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Question Engineering:

Learning Approach in the Age of Artificial Intelligence

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Abstract:

This essay explores integrating artificial intelligence (AI) in education, focusing on the concept of question engineering as a robust learning approach. It emphasizes the importance of questioning and critical thinking in the learning process. Question engineering is, in line, with the principles of Blooms Taxonomy. Encourages the development of higher order thinking abilities. The essay discusses the impact of (AI) on question engineering, including (AI) technologies in education and the benefits they bring, such as automated feedback, adaptive questioning, and data-driven insights. It also examines how question engineering combined with (AI) can enhance critical thinking by developing skills, promoting met cognition and generating tailored questions.

The essay addresses challenges and ethical considerations, such as overreliance on (AI), and the need in human guidance. Strategies in implementing question engineering with (AI) in education are discussed, including training educators and fostering collaboration. The essay concludes by discussing future implications and the importance of a balanced approach that combines (AI) and human expertise in transforming the learning approach.

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I. Introduction:

Artificial intelligence (AI) has become a game changer, in industries including education. It is fascinating to see how (AI) has revolutionized the way we teach and learn over time. By using technologies like machine learning and natural language processing educational institutions have been able to improve students' learning experience customize instruction and offer insights, to educators. This integration of (AI) in education has opened up new possibilities in improving student engagement, academic performance, and overall educational outcomes.

Within the realm of education, questioning and critical thinking play crucial roles in fostering deep understanding and intellectual growth. Encouraging students to inquire and engage in thinking not allows them to actively participate in the topic at hand but also empowers them to assess information consider varying viewpoints and cultivate comprehensive perspectives. These abilities are crucial, in thriving in todays changing world, where knowledge is continuously advancing and the capacity to navigate matters and resolve problems holds significant importance. By nurturing questioning and critical thinking, educators empower students to become independent learners who can approach challenges with a thoughtful and analytical mindset.

Building upon the potential of (AI) and the significance of questioning and critical thinking, question engineering emerges as a robust learning approach. The process of question engineering entails creating and formulating questions that provoke thinking, foster curiosity and facilitate a more comprehensive comprehension of the topic at hand. By utilizing intelligence (AI) technologies question engineering can be expanded to accommodate the requirements of students offering personalized questions and feedback based on their individual learning journey. Combining intelligence (AI) and the practice of crafting questions has potential in the field of education. It not improves thinking abilities but also enables customized learning opportunities that adapt to the individual strengths and interests of every student. By harnessing the potential of (AI) by question engineering, education can be transformed into a dynamic and intellectually stimulating process that nurtures inquisitive minds and fosters deep understanding.

In the rapidly evolving age of artificial intelligence, question engineering emerges as a transformative learning approach. This introduction explores the potential impact of question engineering in revolutionizing the learning process and capitalizing on the advancements in (AI) technology. By answering the following question: **How can the practice of crafting targeted questions transform the way we approach learning in this era of intelligence?** To simplify this question, the following sub-questions were asked:

- What does question engineering mean. How can we. Apply it in the field of education?
- How has the inclusion of artificial intelligence affected the effectiveness and efficiency of question engineering methods?
- In what ways does Combining question engineering and artificial intelligence enhance critical thinking skills in students?
- What are the main challenges and ethical considerations that arise when implementing question engineering with AI, and how can they be addressed?
- What steps and considerations should be considered when implementing question engineering with artificial intelligence in educational settings?
- What are the potential future implications and trends of question engineering with (AI), and what conclusions can be drawn about its impact on education?

Objectives of the study: The purpose of this study is to comprehensively examine question engineering, its relationship with artificial intelligence, and its impact on education. By addressing these questions, the study aims to explore the definition and application of question engineering in educational contexts, analyze the effects of integrating artificial intelligence on question engineering practices, and investigate how Combining question engineering and (AI) enhances critical thinking skills in students. Additionally, the study seeks to identify and address challenges and ethical considerations associated with implementing question engineering with (AI), Guide the steps and considerations in practical implementation in educational settings, and explore the future implications and trends of question engineering with (AI) to inform decision-making, educational policies, and future research and development efforts in this field.

Study methodology: Overall, this methodology involves a systematic approach that combines research, analysis, evaluation, and critical thinking to address each question thoroughly and provide well-informed and comprehensive answers. And this by research and literature review: Gather information from reputable sources such as academic papers, books, and scholarly articles to understand the concepts of question engineering, artificial intelligence, critical thinking, challenges, and ethical considerations. And explore how Combining question engineering and artificial intelligence enhances students' critical thinking skills. Review empirical studies and educational experiments that demonstrate the positive effects of these approaches on critical thinking abilities. It should also be noted that the (chat GPT) program was utilized as a tool to successfully complete the study.

Previous studies: The introduction provides a concise review of previous studies on the topic, highlighting critical findings and gaps in the existing literature: **1.** Study: **Yehudit J. Dori, Orit Herscovitz** , Title:" Question-posing capability as an alternative evaluation method: Analysis of an environmental case study "**(Dori & Herscovitz, 1999)** .

The study examined the impact of developing students' question-posing abilities on problem-solving skills. Using the jigsaw method, 10th-grade students studied air quality by case studies and real-world problems. After the module, students showed a significant increase in the number and complexity of questions, with higher achievers displaying more remarkable improvement. Post-test results revealed an increased focus on practical solutions and opinions, indicating improved awareness and analytical skills. The article recommends assessing question-posing capability as an alternative evaluation approach to gauge problem-solving and critical thinking skills.

