalists should design assessments reflecting 21st-century goals as well as accommodating various styles of learning (Singh & Hiran, 2022). Educationalists have to match the assessment tasks with the curriculum outcomes by providing personalized feedback (Saija et al., 2023).

Attitudes towards GenAI tools aimed at education differ regionally among people. Among the educationalists of all educational levels, some find the GenAI tools useful in improving teaching methods and learning outcomes, while others have concerns about cheating during exams as well as ethics relevant to the use of such a technology (Sullivan et al., 2023). Establishing supportive attitudes about the positive potentials associated with the integration of AI at schools should therefore take into account these diverse perspectives in order to address any potential barriers (Park & Kwon, 2024).

When it comes to the education sector, the use of AI has led to many arguments. For instance, questions have been asked concerning AI's pedagogical implications, ability to boost student engagement, and impact on the pursuit of academic honesty. (Zhang & Aslan, 2021). Moreover, with the use of this technology, educationalists are now able to determine how they can personalize each student's learning and develop interactive experiences with the learners, in addition to its numerous other advantages (Pack & Maloney, 2024).

Moreover, Simms (2024) pointed out the consideration of ethical issues in addition to the negatively affected traditional methods as a consequence of AI's adoption and thus suggested full educationalist training before any further emergence of negative outcomes, stating that much more could have been performed in a different way if only the educationalists were more interested and concentrated at the meetings where people had drawn attention to great points. Lane et al. (2024) advised that the stakeholders have to keep a close eye on both sides while integrating GenAI tools as they are the best means of teaching the students.

In special needs education, AI promotes inclusive pedagogy and supports students with diverse learning needs (Garg & Sharma, 2020). AI can help create personalized learning experiences for individuals, adjust teaching approaches, and cultivate an inclusive educational atmosphere that will improve learning outcomes as well as ensure fairness for all the students (Maghsudi et al., (2021). This will be achieve through the use of technology.

In brief, the incorporation of GenAI tools in the domain of education has the potential to extensively change the way we teach and learn, the methods of assessment utilized, and student involvement. Obviously, there are many advantages brought about by such technologies; however, it is important for practitioners not to ignore issues concerning academic honesty, ethical application, or even educationalist training procedures during the utilization of the same. Therefore, stakeholders should investigate the risks posed by AI in education and testing so as to reveal its full potential and create innovative environments that are accessible to everyone.

2.2. Initial Reactions: Bans and Restrictions

The introduction of AI in schools has faced different reactions, with some schools opting to ban or limit its use. Such initial reactions were driven by privacy concerns, data security issues, and a fear that it could disrupt traditional teaching methods (Volante et al., 2023). However, research shows that these measures are hardly effective. According to Hong et al. (2022), such bans can easily be circumvented, thus making them unreliable.

While intending to protect student privacy as well as uphold academic integrity, such restrictions often lose the plot. By discouraging the use of AI tools through clear bans, schools risk missing out on the potential benefits brought about by their use, such as improving learning outcomes through formative assessment practices. Instead, educational institutions may integrate the AI tools in an ethically responsible manner that supports students' learning and development (Volante et al., 2023).

The discussion around the regulation of AI goes beyond education and brings about more extensive ethical questions. Morley et al. (2021) argued for the need for more pragmatic ethics in AI and emphasized the continual assessment of ethics involved in every stage, from designing the algorithms to deploying systems

at businesses or government agencies, etc. Therefore, rather than adopting all inclusive bans, we should focus only on those areas of high risk while putting in place the necessary safeguards (De Laat, 2021).

Moreover, the evolving nature of AI technology presents additional challenges for regulation. Lam et al. (2022) noted the lack of user-friendly tools for creating interactive educational resources, highlighting a potential gap for effective AI education. Addressing these gaps is essential for fostering AI literacy among students and educationalists.

Eventually, while initial reactions to GenAI tools in education are marked by attempts to ban or restrict their use, such approaches have proven to be highly ineffective. A deliberate understanding of the benefits and challenges associated with the integration of AI is necessary to develop more effective regulatory frameworks and educational practices.

2.3. AI Detection Tools: Working Principle and Limitations

The use of AI detection tools has become a common practice for managing the integration of GenAI tools in education. These tools employ machine learning algorithms, neural networks, and deep learning techniques to identify patterns and anomalies in data (Adıgüzel et al., 2023). Despite their advanced capabilities, AI detection tools have notable limitations.

AI detection tools analyze text for patterns typically associated with AI-generated content, such as uniform sentence structure, specific word overuse, and predictable paragraph lengths (Chakraborty et al., 2023). These tools are trained on vast datasets of human and AI-generated texts, enabling them to identify subtle 'tells' of AI involvement. Unlike traditional plagiarism detectors that compare submissions against a database, AI detectors focus on linguistic and stylistic cues to differentiate human from machine-generated text.

However, the effectiveness of AI detection mechanisms tends to be hampered by continuous advancements in the area. According to Perkins et al. (2024), newer models, such as Anthropic's Claude 3 Opus, generate texts that look very much like human writing, thereby reducing the predictability on which detection tools rely. They also pointed out that the overall precision of algorithms for the recognition of AI-generated content stands at 39.5% only but decreases to 22% in the case of adversarial methods. This means that there is a high frequency of false positives where texts written by people are mistaken as having been created by machines. These mistakes pose significant threats, such as unfair treatment of students and the possible unnoticed misuse of genuine AI.

Some of the adversarial techniques that can be employed to circumvent detection by AI tools involve introducing misspellings, writing like non-native speakers, and increasing burstiness in writing styles. These approaches take advantage of weaknesses present in algorithms used to detect AI-generated texts, making them hard to find. For instance, changing sentence structure or introducing typos may imitate human writing patterns, hence confusing discovery software (Perkins et al., 2024).

Additionally, another reason why AI detection tools have limited use is because they are inequitable. Students from wealthier families might use higher-quality (more expensive) AI tools that are able to avoid discovery, a consideration that gives rise to issues of fairness during assessments (Sullivan et al., 2023). Moreover, adoption of these systems increases teachers' workload since ambiguous findings usually need careful reading, and such findings may lead to conflicting interactions with the learners, thereby resulting in exhaustion among educationalists (Swiecki et al., 2022).

In conclusion, AI detection tools come with certain hitches. These include false negatives and false positives, which may lead to the exclusion of worthy candidates. It is important to consider these issues if we are to make the most of AI detection tools. By doing so, stakeholders would have a higher chance of finding solutions that are not only more effective but also fairer. More importantly, in consideration of these challenges, making GenAI tools prominent in educational assessment processes may promote equal opportunity, minimize educationalists' workloads in evaluative activities, and enhance testing transparency and validity relative to educational goals (Ogunleye et al., 2024). Therefore, the creation of an AIAS does

not only signify a reaction towards technical difficulties brought about by GenAI tools but also implies a way forward towards responsible utilization of its potentials.

3. Foundations and Advancements in AI-Integrated Educational Assessment

As the educational landscape continues to evolve with the integration of artificial intelligence, there is a growing need for comprehensive frameworks to guide this integration responsibly and effectively (Chang et al., 2023; García-Martínez et al., 2023; Gillani et al., 2023; Michaeli et al., 2022; Mollick & Mollick, 2023b; Ng et al., 2023; Nguyen et al., 2023; Tong et al., 2024; Zhou et al., 2020). This section explores the development and enhancement of such frameworks, beginning with the pioneering AI Assessment Scale (AIAS) and progressing to its more advanced iteration, the Comprehensive AI Assessment Framework (CAIAF). By examining the foundations laid by the AIAS and the rationale behind its evolution, we can better understand the critical role these frameworks play in shaping the future of AI-enhanced education. This exploration not only highlights the current state of AI integration in educational assessment but also underscores the importance of continuous adaptation to meet the challenges and opportunities presented by rapidly advancing AI technologies.

3.1. Introduction of the AI Assessment Scale (AIAS)

The AIAS, can be seen in the Figure 1, introduced by Perkins, Furze, Roe, and MacVaugh (2024) stands out as the first attempt to systematize the integration of AI in educational assessment. This scale was developed in response to the increasing demand for the introduction of AI tools into education with a view to ensuring academic honesty, instilling ethical practices, and boosting learning outcomes.