2. study: **Goodman, L** & **Berntson, G**. Title: "The Art of Asking Questions: Using Directed Inquiry in the Classroom" **(Goodman & Berntson, 2000)**. The study assesses the effectiveness of directed inquiry in the classroom using a mixed-methods approach. Classroom observations, student questionnaires, and teacher interviews were used to collect data. Directed inquiry led to positive outcomes, including increased curiosity, critical thinking skills, active participation, improved subject understanding and retention, and higher levels of student engagement and motivation. Educators should adopt directed inquiry as a teaching strategy, promote inquiry-based learning, provide professional development in teachers, and integrate inquiry-based approaches into educational frameworks.

3. Study: **Ian D. Beatty, William J. Gerace**, **William J. Leonard, and Robert J**. Dufresne Title: "Designing practical questions in classroom response system teaching" **(Beatty, Leonard, Gerace, & Dufresne, 2006)**. The study explores the design of practical questions in classroom response systems (CRS) in teaching. (CRS) technology was implemented, questions were designed, and student responses were observed. Question design significantly influenced student engagement and learning outcomes. Practical questions were clear, relevant, aligned with learning goals, required higher-order thinking, and promoted conceptual understanding. Design questions encouraging higher-order thinking, align them with learning goals, ensure clarity in instructions, and use them in classroom response system teaching.

4. Study: **Nguyen-Thinh Le, Tomoko Kojiri, Niels Pinkwart**. Title: "Automatic Question Generation in Educational Applications – The State of Art" **(Nguyen-Thinh, Tomoko, & Niels, 2014)**. The study provides an overview of the current state of automatic question generation in educational applications. A comprehensive literature review was conducted to analyze existing approaches and techniques. Automatic question generation has gained attention, with rule-based, template-based, and machine learning-based approaches developed. Further explore machine learning techniques, profound learning models, to improve question quality and diversity. Investigate integrating natural language processing and semantic knowledge.

5. study: **Joan Buchanan Hill,** Title: "Questioning Techniques: A Study of

Instructional Practice" **(Buchanan Hill, 2016)**. The study investigates the impact of questioning techniques on student learning outcomes. Mixed-methods approach using classroom observations, teacher interviews, surveys, and student assessments. Open-ended questions increased student engagement and critical thinking, a balanced combination of questions improved comprehension, and wait time after posing a question was necessary. Incorporate open-ended questions, balance question types, and provide sufficient wait time to enhance instructional practices and improve student learning outcomes.

6. Study: **Ester Aflalo**, Title: "Students generating questions as a way of learning" **(Ester, 2018)**. This research presents a framework, in integrating student question creation into a setting. A group of 133 students worked together to generate questions respond to their peers questions and evaluate them. When comparing the exam grades before and after the question creation activity there wasn't a improvement in overall academic performance. However when specifically examining how well students answered thinking questions there was a noticeable improvement in their ability to tackle such questions. Additionally the students mentioned benefits such as reduced test anxiety, practical group learning and the development of a question database that supported their exam preparation. The implications of these findings, in education are thoroughly discussed.

7. Study: **Devang Kulshreshtha, Muhammad Shayan, Robert Belfer, Siva Reddy, Iulian Vlad Serban, Ekaterina Kochmar**, Title: "Few-shot Question Generation in Personalized Feedback in Intelligent Tutoring Systems" **(Kulshreshtha, 2022)**. The study develops a few-shot question generation model in personalized feedback in Intelligent Tutoring Systems (ITS). Training the model using limited data, employing transfer learning and fine-tuning, comparing generated questions with human-generated ones. The model successfully generated personalized feedback questions comparable in quality and relevance to human-generated questions. Explore data augmentation techniques, evaluate the impact of generated questions on student learning outcomes, and conduct user studies to assess effectiveness.

Study structure: This study investigates the concept of question engineering as a robust learning approach, focusing on its relevance, benefits, and challenges within the context of artificial intelligence. By addressing the following points:

- **Understanding Question Engineering**
- **The Impact of Artificial Intelligence on Question Engineering.**
- **Enhancing Critical Thinking with Question Engineering and (AI)**
- **Addressing Challenges and Ethical Considerations**
- **Implementing Question Engineering with AI in Education**

II .Understanding Question Engineering

Question engineering involves deliberately designing thought-provoking questions to enhance learning, promoting

critical thinking and deeper understanding. It fosters inquiry-based learning and aligns with Bloom's Taxonomy principles. By integrating question engineering, educators create an environment that nurtures curiosity, engagement, and meaningful learning experiences. The following is an explanation in that:

A. concept of question engineering: Primary source learning offers an immersive method in students to enhance their thinking skills. When it comes to primary source documents, like photographs, cartoons, letters, maps or newspaper articles they serve as a starting point in students to delve into perspectives closely analyze and interpret them establish connections make inferences and above all ask questions. As historian David Hackett Fischer eloquently stated in his 1970 book Historians' Fallacies toward a Logic of Historical Thought; "Without questioning there can be no thinking. No exploration of the past or meaningful planning in the future." It is undeniable that questioning plays a role in guiding students towards exploring primary source documents with curiosity while relating them to their present reality. If the goal of social studies education is to foster students historical thinking abilities and encourage them to adopt the mindset of historians and social scientists then there is arguably no skill, than the art of formulating thought provoking inquiries. **(Melville & Minigan, 2018)**.

Accordingly, it can be said that question engineering is a strategic approach to formulating and designing practical questions. It involves crafting questions that elicit desired information, provoke critical thinking, and guide the direction of a conversation or inquiry. The concept of question engineering encompasses various aspects, including the structure, content, and purpose of the questions. Here are some critical elements and considerations involved in question engineering:

- **Clarity and Precision:** Questions should be clear, concise, and unambiguous.

- **Purpose and Goal:** Questions should have a clear purpose or goal aligned with the desired outcome.

- **Open-Ended vs. Closed-Ended:** Choose between open-ended or closed-ended formats based on the context.

- **Depth and Complexity:** Design questions to encourage critical thinking and explore deeper understanding.

- **Sequencing and Flow:** Arrange questions strategically to guide the conversation and build on previous answers.

- **Context and Audience:** Tailor questions to the knowledge, experience, and interests of the individuals involved.

- **Avoiding Bias:** Ensure questions are neutral and unbiased, promoting fair and accurate responses.

- **Reflective and Probing Questions:** Include reflective questions and follow up with probing questions in deeper insights.

By employing question engineering techniques, individuals can enhance their communication, promote critical thinking, and extract valuable insights from discussions, interviews, surveys, and other interactive contexts.

B. The role of question engineering in fostering inquiry-based learning: Questioning is essential to the core of education, and the inquiries posed by students are pivotal in promoting substantial learning and fostering motivation to learn. Within the realm of scientific studies, questioning holds a critical position in the research and problem-solving journey, representing a fundamental skill that students need to cultivate **(Chin & Osborne, 2008, p. 39)**.

Question engineering plays a crucial role in fostering inquiry-based learning. Inquiry-based learning is an approach that focuses on encouraging students to actively engage in the learning process by posing questions, investigating ideas, and exploring concepts.

Question engineering involves crafting thoughtful and purposeful questions that stimulate students' curiosity, critical thinking, and problem-solving skills. By designing practical questions, educators can guide students by the inquiry process, enabling them to explore topics deeply, make connections, and construct their own knowledge. Here are some ways in which question engineering supports inquiry-based learning:

- **Provoking curiosity:** Well-crafted questions ignite students' interest, encouraging them to delve deeper and seek answers.

- **Encouraging exploration:** practical questions empower students to explore different perspectives, analyze information, and think critically.

- **Promoting higher-order thinking:** Thoughtful questions challenge students to engage in analysis, synthesis, and evaluation in deeper understanding.

- **Guiding inquiry process:** Question engineering helps scaffold learning by strategically sequencing questions and assisting with research plans.

- **Fostering collaboration:** Questions encouraging collaboration and dialogue promote peer-to-peer learning and communication skills.

- **Assessing learning:** Questions serve as a valuable tool in assessing understanding, monitoring progress, and evaluate critical thinking skills.

To foster the growth of thinking abilities, reasoning skills, and critical thinking, it is crucial to promote an environment encouraging questioning. Mainly, when students ask in-depth questions, it signifies their engagement with the subject matter, their efforts to connect new concepts with prior knowledge, and their pursuit of comprehension. These questions serve to enrich students' understanding as they gradually unravel information, identify gaps, and develop a stronger motivation to learn. Moreover, students' questions allow educators to evaluate the depth of their

knowledge, uncover misconceptions, discern their learning interests, and potentially shape the sequence of lessons **(Ester, 2018, p. 64)**. When students dedicate their time to formulating and engaging with questions based on sources they cultivate civic skills that contribute to their understanding critical thinking abilities, lifelong learning and overall development **(Melville & Minigan, 2018)**.

In summary, question engineering is an integral part of fostering inquiry-based learning. Well-crafted questions provoke curiosity, encourage exploration, promote higher-order thinking, guide the inquiry process, foster collaboration, and provide assessment opportunities. By employing practical question engineering techniques, educators can empower students to become active learners, critical thinkers, and independent investigators.

C. How question engineering aligns with the principles of Bloom's Taxonomy and higher-order thinking skills: Question sand levels can be categorized based on the level of thinking required to answer them. One widely recognized classification system is Bloom's Taxonomy, which presents a hierarchical structure of questions that spans from knowledge-based questions, representing the lowest level of thinking, to comprehension, application, analysis, synthesis, and evaluation questions **(Bloom & Krathwohl, 2020)**. Subsequently, Anderson and krathwohl revised the taxonomy, placing more remarkable emphasis on distinguishing between cognitive processes, and categorized questions into the following groups: remembering, understanding, applying, analyzing, evaluate, and creating. Another taxonomy divided questions into two groups: confirmation questions and transformation questions. Confirmation questions aim to clarify information, define concepts, and provide explanations, while transformation questions involve restructuring and reorganizing the student's understanding. Transformation questions are regarded as higher-order inquiries **(De Jesus, Teixeira-Dias, & Watts, 2003, p. 1034)**.

When students encounter unfamiliar topics, they tend to ask confirmation and foundational knowledge questions. Conversely, on topics they are more familiar with, they can pose transformational or higher-order questions that have a more remarkable educational impact. Asking higher-order questions can be challenging for students when they are in the early stages of learning a topic. Thus, in order to ask such questions, students need to have a solid understanding of the subject matter **(Scardamalia & Bereiter, 1992, p. 177)**.