1	**NO AI**	The assessment is completed entirely without AI assistance. This level ensures that students rely solely on their knowledge, understanding, and skills. **AI must not be used at any point during the assessment.**
2	**AI-ASSISTED IDEA GENERATION AND STRUCTURING**	AI can be used in the assessment for brainstorming, creating structures, and generating ideas for improving work. **No AI content is allowed in the final submission.**
3	**AI-ASSISTED EDITING**	AI can be used to make improvements to the clarity or quality of student created work to improve the final output, but no new content can be created using AI. **AI can be used, but your original work with no AI content must be provided in an appendix.**
4	**AI TASK COMPLETION, HUMAN EVALUATION**	AI is used to complete certain elements of the task, with students providing discussion or commentary on the AI-generated content. This level requires critical engagement with AI generated content and evaluating its output. **You will use AI to complete specified tasks in your assessment. Any AI created content must be cited.**
5	**FULL AI**	AI should be used as a 'co-pilot' in order to meet the requirements of the assessment, allowing for a collaborative approach with AI and enhancing creativity. **You may use AI throughout your assessment to support your own work and do not have to specify which content is AI generated.**

Fig. 1. AI Assessment Scale by Perkins et al. (2024).

AIAS aims at providing a universal benchmark that may be used to measure the extent of AI's adoption across different levels of educational institutions. It is composed of five tiers, each signifying a specific stage at which AI should be integrated into educational undertakings. The stages are structured in such a manner as to create a pathway for the educationalists to assess their current positions on the use of AI while teaching and learning in order to be informed of future actions.

- *Level 1: No AI (Human-Only)* - This level represents traditional assessment methods without any AI involvement, ensuring that students rely solely on their knowledge, understanding, and skills.
- *Level 2: AI-Assisted Idea Generation and Structuring* - At this level, AI is used to assist in brainstorming and organizing ideas but is not involved in the final content creation.
- *Level 3: AI-Assisted Editing* - AI tools are employed to improve the clarity and quality of student-created work, but no new content is generated by AI.
- *Level 4: AI Task Completion with Human Evaluation* - AI completes specific elements of a task with human evaluation, ensuring academic integrity and understanding.
- *Level 5: Full AI Integration* - AI is used extensively throughout the assessment process, collaborating with students to enhance creativity and learning outcomes.

The primary purpose of the AIAS is to provide a structured approach to integrating AI in education. By defining clear levels of AI involvement, the scale helps educationalists implement AI tools responsibly and ethically. The benefits of the AIAS include:

- *Encouraging Ethical Use of AI:* Being transparent and fair when using AI in education and making sure it lasts long.
- *Improving Learning Outcomes:* Using AI for customized learning experiences and immediate responses.
- *Keeping Academic Integrity:* Ensuring that AI tools complement educational assessments rather than compromise them.

3.2. Rationale for Enhancing AIAS

The need to enhance the AIAS framework stems from several factors that reflect the dynamic nature of AI in educational settings:

- *Rapid AI Advancements:* Significant developments in AI capabilities since the introduction of AIAS necessitate a more comprehensive framework to accommodate these advancements.
- *Expanding Scope:* The original AIAS lacked sufficient differentiation between educational levels, limiting its applicability across diverse educational settings.
- *Ethical Considerations:* While providing a valuable starting point, the AIAS did not explicitly incorporate ethical guidelines crucial for responsible AI integration in education.
- *Implementation Challenges:* Feedback from educators attempting to implement the AIAS revealed the need for more detailed guidance and practical examples to facilitate real-world application.

While extensive testing has not yet produced negative results, early implementation attempts highlighted these areas for improvement.

3.3. The Significance of Advancing AI Assessment Frameworks

The importance of this study lies in several key areas that address the evolving needs of AI integration in education:

- *Ethical Imperative:* As AI tools become more prevalent in education, there is a growing concern about their ethical implications. The proposed Comprehensive AI Assessment Framework (CAIAF)

incorporates robust ethical guidelines, ensuring that AI integration aligns with principles of transparency, equity, and privacy.

- *Enhanced Adaptability:* The CAIAF addresses the limitations of the original AIAS by introducing advanced AI levels and differentiating between primary, secondary, undergraduate, and graduate education, accounting for the rapid advancements in AI technology and diverse educational needs.
- *Improved Usability:* The addition of visual representations and grading variability within levels makes the CAIAF more intuitive and easier to implement across various educational contexts.
- *Future-Proofing:* By including placeholders for future AI advancements, the CAIAF ensures its relevance and applicability as AI technology continues to evolve.
- *Promoting Responsible Integration:* The framework provides a structured approach to integrating AI in education, moving beyond simple restrictions to foster innovation while maintaining academic integrity.

The CAIAF proactively addresses these issues, providing a more robust, flexible, and ethically grounded framework for AI integration in educational assessments. By enhancing the AIAS to create the CAIAF, this study contributes significantly to the field of AI in education, offering a tool that can guide educators, policymakers, and institutions in the ethical and effective integration of AI technologies in educational assessments.

This framework has the potential to shape the future of AI-enhanced education, ensuring that technological advancements align with pedagogical best practices and ethical standards. As we move forward, the CAIAF serves as a cornerstone for responsible AI adoption, fostering an educational environment that harnesses the power of AI while prioritizing student learning, ethical considerations, and academic integrity.

4. Transformation of AIAS to Comprehensive AI Assessment Framework (CAIAF)

Enhancements to the AIAS are essential to address the evolving challenges and opportunities presented by GenAI tools in education. These enhancements include the integration of ethical guidelines, allowance for advanced AI levels, differentiation between educational levels and adjustments, and visual representation and grading variability in AI integration. Each component is crucial for creating a robust, adaptive, and ethical framework for AI use in educational assessments.

The transformation from AIAS to CAIAF represents a significant leap forward in our approach to AI integration in education. This evolution is not merely a refinement of existing ideas but a comprehensive reimagining of how we conceptualize and implement AI in educational settings. The CAIAF addresses critical gaps in the original AIAS, particularly in terms of ethical considerations, adaptability to rapid technological advancements, and applicability across diverse educational contexts (Holmes et al., 2022).

The transformation process was carried out in several key phases:

- Problem Identification: The first phase involved identifying the limitations of the AIAS framework through critical analysis of existing research and real-world case studies where AIAS had been implemented. Feedback from educators and policymakers revealed that the original framework lacked sufficient differentiation between educational levels and did not adequately account for the rapid pace of AI advancements.
- Literature Review: A comprehensive literature review was conducted, drawing on recent studies in educational technology, AI ethics, and online learning. This review informed the theoretical foundation of the CAIAF and provided insights into best practices for AI integration. Key references included studies on generative AI tools, such as ChatGPT (Bubeck et al., 2023), and existing ethical AI frameworks in educational contexts (Holmes et al., 2022).
- Framework Redesign: Based on the findings from the literature review and the identified gaps, the AIAS was transformed into the CAIAF. The redesigned framework incorporated new ethical

guidelines, advanced AI levels, and future-proofing elements to accommodate future developments. The differentiation between educational levels was introduced to make the framework applicable across primary, secondary, undergraduate, and graduate education. Additionally, advanced AI levels, including the newly added Level 6 for real-time AI interaction, were designed in response to emerging trends in AI capabilities.

- Expert Validation: The redesigned CAIAF was validated through a panel of experts in AI, educational technology, and ethics. These experts reviewed the framework and provided critical feedback on its usability, ethical soundness, and relevance to contemporary educational challenges. Their feedback was incorporated into the final design, ensuring that the framework was both practical and ethically robust.

4.1. Ethical Guidelines Integration

The AIAS is critical to ensuring responsible and beneficial use of AI tools in educational settings. Ethical considerations are paramount in shaping how AI technologies are implemented, addressing issues such as transparency, equity, pedagogical alignment, accountability, and privacy. Using AI without ethical principles would be irresponsible and would lead to significant harm, bias, and inequality (Holmes et al., 2022; Klimova et al., 2023).

The integration of ethical guidelines into the CAIAF is not just an add-on but a fundamental restructuring of the framework's core principles. This approach aligns with the growing recognition that ethical considerations must be at the forefront of AI implementation in education, rather than an afterthought (Zawacki-Richter et al., 2019). By embedding ethical principles directly into the assessment framework, we create a model that inherently promotes responsible AI use, fostering a culture of ethical technology adoption in educational institutions.

Aligning these ethical principles with established standards and guidelines from prominent organizations such as the International Society for Technology in Education (ISTE), the Association for Educational Communications and Technology (AECT), the Institute of Electrical and Electronics Engineers (IEEE), and the European Union (EU) ensures a comprehensive framework for the ethical use of technology in education. These standards promote transparency, equity, accountability, and privacy in AI implementation (Network, 2001; Jones, 2016; Hamiti et al., 2014; Mata, 2022). By embedding these ethical principles into the AIAS, educators can foster an environment that not only makes prominent the benefits of AI technologies but also upholds the highest ethical standards, ensuring responsible and effective AI integration in education. This approach addresses ethical challenges and aligns with greater educational equity, transparency, and accountability goals, as highlighted in recent studies and guidelines (Leimanis, 2020; Shih et al., 2021).

The ethical principles that should be emphasized to each student along with the assignment in a way that is appropriate for the relevant level and guidance on how to achieve them are as follows:

- *Transparency:* Students need to declare whether they have used any AI tools or not so that the level of the AI they worked with can be known.
- *Equity and Inclusivity:* Equal access to AI technologies should be provided to students of diverse socio-economic backgrounds.
- *Pedagogical Alignment:* Employing AI in learning should be geared towards accomplishing educational objectives that promote creativity.
- *Accountability:* The student should ensure the originality of his or her work after using AI, hence not breaching academic ethics.
- *Privacy and Data Protection:* AI tools must safeguard student information privacy by upholding data protection laws.

These principles are not merely guidelines but form the ethical backbone of the CAIAF. By integrating them into the framework, we create a model that inherently promotes ethical AI use, fostering a culture of

responsible technology adoption in educational institutions. This approach aligns with recent research emphasizing the importance of ethics in educational technology (Zawacki-Richter et al., 2019; Holmes et al., 2022).

4.2. Integration of Advanced AI Levels with Future Provisions

Progressive growth in AI technology, especially brought by models like GPT-4o, has made it necessary to add a new stage under the AIAS scale called advanced AI integration (Level 6), which allows for real-time interaction and acts as a personal assistant, indicating the current trendsetter nature of this field.

The addition of Level 6 and provisions for future advancements in the CAIAF is a critical enhancement that addresses one of the main limitations of the original AIAS – its static nature in the face of rapidly evolving AI technologies. This forward-thinking approach aligns with recent research highlighting the need for adaptive frameworks in educational technology (Luckin & Holmes, 2016). By incorporating advanced AI levels and placeholders for future developments, the CAIAF becomes a dynamic tool capable of evolving alongside technological advancements, ensuring its long-term relevance and applicability.

Level 5 represents a major step for the integration of AI with education in that it relies heavily on the use of various AI tools to aid in different activities during the learning process. At this level, AI tools may be used for content generation, feedback provision, and even assignment grading. However, such applications do not usually provide advanced real-time interaction or highly personalized assistance observed at level 6.

Real-time interaction abilities are what distinguish level 6 from full AI integration through AI tools that are able to answer the students' questions instantly and organize live tutoring sessions, among other capabilities. AI at level 6 can respond to students' needs as they study, unlike at level 5, where it may only act within given limits by waiting for the completion of the activities and then responding accordingly later on.

For instance, level 5 AI can create a comprehensive study guide after going through a student's coursework, while level 6 AI discusses the same guide with the student live by giving immediate answers to any arising questions and by changing the explanations dynamically based on how well or poorly the student is grasping the concepts. This kind of engagement considerably imitates the acts of a human tutor, thus making it possible for learners to get support at the moment they need it.

While level 5 may have general support tools from AI, level 6 ensures that these supports are customized enough to take into account each student's unique learning path so far. In the context of contemporary education, it is necessary to create educational experiences that are interactive and flexible since they meet different student requirements and learning styles. More importantly, advanced AI tools have the ability to evaluate a learner's progress continuously and modify the content accordingly so as to provide them with an individualized learning path.

The distinction between Level 5 and Level 6 in the CAIAF represents a significant advancement in our understanding of AI's potential in education. This differentiation acknowledges the rapid progress in AI capabilities, particularly in areas such as natural language processing and adaptive learning. Recent studies have shown that advanced AI systems can provide personalized learning experiences that rival or even surpass traditional human tutoring in certain contexts (Kulik & Fletcher, 2016). By incorporating these advanced capabilities into the framework, the CAIAF paves the way for more sophisticated and effective AI integration in educational settings.

4.2.1. Future-Proofing the Framework with Placeholders

The advancement of AI is no secret, and this is why we need to future-proof our assessment scales by adding placeholders for possible new future levels. This was forecasted just short after the introduction of level 6 due to the rapid development pace, and it is indicative that there may always be something beyond what anyone knows at any given time relevant to such factors. The inclusion of placeholders in advance within such tools as educational instruments meant for AI's use in educational institutions indicates our understanding of the fast pace of the technology in order to prevent any lagging.

Using placeholders in scales makes them more valuable and reliable in time as they can be easily replaced to reflect the new changes (Green et al., 2020). This forward-thinking indicates the AIAS's usefulness for teachers in integrating AI into their teaching methods, even in cases of future technological advancements. A forecast of growth implies that a measure would be constantly updated as technology advances, which therefore makes it relevant within educational setups. For instance, future developments in AI may involve advanced natural language processing abilities, emotional intelligence, or even better adaptive learning algorithms, among others. With the placeholders present in AIAS, it can quickly adapt to and adopt these new advancements so that educationalists have the most recent tools for using AI effectively.

The inclusion of placeholders for future AI advancements in the CAIAF is a critical feature that sets it apart from other frameworks. This approach acknowledges the rapid pace of AI development and the need for educational frameworks to remain relevant in the face of technological change. Recent research in educational technology emphasizes the importance of adaptable frameworks that can evolve with technological advancements (Luckin & Holmes, 2016). By incorporating placeholders, the CAIAF not only anticipates future developments but also provides a structure for ongoing evaluation and integration of new AI capabilities in education.

Furthermore, the placeholder approach aligns with the concept of "future-proofing" in educational technology, as discussed by Selwyn (2013). This strategy ensures that the CAIAF remains a living document, capable of evolving alongside technological advancements, rather than becoming quickly outdated. This flexibility is crucial in a field as dynamic as AI in education, where new capabilities and applications emerge rapidly.

Potential future developments that these placeholders might accommodate include:

- Advanced emotional intelligence in AI tutoring systems
- Integration of virtual and augmented reality in AI-enhanced learning environments
- AI-driven personalized curriculum development
- Quantum computing-enhanced AI for complex educational simulations

By anticipating these future developments, the CAIAF provides a structure for ongoing evaluation and integration of new AI capabilities in education, ensuring its long-term relevance and applicability.

4.3. Differentiation Between Educational Levels and Adjustments

The AIAS differentiates between educational levels in order to account for the various stages of development, cognitive abilities, and academic requirements of students at each level. According to Perkins et al. (2024), who are the authors of the original study, failure to separate K-12 from higher education was a notable limitation in their work. The primary and secondary education levels were considered to be K-12, while the undergraduate and postgraduate education levels were considered to be higher education. By doing so, specificity was brought into this scale, making it a possible tool for the primary, secondary, and tertiary levels of education. This would facilitate more purposeful, specific adjustments, which could be matched better.

This differentiation makes the scale as specific and detailed as possible, indicating that it is applicable from the beginning to the end of education. It was observed that ethical behaviors developed during childhood tend to persist in adulthood (Badeni & Saparahayuningsih, 2019; Pushpa, 2012; Puyo, 2021; Rafikov et al., 2021). Thus, this implies that if we adopt such a scale in early childhood programs and then gradually introduce it at higher grade levels, eventually no student would consider it the imposition of anything as they would be accustomed to their own pace (Foray & Raffo, 2012). Likewise, at points where innovation meets resistance among groups who had initially opposed it, there tends become less over time with sustained efforts towards its full integration into systems being seen more as habit forming rather than constituting merely an affront against established routines (Ng, 2009). Consequently, specific adjustments to be developed along with illustrative examples according to different levels of education may be beneficial for the target groups involved.

The differentiation between educational levels in the CAIAF is a crucial enhancement that addresses a significant limitation of the original AIAS. This approach aligns with established educational theories that emphasize the importance of age-appropriate interventions and scaffolding in learning (Vygotsky, 1978). By tailoring AI integration strategies to specific educational levels, the CAIAF acknowledges the diverse cognitive abilities, ethical reasoning capacities, and academic needs of students at different stages of their educational journey.

Moreover, this differentiation allows for a more nuanced and effective implementation of AI in educational settings. Recent research in educational technology has highlighted the importance of context-specific approaches to technology integration (Mishra & Koehler, 2006). By providing level-specific guidelines, the CAIAF enables educators to implement AI tools in ways that are developmentally appropriate and pedagogically sound, maximizing the benefits of AI while minimizing potential risks.