Question engineering is the process of designing practical questions that promote meaningful learning and critical thinking. When aligning question engineering with the principles of Bloom's Taxonomy and higher-order thinking skills, it is necessary to understand the levels of cognitive complexity outlined in Bloom's Taxonomy and how they relate to creating questions. Bloom's Taxonomy categorizes

cognitive skills into six levels, arranged in a hierarchical order from lower to higher-order thinking skills: Knowledge, Comprehension, Application, Analysis, Synthesis, and Evaluation. Here is how question engineering can align with each level:

- **Knowledge:** Focus on recalling factual information and basic concepts by questions that test memory and understanding.

- **Comprehension:** Demonstrate understanding by explaining, summarizing, or interpreting information by questions that assess comprehension.

- **Application:** Apply knowledge or concepts to solve problems or perform tasks by challenging learners with real-world scenarios.

- **Analysis:** Break down information into parts, identify patterns, and analyze relationships by questions encouraging comparison, categorization, and cause-and-effect analysis.

- **Synthesis:** Combine elements in innovative ways to create something new, prompting learners to generate ideas, design solutions, or create original works.

- **Evaluation:** Critically assess information, arguments, or concepts, and make judgments based on criteria and evidence by questions encouraging evaluation, analysis, and defence of positions.

In the field of question engineering the objective is to guide learners by a series of stages beginning with skills and gradually advancing to more complex ones. Educators can achieve this by formulating questions that address levels of “Blooms Taxonomy”. By doing they can foster comprehension encourage critical thinking and facilitate the cultivation of advanced cognitive abilities, in learners.

III. The Impact of Artificial Intelligence on Question Engineering:

The impact of artificial intelligence on question engineering has revolutionized the process by automating question generation .The following is an explanation in that:

A. Overview of* (AI) *technologies in education: Artificial intelligence (AI) plays an expanding role, in the field of education. One vital aspect's personalized teaching systems, which have already gained traction and show results in enhancing learning outcomes. (AI) powered educational systems can also leverage techniques to create an interface that significantly enhances the learning experience. In instance this interface may incorporate natural language processing and generation speech interfaces, avatars as video analysis to assess learner engagement and emotional responses **(Khosravi & al, 2022, p. 1)**. (AI) technologies have made a significant impact on the field of education, revolutionizing the way students learn and teachers instruct. Here is an overview of some critical (AI) technologies in education:

-Intelligent Tutoring Systems (ITS): (AI) algorithms provide personalized learning experiences, assess strengths and weaknesses, tailor content, and offer immediate feedback.

-Adaptive Learning: (AI) creates customized learning paths by analyzing student per in mance and adjusting content, pace, and difficulty level.

- Natural Language Processing (NLP): AI systems process human language in language assessment, automated grading, and tutoring purposes.

- Virtual Reality (VR) and Augmented Reality (AR): VR and AR technologies create immersive learning environments in enhanced engagement and comprehension.

- Intelligent Content Creation: (AI) generates educational content, automating the creation process and saving teachers' time.

- Data Analytics and Predictive Modeling: AI analyzes educational data to identify patterns, trends, and provide timely intervention.

- Chatbots and Virtual Assistants: (AI)-powered assistants provide instant support and automate administrative tasks.

- Intelligent Grading and Feedback: AI automates grading and offers feedback on student work.

- Emotion Recognition and Personalized Support: (AI) analyzes student emotions to provide personalized support and adapt instructional strategies.

- Recommender Systems: (AI) suggests relevant learning resources based on individual preferences and past behaviour.

The utilization of Question Engineering, in education shares similarities with the application of (AI). It also has unique requirements. It encompasses six aspects that revolve around the concept of explain ability in studying, designing and developing (AI) tools. These aspects specifically address the stakeholders involved the advantages obtained various approaches to presenting explanations, utilized categories of (AI) models human cantered designs, in (AI) interfaces and potential challenges associated with providing explanations within a context **(Khosravi & al, 2022, p. 01)**.

Overall, (AI) technologies in education have the potential to transform the learning experience, making it more personalized, engaging, and practical. However, it is necessary to ensure ethical use, address privacy concerns, and maintain a balance between technology and human interaction in the educational process.

B. AI-powered tools and platforms that support question engineering: (AI)-powered tools and platforms have become increasingly prevalent in supporting question engineering processes. These tools leverage natural language processing (NLP) and machine learning techniques to assist in various aspects of question formulation, analysis, and optimization. Here are some examples of (AI)-powered tools and platforms that can aid in question engineering:

-Text Analytics Platforms: NLP-based platforms analyze text for question

quality, complexity, and biases, offering insights and suggestions for improvement.

- **Question Generation Tools:** (AI) tools generate questions automatically from specific topics, documents, or datasets, aiding assessments and content creation with contextually relevant questions.

- **Sentiment Analysis Tools:** Tools analyze question text to determine sentiment, evaluate emotional tone, bias, and detect offensive or discriminatory language.

- **Bias Detection and Mitigation Tools:** AI tools identify and address biases in questions, detect gender, racial, or cultural biases, promoting fairness and inclusivity.

- **Question Optimization Platforms:** (AI) platforms optimize questions based on user feedback, analyzing responses, identifying issues, and suggesting improvements in enhanced assessment quality.

- **Chatbot Development Frameworks:** NLP-enabled frameworks create interactive question-and-answer systems, allowing dynamic quizzes or knowledge-based systems with immediate user responses.

When using (AI)-powered tools and platforms in question engineering, it is necessary to note that they are meant to augment human expertise and not replace it entirely. Human review and validation are essential to ensure the quality, relevance, and fairness of the questions being generated or analyzed.

C. ***Benefits of using AI in question engineering:*** Using AI in question engineering can offer several benefits, including:

- **Efficiency:** (AI) automates question engineering, saving time by generating questions based on rules or patterns.