4.3.1. K-12 Education

4.3.1.1. Primary Education

The first part of education requires basic knowledge of AI's ethics and safety. AI's mechanics are learned through the supremacy of practice over theory. According to this method, a child can comprehend all the concepts about AI by performing real acts and easy tasks. In addition, it is important to begin teaching the ethical use of AI as early as possible so that children grow up with responsible attitudes towards technology. Studies show that exposure to ethics at an early stage greatly affects people's long-term behavior and attitudes towards technologies (Wang & Zhai, 2019).

4.3.1.2. Secondary Education

At this level, the learners should be exposed to more complex AI tools as well as their application across different subjects. Similarly, secondary education students need to know its operation principles both at the theoretical and practical level through demonstration of the principles in real-life situations or fieldwork. In addition, attention should be paid continuously to promoting responsible privacy considerations regarding powerful educational use cases for advanced AI technologies. The integration of ethical dimensions into discussions around technology literacy has been identified by some literature works in this domain, and it was found to be beneficial for enhancing students' comprehension skills associated with critical thinking (Pasricha, 2023).

4.3.2. Higher Education

4.3.2.1. Undergraduate Level

At this stage, studies focus more on the implementation of things learned at the secondary educational level under STEM domains, especially the ones relevant to practical aspects of AI. Additionally, the social science domains also cannot ignore AI, as it provides some tools through which data analysis may be made much easier and more comprehensible. Therefore, strong emphasis should be placed on integrity as well as responsibility regarding the ethical use of AI. For instance, research has shown that if undergraduate curricula incorporate teachings about AI, significantly better designed programs fostering problem-solving abilities among learners and also enhancing innovational skills may emerge (Mollick & Mollick, 2023a).

4.3.2.2. Graduate Level

AI is used by graduate students in different ways. To apply advanced AI techniques to their specific fields of study, researchers develop complex projects using AI. In order to conduct responsible research, it is important to consider ethics in terms of data integrity and security. According to Borenstein & Howard (2021), future challenges will require programs at the graduate level to incorporate advanced applications along with training on ethics.

4.3.3. Tailored AI Integration Across Educational Levels with Exemplification

To enhance the scale, distinct examples should be provided for all six levels across various educational settings, such as primary, secondary, undergraduate, and postgraduate. Thus, the tool's usage will be easier

for the educationalists through being more specific about the point of integration of the technology into their curriculum and through the alignment of it with the diverse needs of the students.

Furthermore, if each level has clear examples assigned to them, then the educationalists can gradually understand how AI supports learning at different phases until it is fully implemented without violating any ethical standards, failing which would imply a lack of evidence-based planning guides for assessment purposes, according to Chan and Tsi (2023).

Unique instances at each stage also aid in understanding and following the ethical principles integrated in the AIAS. Through the observation of practical examples for each level, educationalists and learners can gain a better understanding of the ethical concerns and duties related to AI applications at various points. This will make them more compliant with ethical norms in addition to promoting responsibleness and awareness in the use of AI for educational purposes (Ma & Jiang, 2023).

4.4. Visual Representation and Grading Variability in AI Integration

For the AIAS to be effective, there must be ways of visually representing how AI is integrated into various levels. In education, for example, it may be difficult for students and educationalists to understand the extent of the usage of AI without the use of visual tools like color gradients (Zhou et al., 2020). To show the different levels of AI integration graphically, the Comprehensive AI Assessment Framework (CAIAF) uses a range of blue shades from dark to light. Using a red-green gradient would have been wrong because it might mean negative positivity progression which is not all-inclusive. While the red gradient has a negative implication that points to failure or ban, the green gradient, on the contrary, has a positive implication such as success, and this leads to fear or even bias among users, according to Xu et al. (2023) and Elliot & Maier (2014). A neutral, universally attractive design that fosters clarity and inclusivity visually is created by utilizing this blue spectrum, thus making no reference whatsoever.

With the introduction of "Level 6: Advanced AI Integration," it became necessary to come up with a new scheme for colored bands. This is because when more levels are added and future improvements embraced, there can only be one continuous-color scale so as not to cause confusion due to many different colors being used concurrently, which could be quite messy in visual terms (Frankel & DePace, 2012; Singh & Riedel, 2016; Zeileis et al., 2009). In addition, such an approach simplifies understanding of the system, thereby preventing cognitive overload among people who may find getting acquainted with complex systems hard enough even without them being represented in visually complex terms, such as multiple distinct hues simultaneously employed.

Educational research supports using visual aids in education in order to improve comprehension and engagement (Stobart (2004). According to studies cited by Yen et al. (2012), and Poza-Luján et al.; continuous scales along gradients or other similar devices not only help students comprehend difficult concepts better but also increase their interest levels significantly while reducing mental effort during assessments. Therefore, we should adopt an approach that enhances both cognitive ease and appeal within our educational systems through more student-friendly design strategies like these.

The introduction of visual representation and grading variability in the CAIAF represents a significant advancement in making the framework more accessible and nuanced. This approach aligns with research on visual learning and cognitive load theory, which suggests that visual representations can enhance understanding and retention of complex information (Mayer, 2009). By using a gradient color scheme and introducing grading variability within levels, the CAIAF provides a more intuitive and flexible tool for educators and policymakers. This visual approach not only makes the framework more user-friendly but also allows for a more precise and nuanced assessment of AI integration in educational settings, contributing to more effective and tailored implementation strategies.

4.4.1. Grading Variability Within Levels

To accommodate the different degrees of integration at each level, grading variability should be included for enhancing enhance adaptability and effectiveness. This can greatly enhance the adaptability and effectiveness of AIAS. For instance, when it comes to level two (AI-assisted idea generation and

structuring), minimal assistance from AI may be provided in brainstorming, whereas extensive support for organizing thoughts may be offered by highly developed systems, depending on the student's educational stage or grade level. Primary school pupils might use simple tools powered by weak AI that generate basic ideas while they are at the primary educational level, but different software equipped with higher capabilities may come into play during their secondary education so that they can handle topics more holistically.

When it comes to level 3 (AI-Assisted Editing), variability can range from basic grammar and spell checking to complete content revision. In undergraduate education, students could employ AI for the purpose of correcting grammar mistakes and enhancing clarity in writing their essays or reports. At a graduate level, however, such tools may be used to perform extensive editing on academic papers so as to ensure that they meet not only coherence but also the more sophisticated standards expected of such documents.

Moreover, full integration of AI into tasks is allowed at level 5, where learners are free to extensively use these tools throughout their assignments, but this should be reflected in the grading system because different levels of complexity and depth in AI use can warrant various grades. For instance, a student pursuing a bachelor's degree could employ it for collecting data as well as carrying out preliminary analysis, while another one doing a master's may integrate them into each stage of research, from hypothesis generation through data analysis to report writing. Hence, even though we are restricted to six points on our scale, there will still be a wide range of potential applications and assessments within each point.

Moreover, the use of a gradient color scheme improves the visual indication of assessment diversity. This is because, in the former scale, each level was represented with a single color, which made someone think that the levels themselves could not be graded, but this approach helps to eliminate such misunderstandings by using different shades of AI integration within each level.

As a result, if the current revisions proposed for the AIAS developed and put into use by Perkins et al. (2024) are carried out, this version, which is now more inclusive, will have a more accurate orientation and will be more educationalist- and student-friendly by evolving into the one observed in the Appendix Part. At the same time, this scale, which was formed after the recent revisions, is now named the Comprehensive AI Assessment Framework (CAIAF).

5. Conclusion and Suggestions

This article examines how GenAI tools have changed education by showing the opportunities and challenges they bring. The reactions against the use of AI in educational assessments are diverse, and dealing with these reactions has been at the center of attention. Problems that come with integrating AI were investigated and answered through the identification of the need for ethical principles and the determination of different educational levels, advanced levels of AI, and visual representations, among others.

A significant part of this study focused on improving the original AIAS created by Perkins et al. (2024). This was achieved by adding ethical guidelines, introducing higher levels of AI, and ensuring clear differentiation between K-12 and higher learning institutions. Additionally, a multi-colored grading system with varying degrees has been adopted for more detailed results, thereby leading to the development of the CAIAF, which provides strong yet flexible guidelines for the ethical use of AI in educational settings.

This work has deep future implications for educational practices. With the continuous advancement of AI, its incorporation into the system should be done cautiously so as to maximize its benefits while mitigating its risks. CAIAF lays down ground rules but still needs more improvements, and adjustments can be made depending on various contexts. Future studies may try out this model in different settings with the aim of gauging its efficacy and pointing out areas that may require modifications.

The CAIAF has been designed with flexibility in mind to accommodate the rapid evolution of AI technology. To ensure its continued relevance and effectiveness, we propose the following strategies for adapting the framework to new AI developments:

I. Regular Review Process: Establish an annual review cycle to assess the latest AI advancements and their potential impact on educational practices.

II. Stakeholder Feedback Loop: Create a mechanism for educators, students, and AI experts to provide ongoing feedback on the framework's applicability and effectiveness.

III. Modular Structure: Organize the framework into modules that can be easily updated or replaced as new AI capabilities emerge, without disrupting the entire system.

IV. AI Integration Levels: Maintain the flexibility of the existing levels while allowing for the addition of new levels or sub-levels to accommodate breakthrough AI technologies.

V. Ethical Considerations: Continuously update the ethical guidelines to address new challenges posed by evolving AI capabilities.

VI. Cross-disciplinary Collaboration: Foster partnerships between educators, AI researchers, and ethicists to anticipate and prepare for future AI developments in education.

Furthermore, in order to adapt to the ever-changing landscape of AI, the model has to be flexible enough to incorporate new advancements and applications. This means that as the world becomes more AI-oriented, our teaching methods should not only be up-to-date but also efficient. The placeholder values at different levels of integration for future use within formal education underscore the necessity for continuous improvement and adaptation.

For effective implementation and utilization of the holistic AI assessment model, it is recommended that educationalists, policy-makers, and members of academia embrace, use, and improve the framework regularly. There is a need for cooperation among these stakeholders to ensure that AI is applied in an ethical and constructive manner in schools. Additionally, we suggest the creation of an online platform or repository where updates, case studies, and best practices related to the CAIAF can be shared and discussed by the educational community.

It is important to note the desire for continuing discourse and exploration. One must be prepared at all times for such changes brought about by the rapid advancements in AI in order not to fall behind where educational practice is concerned. By cultivating a climate where change is always welcomed and considered as a chance to grow –instead of shunning new ideas-, we can use AI to improve our teaching methods significantly.

To further enhance the framework's adaptability, we propose the development of an AI-powered tool that can automatically suggest updates to the CAIAF based on emerging research, technological advancements, and user feedback. This tool could help identify potential gaps in the framework and propose adjustments to keep pace with the rapidly evolving AI landscape.

However, the primary focus for future work should be around implementing this framework in real educational settings. Through its practical application, we hope to gain much-needed insight into what works or fails and, thus, to further shape our model accordingly. It is therefore incumbent upon us, as educationalists, to be committed to advancing learning experiences through AI integration within schools, colleges, universities, etc., and to continue using this instrument rigorously so as to ensure that there is continuous improvement in relation to the effectiveness of different AI systems meant for supporting various aspects involved in the education sector.

In conclusion, the CAIAF represents a significant step forward in guiding the ethical and effective integration of AI in education. By embracing flexibility, fostering collaboration, and maintaining a proactive approach to adaptation, we can ensure that this framework remains a valuable tool for educators and policymakers in navigating the exciting and complex landscape of AI in education for years to come.

References

Adıgüzel, T., Kaya, M., & Cansu, F. (2023). Revolutionizing education with AI: Exploring the transformative potential of ChatGPT. *Contemporary Educational Technology, 15*(3), ep429. https://doi.org/10.30935/cedtech/13152

Badeni, B., & Saparahayuningsih, S. (2019). Who is responsible for the child's moral character education? *Education Quarterly Reviews, 2*(1), 23-32. https://doi.org/10.31014/aior.1993.02.01.35

Borenstein, J., & Howard, A. (2021). Emerging challenges in AI and the need for AI ethics education. *AI Ethics, 1*, 61-65. https://doi.org/10.1007/s43681-020-00002-7

Boscardin, C. (2024). ChatGPT and generative artificial intelligence for medical education: Potential impact and opportunity. *Academic Medicine, 99*(1), 22-27. https://doi.org/10.1097/acm.0000000000005439

Bubeck, S., Chandrasekaran, V., Eldan, R., Gehrke, J., Horvitz, E., Kamar, E., … & Zhang, Y. (2023). Sparks of artificial general intelligence: Early experiments with GPT-4. *arXiv preprin*arXiv:2303.12712.

Chakraborty, S., Bedi, A. S., Zhu, S., An, B., Manocha, D., & Huang, F. (2023). On the possibilities of ai-generated text detection. *arXiv preprint arXiv:2304.04736*. https://doi.org/10.48550/arXiv.2304.04736

Chan, C. K. Y., & Tsi, L. H. (2023). The AI revolution in education: Will AI replace or assist teachers in higher education? *arXiv preprint* arXiv:2305.01185.

Chang, D. H., Lin, M. P. C., Hajian, S., & Wang, Q. Q. (2023). Educational design principles of using AI chatbot that supports self-regulated learning in education: Goal setting, feedback, and personalization. *Sustainability, 15*(17), 12921. https://doi.org/10.3390/su151712921

De Laat, P. (2021). Companies committed to responsible AI: From principles towards implementation and regulation? *Philosophy & Technology, 34*(4), 1135-1193. https://doi.org/10.1007/s13347-021-00474-3

Dickey, E., & Bejarano, A. (2023). A model for integrating generative AI into course content development. *arXiv preprint* arXiv:2308.12276.

Elliot, A. J., & Maier, M. A. (2014). Color psychology: Effects of perceiving color on psychological functioning in humans. *Annual Review of Psychology, 65*, 95-120. https://doi.org/10.1146/annurev-psych-010213-115035

Foray, D., & Raffo, J. (2012). Business-driven innovation: Is it making a difference in education? An analysis of educational patents. http://dx.doi.org/10.1787/5k91dl7pc835-en

Frankel, F., & DePace, A. H. (2012). *Visual strategies: A practical guide to graphics for scientists & engineers*. Yale University Press.

Gampala, S., Vankeshwaram, V., & Gadula, S. S. P. (2020). Is artificial intelligence the new friend for radiologists? A review article. *Cureus, 12*(10). https://doi.org/10.7759/cureus.11137

Gao, X. (2024). Language education in a brave new world: A dialectical imagination. *Modern Language Journal, 108*(2), 556-562. https://doi.org/10.1111/modl.12930

García-Martínez, I., Fernández-Batanero, J. M., Fernández-Cerero, J., & León, S. P. (2023). Analysing the impact of artificial intelligence and computational sciences on student performance: Systematic

review and meta-analysis. *Journal of New Approaches in Educational Research*, *12*(1), 171-197. https://doi.org/10.7821/naer.2023.1.1240

Garg, S., & Sharma, S. (2020). Impact of artificial intelligence in special need education to promote inclusive pedagogy. *International Journal of Information and Education Technology, 10*(7), 523-527. https://doi.org/10.18178/ijiet.2020.10.7.1418

Gillani, N., Eynon, R., Chiabaut, C., & Finkel, K. (2023). Unpacking the "Black Box" of AI in education. *Educational Technology & Society*, *26*(1), 99-111. https://doi.org/10.30191/ETS.202301_26(1).0008

Green, C., Mynhier, L., Banfill, J., Edwards, P., Kim, J., & Desjardins, R. (2020). Preparing education for the crises of tomorrow: A framework for adaptability. *International Review of Education, 66*, 857-879. https://doi.org/10.1007/s11159-020-09878-3

Hamiti, M., Reka, B., & Baloghová, A. (2014). Ethical use of information technology in high education. *Procedia-Social and Behavioral Sciences, 116*, 4411-4415. https://doi.org/10.1016/j.sbspro.2014.01.957

Holmes, W., Porayska-Pomsta, K., Holstein, K., Sutherland, E., Baker, T., Shum, S. B., … & Koedinger, K. R. (2022). Ethics of AI in education: Towards a community-wide framework. *International Journal of Artificial Intelligence in Education*, 1-23. https://doi.org/10.1007/s40593-021-00239-1

Hong, Y., Nguyen, A., Dang, B., & Nguyen, B. P. T. (2022, July). Data ethics framework for artificial intelligence in education (AIED). In 2022 International Conference on Advanced Learning Technologies (ICALT) (pp. 297-301). IEEE. https://doi.org/10.1109/ICALT55010.2022.00095

Jones, S. (2016). Doing the right thing: Computer ethics pedagogy revisited. *Journal of Information, Communication and Ethics in Society, 14*(1), 33-48. https://doi.org/10.1108/JICES-07-2014-0033

Kamalov, F., & Gurrib, I. (2023). A new era of artificial intelligence in education: A multifaceted revolution. *arXiv preprint* arXiv:2305.18303.