- **Scalability:** (AI) enables quick and consistent generation of a significant number of questions, ideal in significant datasets or high-volume assessments.

- **Consistency:** AI algorithms maintain uniformity in question structure, difficulty, and quality, adhering to standards and reducing human error.

- **Adaptability:** (AI) analyzes content to generate contextually relevant questions tailored to different domains and subjects.

- **Diverse Question Types:** (AI) generates various question types, providing educators with a broader range of options to assess different learning objectives.

- **Personalization:** (AI) leverages learner data to create personalized questions that cater to individual preferences, styles, and knowledge levels.

- **Quality Assurance:** (AI) checks question validity, relevance, and detects biases or errors, ensuring questions meet desired standards.

- **Continuous Improvement:** (AI) learns from feedback and user interactions to optimize question generation, refine difficulty, and enhance quality over time.

Overall, (AI) in question engineering enhances efficiency, scalability, consistency, and adaptability while enabling personalization and maintaining high-quality standards. It empowers educators, trainers, and assessment

designers to create assessments that align with learning objectives and provide meaningful insights into learners' knowledge and skills.

IV. Enhancing Critical Thinking with Question Engineering and (AI)

Enhancing critical thinking with question engineering and (AI) involves leveraging (AI)-powered question generation techniques to create thought-provoking and challenging questions that stimulate critical thinking skills. Here is how it can be achieved:

A. Developing critical thinking skills by well-crafted questions: Question engineering is a catalyst in student empowerment and critical thinking. As students learn to formulate their own questions, their thinking expands in a divergent manner, embracing broader and more creative perspectives. They also engage in convergent thinking when they discern the types of questions to ask and prioritize, narrowing down options, analyzing, evaluate, comparing, and synthesizing information. Additionally, by reflection on the question engineering process, students actively practice met cognition by contemplating their own thinking. By honing all three of these thinking abilities, students emerge as astute questioners, thinkers, and problem solvers **(Rothstein & Santana, 2014)**.

Developing critical thinking skills is an necessary aspect of education and problem-solving. One practical way to enhance critical thinking is using well-crafted questions. Well-crafted questions stimulate deep thinking, encourage analysis and evaluation, and promote the development of logical and independent thought processes. Here are some strategies in using well-crafted questions to develop critical thinking skills:

- **Open-ended questions:** Promote critical and creative thinking with multiple possible answers; start with "why," "how," or "what if."

- **Socratic questioning:** Encourage deep thinking by using probing questions to examine assumptions and reasoning; develop analytical and evaluative thinking.

- **Problem-solving questions:** Engage students in analyzing real-world problems, considering perspectives, and generating solutions; foster critical thinking and evaluation.

- **Compare and contrast questions:** Develop critical thinking skills by identifying similarities and differences, evaluate perspectives, and assessing strengths and weaknesses.

- **Predictive questions:** Stimulate critical thinking by making predictions based on evidence, analyzing data, and considering cause-and-effect relationships.

Remember, the critical is to create environment encouragings students to think critically, ask questions, and engage in thoughtful discussions. By incorporating well-crafted questions into your teaching or learning process, you can foster the development of critical thinking skills and empower students to become independent and analytical thinkers.

B. Promoting met cognition and self-directed learning: Promoting met cognition and self-directed learning can significantly enhance an individual's ability to learn effectively and independently. Here are some strategies and techniques you can employ to foster met cognition and encourage self-directed learning:

- Teach met cognitive strategies such as goal-setting and self-reflection.
- Model met cognition by verbalizing your own thought process.
- Encourage students to reflect on their learning experiences.
- Gradually reduce support to foster self-directed learning.
- Help students set “SMART” goals and develop action plans.
- Teach students self-assessment skills using rubrics and criteria.
- Cultivate critical thinking by open-ended activities.
- Foster a growth mindset and embrace challenges.
- Provide resources and support in self-directed learning.
- Celebrate progress and achievements along the journey.

Remember that promoting met cognition and self-directed learning is an ongoing process that requires consistent effort and reinforcement. By implementing these strategies, you can empower students to become active and self-directed learners who are capable of taking control of their own education.

C. Leveraging (AI) to generate challenging and tailored questions: Leveraging (AI) to generate challenging and tailored questions is an exciting application that can be achieved using techniques such as natural language processing and machine learning. By understanding the context and specific requirements, AI can generate questions that are both challenging and relevant to the topic at hand. Here are some ways (AI) can be used to accomplish this:

- **Contextual Understanding:** (AI) models trained on vast amounts of text can comprehend the context of a given topic. This understanding allows the (AI) to generate questions that are relevant to the specific subject matter and tailored to the level of difficulty required.

- **Machine Learning:** (AI) can learn from existing sets of questions and their corresponding answers. By analyzing patterns and structures in these questions, the (AI) model can generate new questions that align with the desired level of challenge and adhere to the format and style of existing questions.

- **Adaptive Difficulty:** (AI) can adapt the difficulty level of the questions based on users performance. By continuously monitoring users responses and assessing their proficiency, the (AI) can adjust the difficulty of subsequent questions to ensure an optimal level of challenge that promotes learning and engagement.

- **Personalization:** (AI) can consider users background, preferences, and learning goals to generate tailored questions. By considering individual characteristics and knowledge gaps, the (AI) can create a

personalized question set that addresses the specific needs of the user, maximizing the effectiveness of the learning experience.