Kitsios, F., & Kamariotou, M. (2021). Artificial intelligence and business strategy towards digital transformation: A research agenda. *Sustainability*, *13*(4), 2025. https://doi.org/10.3390/su13042025

Kılınç, S. (2023). Embracing the future of distance science education: Opportunities and challenges of ChatGPT integration. *Asian Journal of Distance Education, 18*(1), 205-237. https://doi.org/10.5281/zenodo.7857396

Klimova, B., Pikhart, M., & Kacetl, J. (2023). Ethical issues of the use of AI-driven mobile apps for education. *Frontiers in Public Health*. https://doi.org/10.3389/fpubh.2022.1118116

Kulik, J. A., & Fletcher, J. D. (2016). Effectiveness of intelligent tutoring systems: a meta-analytic review. *Review of educational research*, *86*(1), 42-78. https://doi.org/10.3102/0034654315581420

Lam, T., Cheung, M., Munro, Y., Lim, K., Shung, D., & Sung, J. (2022). Randomized controlled trials of artificial intelligence in clinical practice: Systematic review. *Journal of Medical Internet Research, 24*(8), e37188. https://doi.org/10.2196/37188

Lane, S. H., Haley, T., & Brackney, D. E. (2024). Tool or tyrant: Guiding and guarding generative artificial intelligence use in nursing education. *Creative Nursing, 30*(2), 125-132. https://doi.org/10.1177/10784535241247094

Leimanis, A. (2020, February). Self-imposed ethical guidelines for AI in education. In International Scientific Conference "SOCIETY, INTEGRATION, EDUCATION-SIE2020".

Luckin, R., & Holmes, W. (2016). *Intelligence unleashed: An argument for AI in education.*

Ma, X., & Jiang, C. (2023). On the ethical risks of artificial intelligence applications in education and its avoidance strategies. *Journal of Education, Humanities and Social Sciences*, *14*, 354-359. https://doi.org/10.54097/ehss.v14i.8868

Maghsudi, S., Lan, A., Xu, J., & van Der Schaar, M. (2021). Personalized education in the artificial intelligence era: What to expect next. *IEEE Signal Processing Magazine*, *38*(3), 37-50. https://doi.org/10.1109/MSP.2021.3055032

Mahligawati, F., Allanas, E., Butarbutar, M. H., & Nordin, N. A. N. (2023, September). Artificial intelligence in physics education: A comprehensive literature review. In *Journal of Physics: Conference Series* (Vol. 2596, No. 1, p. 012080). IOP Publishing. https://doi.org/10.1088/1742-6596/2596/1/012080

Mâță, L. (2022). Ethical rules of online communication between university teachers and students. In: Mâță, L. (Ed.) *Ethical use of information technology in higher education*. EAI/Springer Innovations in Communication and Computing. Springer, Singapore. https://doi.org/10.1007/978-981-16-1951-9_7

Mayer, J. (2009). *The growing interdependence between financial and commodity markets* (No. 195). United Nations Conference on Trade and Development.

Mello, R. F., Freitas, E., Pereira, F. D., Cabral, L., Tedesco, P., & Ramalho, G. (2023). Education in the age of generative AI: Context and recent developments. *arXiv preprint* arXiv:2309.12332.

Michaeli, T., Romeike, R., & Seegerer, S. (2022, August). What students can learn about artificial intelligence–recommendations for K-12 computing education. In *IFIP World Conference on Computers in Education* (pp. 196-208). Cham: Springer Nature Switzerland. https://doi.org/10.1007/978-3-031-43393-1_19

Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge: A framework for teacher knowledge. *Teachers college record*, *108*(6), 1017-1054. https://doi.org/10.1111/j.1467-9620.2006.00684.x

Mollick, E. R., & Mollick, L. (2023a). Using AI to implement effective teaching strategies in classrooms: Five strategies, including prompts. *Including Prompts (March 17, 2023)*. http://dx.doi.org/10.2139/ssrn.4391243

Mollick, E., & Mollick, L. (2023b). Assigning AI: Seven approaches for students, with prompts. *arXiv preprint arXiv:2306.10052*.

Morley, J., Elhalal, A., Garcia, F., Kinsey, L., Mökander, J., & Floridi, L. (2021). Ethics as a service: A pragmatic operationalisation of AI ethics. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.3784238

Network, P. O. D. (2001). Ethical guidelines for educational developers. *To Improve the Academy*, *19*.

Ng, P. T. (2009). Innovation in education: Some observations and questions. *International Journal of Innovation in Education*, *1*(1), 8-11. https://doi.org/10.1504/IJIIE.2009.0301

Ng, D. T. K., Leung, J. K. L., Su, J., Ng, R. C. W., & Chu, S. K. W. (2023). Teachers' AI digital competencies and twenty-first century skills in the post-pandemic world. *Educational technology research and development*, *71*(1), 137-161. https://doi.org/10.1007/s11423-023-10203-6

Nguyen, A., Ngo, H. N., Hong, Y., Dang, B., & Nguyen, B. P. T. (2023). Ethical principles for artificial intelligence in education. *Education and Information Technologies*, *28*(4), 4221-4241. https://doi.org/10.1007/s10639-022-11316-w

Ogunleye, B., Zakariyyah, K. I., Ajao, O., Olayinka, O., & Sharma, H. (2024). Higher education assessment practice in the era of generative AI tools. *arXiv preprint* arXiv:2404.01036.

Olga, A., Saini, A., Zapata, G., Searsmith, D., Cope, B., Kalantzis, M., … & Kastania, N. P. (2023). Generative AI: Implications and applications for education. *arXiv preprint* arXiv:2305.07605.

Pack, A., & Maloney, J. (2024). Using artificial intelligence in TESOL: Some ethical and pedagogical considerations. *TESOL Quarterly, 58*(2), 1007-1018. https://doi.org/10.1002/tesq.3320

Park, W., & Kwon, H. (2024). Implementing artificial intelligence education for middle school technology education in Republic of Korea. *International Journal of Technology and Design Education, 34*(1), 109-135. https://doi.org/10.1007/s10798-023-09812-2

Pasricha, S. (2023, June). Ethics in computing education: Challenges and experience with embedded ethics. In *Proceedings of the Great Lakes Symposium on VLSI 2023* (pp. 653-658). https://doi.org/10.1145/3583781.3590240

Perkins, M., Furze, L., Roe, J., & MacVaugh, J. (2024). The artificial intelligence assessment scale (AIAS): A framework for ethical integration of generative AI in educational assessment. *Journal of University Teaching and Learning Practice, 21*(06). https://doi.org/10.53761/q3azde36

Perkins, M., Roe, J., Vu, B. H., Postma, D., Hickerson, D., McGaughran, J., & Khuat, H. Q. (2024). GenAI detection tools, adversarial techniques and implications for inclusivity in higher education. *arXiv preprint* arXiv:2403.19148.

Poza-Lujan, J. L., Calafate, C. T., Posadas-Yagüe, J. L., & Cano, J. C. (2015). Assessing the impact of continuous evaluation strategies: Tradeoff between student performance and instructor effort. *IEEE Transactions on Education, 59*(1), 17-23. https://doi.org/10.1109/TE.2015.2418740

Pushpa, S. (2012). Ethical leadership: Need for business ethics education. *International Journal of Advances in Management and Economics, 1*(1), 14-19.

Puyo, J. G. B. (2021). A value and character educational model: Repercussions for students, teachers, and families. *Journal of Culture and Values in Education, 4*(1), 100-115. https://doi.org/10.46303/jcve.2020.7

Rafikov, I., Akhmetova, E., & Yapar, O. E. (2021). Prospects of morality-based education in the 21st century. *Journal of Islamic Thought and Civilization, 11*(1), 1-21. https://doi.org/10.32350/jitc.111.01

Sajja, R., Sermet, Y., Cikmaz, M., Cwiertny, D., & Demir, I. (2023). Artificial intelligence-enabled intelligent assistant for personalized and adaptive learning in higher education. *arXiv preprint* arXiv:2309.10892.

Selwyn, N. (2013). *Distrusting educational technology: Critical questions for changing times*. Routledge.

Shih, P. K., Lin, C. H., Wu, L. Y., & Yu, C. C. (2021). Learning ethics in AI—teaching non-engineering undergraduates through situated learning. *Sustainability, 13*(7), 3718. https://doi.org/10.3390/su13073718

Simms, R. C. (2024). Work with ChatGPT, not against: 3 teaching strategies that harness the power of artificial intelligence. *Nurse Educator, 49*(3), 158-161. https://doi.org/10.1097/nne.0000000000001634

Singh, S., & Riedel, S. (2016). Creating interactive and visual educational resources for AI. *Proceedings of the AAAI Conference on Artificial Intelligence, 30*(1). https://doi.org/10.1609/aaai.v30i1.9851

Singh, S. V., & Hiran, K. K. (2022). The impact of AI on teaching and learning in higher education technology. *Journal of Higher Education Theory and Practice, 22*(13).

Stobart, G. (2004). Developing and improving assessment instruments.

Sullivan, M., Kelly, A., & McLaughlan, P. (2023). ChatGPT in higher education: Considerations for academic integrity and student learning. https://doi.org/10.37074/jalt.2023.6.1.17

Swiecki, Z., Khosravi, H., Chen, G., Martinez-Maldonado, R., Lodge, J. M., Milligan, S., … & Gašević, D. (2022). Assessment in the age of artificial intelligence. *Computers and Education: Artificial Intelligence, 3*, 100075. https://doi.org/10.1016/j.caeai.2022.100075

Tong, R., Li, H., Liang, J., & Wen, Q. (2024). Developing and Deploying Industry Standards for Artificial Intelligence in Education (AIED): Challenges, Strategies, and Future Directions. *arXiv preprint arXiv:2403.14689*.

Volante, L., DeLuca, C., & Klinger, D. A. (2023). Leveraging AI to enhance learning. *Phi Delta Kappan, 105*(1), 40-45. https://doi.org/10.1177/00317217231197475

Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes* (Vol. 86). Harvard university press.

Wang, Z., Chen, A., Tao, K., Han, Y., & Li, J. (2024). MatGPT: A vane of materials informatics from past, present, to future. *Advanced Materials, 36*(6). https://doi.org/10.1002/adma.202306733

Wang, Z., & Zhai, J. (2019, October). Ethical challenges faced by students in the educational environment of artificial intelligence. In *2019 International Conference on Advanced Education Research and Modern Teaching (AERMT 2019)* (pp. 1-3). Atlantis Press. https://doi.org/10.2991/aermt-19.2019.1

Weber-Wulff, D., Anohina-Naumeca, A., Bjelobaba, S., Foltýnek, T., Guerrero-Dib, J., Popoola, O., … & Waddington, L. (2023). Testing of detection tools for AI-generated text. *International Journal for Educational Integrity, 19*(1), 26. https://doi.org/10.1007/s40979-023-00146-z

Xu, X., Zhang, J., Zhu, Q., & Xia, T. (2023). The influences of gradient color on the weight perception and stability perception: A preliminary study. *i-Perception, 14*(4), 20416695231197797. https://doi.org/10.1177/20416695231197797

Yen, W. M., Lall, V. F., & Monfils, L. (2012). Evaluating academic progress without a vertical scale. *ETS Research Report Series, 2012*(1), i-55. https://doi.org/10.1002/j.2333-8504.2012.tb02289.x

Yeo, K. (2023). Artificial intelligence in cardiology: Did it take off? *Russian Journal for Personalized Medicine, 2*(6), 16-22. https://doi.org/10.18705/2782-3806-2022-2-6-16-22

Zawacki-Richter, O., Marín, V. I., Bond, M., & Gouverneur, F. (2019). Systematic review of research on artificial intelligence applications in higher education–where are the educators?. *International Journal of Educational Technology in Higher Education, 16*(1), 1-27. https://doi.org/10.1186/s41239-019-0171-0

Zeileis, A., Hornik, K., & Murrell, P. (2009). Escaping RGBland: Selecting colors for statistical graphics. *Computational Statistics & Data Analysis, 53*(9), 3259-3270. https://doi.org/10.1016/j.csda.2008.11.033

Zhang, C., Zhang, C., Li, C., Qiao, Y., Zheng, S., Dam, S. K., … & Hong, C. S. (2023). One small step for generative AI, one giant leap for AGI: A complete survey on ChatGPT in AIGC era. *arXiv preprint* arXiv:2304.06488.

Zhang, K., & Aslan, A. B. (2021). AI technologies for education: Recent research & future directions. *Computers and Education: Artificial Intelligence, 2*. https://doi.org/10.1016/j.caeai.2021.100025

Zhou, X., Van Brummelen, J., & Lin, P. (2020). Designing AI learning experiences for K-12: Emerging works, future opportunities and a design framework. *arXiv preprint* arXiv:2009.10228.

Appendix - The Comprehensive AI Assessment Framework (CAIAF)

Comprehensive AI Assessment Framework (CAIAF)