- **Feedback and Iteration:** (AI) can analyze users responses to generated questions and provide feedback, including explanations and suggestions in improvement. This iterative process helps the user learn from their mistakes, reinforces concepts, and ensures that subsequent questions are appropriately challenging.

- **Diversification:** (AI) can generate questions that cover various aspects of a topic, testing different skills, and exploring different angles. This diversification ensures a comprehensive understanding of the subject matter and prevents overreliance on a specific type of question or skill set.

- **Natural Language Generation:** (AI) can use natural language generation techniques to ensure the generated questions are coherent, grammatically correct, and well-structured. This makes the questions more engaging and easier to understand, enhancing the learning experience.

it is necessary to note that while (AI) can generate challenging and tailored questions, human supervision and duration are still necessary to ensure the quality, relevance, and appropriateness of the questions. Additionally, ethical considerations must be considered to avoid biases or creating discriminatory questions**.**

V. Addressing Challenges and Ethical Considerations

Addressing challenges and ethical considerations is crucial in any field or domain where technological advancements and their applications are involved. Whether it is artificial intelligence, biotechnology, or any other emerging technology, it is necessary to be mindful of the potential challenges and ethical implications they may present. The following is an explanation:

***A. Potential pitfalls and limitations of relying heavily on* (AI) *in question education*:** While AI can offer significant benefits in question education, it also comes with potential pitfalls and limitations that need to be carefully considered. Here are some of them **(Blog careerera, 2023)**, **(Singh, 2022)**, **(Duggal, 2023)**:

- **Lack of Contextual Understanding:** (AI) may struggle to grasp the nuances and context of questions, leading to incorrect or irrelevant answers.

- **Bias and Discrimination:** (AI) systems can inherit and perpetuate biases present in the training data, potentially providing discriminatory or unfair answers.

- **Algorithmic transparency and interpretability:** Algorithmic transparency and interpretability pose significant challenges in the realm of (AI), particularly with complex models like deep learning algorithms, which are often perceived as "black boxes" due to their inscrutable decision-making processes.

This opacity hinders human understanding and makes it challenging to identify and rectify biases present in these algorithms **(James, Jake, & Brittany, 2019)**.

- **Lack of Creativity and Critical Thinking:** AI's standardized and formulaic responses limit its ability to handle questions requiring creativity or complex reasoning, hindering the development of critical thinking skills.

- **Overreliance and Dependency:** Heavy reliance on AI may lead to reduced human engagement, dependency on (AI) in answers, and neglect of problem-solving abilities.

- **Privacy and Data Security Concerns:** AI-powered systems collect and analyze student data, raising privacy concerns if not adequately protected and used only in educational purposes.

- **Lack of Emotional Intelligence:** (AI) struggles to understand and respond to emotional needs, potentially resulting in a less personalized and holistic learning experience.

- **Limited Transferability of Knowledge:** (AI) models trained on specific datasets may have limited effectiveness in addressing a wide range of questions and topics.

- **Ethical Considerations:** (AI) use in question education raises ethical questions, such as transparency, accountability, and responsible algorithmic decision-making. Clear guidelines are needed to ensure ethical usage.

Moreover, ethical concerns play a pivotal role in the implementation of AI-based systems. Privacy, fairness, and accountability are among the critical ethical considerations that demand meticulous attention. Striving for responsible and ethical AI usage is an intricate task that necessitates careful navigation through these ethical complexities **(James, Jake, & Brittany, 2019)**.

To mitigate these pitfalls and limitations, it is necessary to strike a balance between (AI) and human involvement in question education. Teachers should remain actively involved to provide guidance, foster critical thinking, address contextual understanding, and create a well-rounded educational experience that goes beyond the limitations of (AI).

B. The importance of human guidance and intervention in the learning process: Human guidance and intervention play a crucial role in the learning process and are essential in practical education. While technology has revolutionized access to information and provided new avenues in learning, it cannot fully replace the value of human interaction and guidance. Here are some reasons why human involvement is necessary **(hevalier & al, 2022, p. 15)**:

- **Personalized Learning**: Human educators tailor instruction to meet individual needs.
- **Emotional Support:** Educators provide encouragement and motivation.

- **Facilitating Understanding:** They break down complex topics and guide learners.
- **Social Interaction and Collaboration**: Educators foster communication and teamwork.
- **Moral and Ethical Development:** They impart values and character guidance.

Adaptability and Flexibility: Educators adjust teaching methods based on progress.

- **Real-Time Feedback:** They provide immediate and specific feedback in improvement.

While technology can enhance the learning experience by providing access to resources, interactive content, and adaptive learning platforms, it cannot replace the unique qualities and contributions of human educators. Combining the benefits of technology with human guidance and intervention creates a robust and holistic educational experience that nurtures the intellectual, emotional, and social development of learners.

VI. Implementing Question Engineering with AI in Education

Question engineering is a process that involves designing and formulating practical questions to promote critical thinking and enhance learning outcomes. (AI) can play a valuable role in assisting with question engineering in education by providing tools and techniques to support educators in generating high-quality questions. The following is an explanation:

A. ***Strategies for integrating question engineering and AI into classroom settings:*** Integrating Artificial Intelligence (AI) into classrooms holds the promise of transforming both student learning and teaching practices. By leveraging (AI) algorithms students can receive feedback and recommendations leading to an interactive and productive learning journey. However while there are advantages, to incorporating (AI) in classrooms there are also challenges that need to be addressed **(Melo, 2023)**. Integrating question engineering and AI into classroom settings can enhance student engagement, critical thinking skills, and overall learning outcomes. Here are some strategies to consider:

- **Educate teachers:** Provide professional development sessions to familiarize teachers with question engineering techniques and the potential of (AI) in the classroom. This training can help them understand how to create practical questions that stimulate student thinking and utilize (AI) tools appropriately.