Level	Description	Ethical Considerations	Applications and Field-Specific Adjustments			
			K-12		Higher Education	
			Primary Education	Secondary Education	Undergraduate	Graduate
Level 1 **No AI (Human-Only)**	The assessment is completed entirely without AI assistance. This level ensures that students rely solely on their knowledge, understanding, and skills. **AI must not be used at any point during the assessment.**	- **Transparency:** Clearly communicate that no AI tools are permitted during the assessment. - **Equity and Inclusivity:** Ensure equal conditions for all students by preventing AI use. - **Pedagogical Alignment:** Focus on assessing unaided student capabilities. - **Accountability:** Require all work to be completed by the student without AI assistance. - **Privacy and Data Protection:** No digital data is collected or analyzed.	- Traditional pen-and-paper assignments with no AI involvement. - Drawing and handwriting exercises. - Physical science experiments without AI tools.	- Written essays and exams completed without AI assistance. - Manual data collection for science projects. - Handwritten lab reports.	- Lab reports and research papers completed manually. - Traditional coding assignments without AI assistance. - Manual statistical analysis using calculators or non-AI software.	- Theses and dissertations written without any AI tools. - Manual literature reviews and citation management. - Research proposals developed entirely by the student without AI assistance.
			- **Range of Use:** All tasks must strictly adhere to no AI use. This includes traditional exams, handwritten essays, physical science experiments, oral presentations, and group discussions that rely solely on students' abilities. - **Emphasis on:** Safety and ethical considerations. - **Focus on:** Building foundational skills and manual problem-solving abilities.		- **Range of Use:** All academic work must be completed without AI assistance. This encompasses written exams, lab reports, in-class presentations, and comprehensive research projects done manually to ensure personal accountability and academic integrity. - **Emphasis on:** Academic integrity and self-reliance. - **Focus on:** Developing critical thinking and personal accountability.	
Level 2 **AI-Assisted Idea Generation and Structuring**	AI can be used in the assessment for brainstorming, creating structures, and generating ideas for improving work. **No AI content is allowed in the final submission.**	- **Transparency:** Require students to disclose the use of AI for idea generation. - **Equity and Inclusivity:** Provide all students with access to similar AI tools for idea generation. - **Pedagogical Alignment:** Support creative thinking and idea development. - **Accountability:** Ensure students retain responsibility for the final content, with no AI-generated content in the final submission. - **Privacy and Data Protection:** Ensure AI tools handle data securely.	- Using AI tools to brainstorm ideas for creative writing assignments. - AI-assisted mind mapping for story development. - Utilizing AI to create simple project outlines.	- Utilizing AI to generate outlines and structure essays. - AI-assisted brainstorming for science fair projects. - Using AI to create timelines for history projects.	- AI-assisted brainstorming sessions for project proposals. - Using AI tools to structure research papers. - Developing presentation outlines with AI support.	- Employing AI for article scanning and structuring research frameworks. - Using AI to generate research hypotheses drafts and project plans. - AI-assisted templates of survey instruments and experimental setups.
			- **Range of Use:** AI tools can assist in brainstorming and organizing ideas. This includes generating topic ideas, creating outlines for essays, mapping out storyboards, and planning project frameworks. Final content must be created by students without AI assistance. - **Emphasis on:** Developmental appropriateness and teacher guidance. - **Focus on:** Encouraging creative thinking and structured planning.		- **Range of Use:** AI can aid in initial idea generation, research proposal structuring, literature review organization, and hypothesis formation. Students must ensure that the AI's role is limited to the idea and structural phases, with no AI-generated content in the final submission. - **Emphasis on:** Fostering advanced applications and critical thinking. - **Focus on:** Supporting research development and hypothesis structuring.	
Level 3 **AI-Assisted Editing**	AI can be used to make improvements to the clarity or quality of student-created work to improve the final output, but no new content can be created using AI. **AI can be used, but your original work with no AI content must be provided in an appendix.**	- **Transparency:** Require students to disclose the use of AI in editing. - **Equity and Inclusivity:** Ensure equitable access to similar AI tools for editing. - **Pedagogical Alignment:** Enhance writing and clarity while maintaining original content. - **Accountability:** Ensure students take responsibility for the final output by providing both original and AI-edited versions. - **Privacy and Data Protection:** Ensure secure handling of student data by AI tools.	- AI tools for basic grammar and spell-checking in writing assignments. - AI-assisted improvements to sentence structure in essays. - Simple vocabulary enhancement suggestions from AI.	- AI-assisted editing to improve clarity and coherence in essays. - Using AI for advanced grammar checks and style enhancements. - AI tools to help with citation formatting and checking.	- Using AI for refining lab reports and enhancing clarity in presentations. - AI-assisted editing of research proposals and term papers. - Utilizing AI tools for revisions and proofreading.	- Advanced AI tools for editing research papers and ensuring adherence to academic standards. - Using AI for comprehensive style and formatting checks. - AI-assisted review of dissertation chapters for coherence and clarity.
			- **Range of Use:** AI tools can be used for basic to advanced editing. This includes spelling and grammar checks, improving text clarity and coherence, enhancing style, and suggesting better word choices. Students must provide both the AI-edited and original versions for comparison. - **Emphasis on:** Safety and ethical considerations. - **Focus on:** Enhancing clarity and coherence in student writing.		- **Range of Use:** AI can assist in refining research papers, thesis drafts, and essays. This includes comprehensive grammar and style editing, improving argument coherence, and ensuring adherence to academic standards. The original and AI-edited versions must be submitted together. - **Emphasis on:** Ensuring academic integrity and self-regulation. - **Focus on:** Refining academic writing and meeting high scholarly standards.	
Level 4 **AI Task Completion, Human Evaluation**	AI is used to complete certain elements of the task, with students providing discussion or commentary on the AI-generated content. This level requires critical engagement with AI-generated content and evaluating its output. **You will use AI to complete specified tasks in your assessment. Any AI-created content must be cited.**	- **Transparency:** Clearly define and disclose the AI's role in completing specific tasks. - **Equity and Inclusivity:** Provide equal access to similar AI tools for task completion. - **Pedagogical Alignment:** Integrate AI while requiring critical evaluation by students. - **Accountability:** Ensure students critically engage with and evaluate AI outputs. - **Privacy and Data Protection:** Ensure data privacy and secure AI tool use.	- Simple AI tasks evaluated by teachers to ensure understanding. - AI-generated flashcards for vocabulary practice, reviewed by teachers. - AI-assisted math problem solving with teacher oversight.	- AI-generated summaries or problem sets reviewed by educators. - AI tools to assist in lab data analysis, with teacher evaluation. - AI-generated practice quizzes for standardized tests, reviewed by teachers.	- AI-assisted data analysis tasks with human evaluation to ensure accuracy. - Using AI to generate preliminary research findings, validated by professors. - AI tools to create draft reports, with final revisions by students.	- AI-generated research models or simulations critically evaluated by supervisors. - AI-assisted analysis of large datasets, with results interpreted by students. - AI tools for preliminary literature review, with comprehensive review by students.
			- **Range of Use:** AI can complete specific tasks such as generating summaries, conducting basic data analysis, and solving straightforward problems. Teachers must evaluate these outputs to ensure student understanding and engagement with the material. - **Emphasis on:** Developmental appropriateness and teacher facilitation. - **Focus on:** Engaging students in critical evaluation of AI outputs.		- **Range of Use:** AI can assist in complex tasks like data processing, initial drafts of reports, and preliminary research analysis. Students must critically evaluate and interpret AI-generated outputs, which are then reviewed by educators to ensure comprehension and accuracy. - **Emphasis on:** Encouraging student-led activities and complex AI integrations. - **Focus on:** Promoting comprehensive understanding and critical analysis of AI-generated data.	
Level 5 **Full AI Integration**	AI should be used as a 'co-pilot' to meet the requirements of the assessment, allowing for a collaborative approach with AI and enhancing creativity. **You may use AI throughout your assessment to support your own work and do not have to specify which content is AI-generated.**	- **Transparency:** Inform about the extent and nature of AI use throughout the assessment. - **Equity and Inclusivity:** Ensure all students have access to similar AI tools for full integration. - **Pedagogical Alignment:** Deepen understanding and explore AI capabilities. - **Accountability:** Ensure students demonstrate understanding of AI contributions. - **Privacy and Data Protection:** Implement strong data protection measures.	- Fully AI-driven educational games and learning activities. - AI-assisted interactive storytelling sessions. - AI tools for personalized learning pathways in subjects like math and reading.	- Comprehensive AI tools for project-based learning and presentations. - AI systems for adaptive learning and individualized tutoring. - AI-assisted simulations for science and social studies.	- Extensive use of AI in capstone projects and collaborative research. - AI tools for immediate feedback on assignments and projects. - Using AI to facilitate group work and project management.	- Full integration of AI in complex research projects, from data collection to analysis and interpretation. - AI tools for advanced modeling and simulations. - Fully AI-driven assistance in collaborative research across different fields.
			- **Range of Use:** AI is fully integrated into learning activities, including interactive educational games, adaptive learning modules, and collaborative projects. AI supports various stages of the learning process, fostering creativity and deeper understanding. - **Emphasis on:** Safety and ethical considerations. - **Focus on:** Enhancing learning through interactive and collaborative AI tools.		- **Range of Use:** AI is extensively used in comprehensive research projects, collaborative assignments, and advanced data analysis. This includes continuous AI assistance throughout the project lifecycle, enhancing the depth and quality of academic work. - **Emphasis on:** Developing critical thinking and self-regulation. - **Focus on:** Utilizing AI for sophisticated academic projects and collaborative research.	
Level 6 **Advanced AI Integration**	AI tools are used as advanced personal assistants and for real-time interactions during the assessment process. This includes AI capabilities such as interpreting camera images, providing instant feedback, and engaging in live dialogues to assist students dynamically. **AI operates alongside the student continuously, facilitating a highly interactive and adaptive learning experience.**	- **Transparency:** Clearly communicate the real-time and personal assistant roles of AI. - **Equity and Inclusivity:** Ensure equitable access to advanced AI tools for dynamic learning experiences. - **Pedagogical Alignment:** Support real-time, adaptive learning experiences. - **Accountability:** Ensure students demonstrate understanding and proper use of real-time AI assistance. - **Privacy and Data Protection:** Ensure robust data protection and privacy measures for real-time AI interactions.	- Interactive AI tutors providing personalized learning experiences. - Real-time feedback from AI during interactive lessons. - AI-driven virtual field trips with real-time interactivity.	- Advanced AI systems for adaptive learning and individualized feedback. - Real-time AI-assisted debates and discussions. - AI tools for real-time collaborative writing and peer review.	- Real-time AI assistants for lab work and research activities. - AI-driven interactive study sessions and tutorials. - Advanced AI tools for real-time data visualization and analysis.	- Cutting-edge AI tools for real-time data analysis, hypothesis testing, and advanced research methodologies. - AI assistants for dynamic research collaboration and project management. - Real-time AI tools for live academic seminars and discussions.
			- **Range of Use:** AI acts as a real-time tutor, providing interactive and personalized learning experiences. This includes adaptive learning paths, immediate feedback, and dynamic content adjustments based on student performance. - **Emphasis on:** Safety, developmental appropriateness, and teacher facilitation. - **Focus on:** Providing personalized, adaptive learning experiences through AI.		- **Range of Use:** AI tools support real-time research activities, advanced data analytics, and continuous interactive learning. This includes real-time hypothesis testing, adaptive research methodologies, and interactive AI assistants managing complex academic tasks. - **Emphasis on:** Advanced applications and independent learning. - **Focus on:** Utilizing real-time AI tools for dynamic research and continuous academic support.	
Possible Future Levels	**Placeholder for Future AI Integration Levels**	**Ethical principles for future levels will continue to emphasize these five principles and maybe more.**	**Applications and field-specific adjustments for future levels will be specified based on emerging AI capabilities and educational needs.**			