- **Introduce AI-powered question generation tools:** Integrate (AI)-powered question generation tools into the classroom to assist teachers in creating various questions. These tools can help generate multiple-choice, open-ended, and scenario-based questions, saving time in teachers while promoting higher-order thinking skills.

- **Collaborative question creation:** Encourage students to actively participate in question creation. Assign them roles as question designers and encourage

collaboration by group activities or online platforms. This approach not only develops their critical thinking skills but also allows them to take ownership of their learning process.

- Scaffold question complexity: Begin with simple questions and gradually increase the complexity to challenge students' thinking. Scaffold questions can provide students with the necessary support to build their understanding and move towards more advanced concepts. AI can assist in generating appropriate scaffolding questions based on individual student performance and progress.

- Formative assessment with AI: Utilize (AI)-powered tools in formative assessment, allowing teachers to gather real-time insights into student learning and adjust instruction accordingly. (AI) algorithms can analyze student responses, identify misconceptions or knowledge gaps, and provide personalized feedback, enabling teachers to offer targeted support.

- AI-based adaptive learning platforms: Explore adaptive learning platforms that leverage AI algorithms to personalize learning experiences based on individual student needs and progress. These platforms can generate tailored questions; recommend learning resources, and track student performance, fostering a differentiated and self-paced learning environment.

- Ethics and responsible AI use: Educate students about the ethical implications and responsible use of AI in the classroom. Discuss topics such as data privacy, algorithm bias, and the importance of critical thinking when using AI-generated responses. Encourage open discussions to promote ethical awareness and responsible decision-making.

- Reflective practices: Engage students in reflecting on the questions they encounter and discussing their approaches to problem-solving. Encourage met cognitive skills by asking students to explaining their reasoning and evaluate the effectiveness of different question types. This reflection helps students develop a deeper understanding of the learning process and enhances their critical thinking abilities.

Question Formulation Technique (QFT) stands out as one of the paramount techniques in the realm of questioning engineering. This process entails engaging in brainstorming sessions to generate a multitude of questions. As advocated by its founding organization, QFT empowers individuals to formulate, manipulate, and employ their own questions, fostering essential skills that extend beyond the classroom, such as lifelong learning, self-advocacy, and democratic participation. Within educational settings, QFT is a valuable tool for facilitating inquiry, stimulating discussion, encouraging debate, and fostering project-based learning, among other benefits **(Teach Thought Staff, 2022)**. The rules in formulating the question according to this technique are as follows **(NSW Department of Education, 2023)**:

1. Ask as many questions as possible.

2. Do not stop to discuss, judge, or answer questions.
3. Write each question exactly as it is given. (This can be done by the teacher or the student, although I have had the most success letting the students do this while I am facilitating the session.)
4. Phrases or "sentence fragments" and other knowledge snippets are fine - just change any of them into questions at the end.

This approach also fosters imagination, critical thinking and introspection. Once students have grasped its application they can employ it in college subjects, their professional endeavours and even in political situations **(Frankie, 2023)**.

Remember that successful integration of question engineering and (AI) in the classroom relies on continuous evaluation and refinement. Regularly assess the impact of these strategies on student engagement, learning outcomes, and the development of critical thinking skills, making adjustments as necessary to optimize the learning experience.

B. Training educators to effectively leverage* (AI)*-powered question engineering tools: Artificial Intelligence (AI) refers to the capabilities of computer programs to engage in tasks involving cognition and learning much, like humans do. AI has become a catalyst in innovation and progress across industries. Notably the field of technology and (AI) advancement has experienced growth mainly due to the global pandemic. According to a report, by technavio the US education sectors (AI) market is expected to witness a growth rate of 48.15% within the three years **(Harve, 2023)**.

As educators we recognize the importance of developing questioning skills. By using question engineering techniques we can change the dynamics. Guide our learners towards learning experiences. This approach encourages struggle empowering everyone involved and allowing in deeper learning **(Lawrence & Rowell, 2021)**. Training educators to effectively leverage (AI)-powered question engineering tools can significantly enhance their teaching capabilities and improve student engagement. Here are some steps to consider when training educators in this area:

-Familiarize educators with (AI)-powered question engineering tools: Begin by introducing educators to the concept of (AI)-powered question engineering tools and explaining their benefits. Provide an overview of how these tools work, their features, and how they can enhance the teaching and assessment process.

- Highlight the advantages of using (AI)-powered question engineering tools: Educators should understand the specific advantages these tools offer, such as the ability to create personalized assessments, generate instant feedback, and analyze student performance data. Emphasize how these tools can save time, provide valuable insights, and support differentiated instruction.

- **Provide hands-on training:** Conduct workshops or training sessions where educators can get hands-on experience with (AI)-powered question engineering tools. They can explore different features, create sample assessments, and analyze the results. Encourage them to experiment and ask questions to deepen their understanding.

- **Share best practices and examples:** Showcase examples of practical question engineering using AI-powered tools. Demonstrate how to create various types of questions, including multiple-choice, short-answer, and essay questions, with the help of these tools. Guide aligning questions with learning objectives and creating assessments that promote critical thinking and problem-solving skills.

- **Discuss data analysis and interpretation:** Educators should be trained in interpreting the data generated by (AI)-powered question engineering tools. Explaining how to analyze student performance reports, identify areas in improvement, and use the data to inform instructional decisions. Help them understand how to use the insights gained from the tools to personalize instruction and provide targeted support to students.

- **Address ethical considerations:** It is necessary to discuss the ethical considerations associated with using (AI)-powered question engineering tools. Educators should be made aware of privacy concerns, data security measures, and the potential biases that may exist in AI algorithms. Provide guidelines for fairness, transparency, and accountability when using these tools.

- **Encourage collaboration and sharing:** Foster a collaborative environment among educators using AI-powered question engineering tools. Encourage them to share their experiences, success stories, and challenges. Facilitate discussions and forums where they can exchange ideas, strategies, and resources related to leveraging these tools effectively.

- **Ongoing support and professional development:** Offer ongoing support and professional development opportunities to educators. Provide access to additional resources, webinars, and training materials that they can refer to after the initial training. Encourage them to explore new features and advancements in (AI)-powered question engineering tools.

Remember, the practical use of (AI)-powered question engineering tools is a continuous learning process. Regular check-ins, feedback loops, and opportunities in educators to reflect on their practice will help them grow and adapt their instructional approaches accordingly.

C. Encouraging collaboration and peer learning by question engineering: When students first engage in question engineering, they exhibit varying levels of proficiency. However, teachers consistently observe that even the most reticent students become remarkably engaged and active participants by this approach. Over time, these students develop expertise in generating, refining,

and prioritizing questions. They become capable of independently applying the question engineering process, whether as part of their homework, as a pre-reading exercise, or during collaborative classroom activities. Furthermore, they employ question engineering to analyze mathematical problems and showcase their enhanced problem-solving abilities **(Rothstein & Santana, 2014)**.

Collaboration and peer learning are robust tools in personal and professional growth. They promote the exchange of knowledge, foster critical thinking, and enhance problem-solving skills. To encourage collaboration and peer learning, you can employ the strategy of asking questions. Here are some ways you can use questions to foster a collaborative learning environment:

- **Icebreaker Questions**: Ask icebreaker questions to create a friendly and open atmosphere. In example:

- "What is one thing you're excited to learn or share in this collaboration?"

- "What unique skills or experiences do you bring to the group?"

- "What are your goals in this collaboration?"

- **Problem-Solving Questions:** Encourage collaboration by posing thought-provoking questions that require group discussion and brainstorming. These questions can include:

- "How would you approach this problem differently?"

- "What are the potential solutions we can explore together?"

- "What are the pros and cons of each approach?"

- **Reflective Questions:** Encourage individuals to reflect on their own learning and share their insights with the group. This helps deepen understanding and promotes self-awareness. Ask questions like:

- "What did you find most challenging about this project, and how did you overcome it?"

- "What have you learned from working with your peers?"

- "How has your perspective changed after collaborating with others?"

- **Feedback Questions:** Encourage constructive feedback and promote a culture of continuous improvement by asking questions that elicit thoughtful responses. Examples include:

- "What aspects of your peer's work do you find mainly impressive?"

- "How can we improve the effectiveness of our collaboration?"

- "What suggestions do you have in enhancing our communication and teamwork?"

- **Knowledge-Sharing Questions:** Encourage participants to share their expertise and learn from one another by asking questions that tap into their knowledge base. Examples include:

- "Could you explaining your approach in more detail?"

- "What resources or tools have you found helpful in your area of expertise?"

- "Can you provide an example or case study that illustrates your point?"

Remember to create a safe and inclusive space where everyone feels comfortable sharing their thoughts and ideas. By asking engaging questions, you can spark collaboration, promote peer learning, and create a dynamic and enriching learning environment.

VII. Conclusion:

Artificial intelligence (AI) has revolutionized various sectors, including education, by enhancing the learning experience and providing personalized instruction. Integrating (AI) technologies like machine learning and natural language processing in education has improved student engagement, academic performance, and overall outcomes. Questioning and critical thinking are crucial in deep understanding, and by fostering these skills, educators empower students to become independent learners. Question engineering, a robust learning approach that utilizes (AI), involves designing targeted questions to stimulate deep thinking and personalized learning experiences. This fusion of (AI) and question engineering holds immense promise in transforming education into a dynamic and intellectually stimulating process that nurtures inquisitive minds and fosters deep understanding. Ask she came the study findings and recommendations are as follows:

Results: The study yielded the following results:

- Question engineering is a process of formulating questions strategically and effectively to gather the desired information or insights from individuals or groups. It involves designing questions that are clear, concise, and relevant to the objectives of the inquiry.
- A balanced approach that combines (AI) and human expertise is crucial in various fields, including education.
- By integrating (AI) technology into education, we can enhance the learning process and provide personalized educational experiences.
- (AI) can assist in automating administrative tasks, such as grading and scheduling, freeing up time in teachers to focus on personalized instruction.
- Educational tools enhanced with (AI) capabilities can analyze sets of data recognizing patterns and providing valuable insights. This empowers educators to make decisions based on data driven approaches.
- Question engineering, a technique that involves crafting practical questions in assessments, can be significantly improved with AI assistance.
- (AI) can analyze previous question data to identify common misconceptions and provide feedback that helps improve the quality of questions.
- (AI) algorithms can adapt to individual learners' needs, providing personalized recommendations and adaptive learning experiences.

- With (AI), educators can gain valuable insights into students' learning progress and identify areas where additional support is needed.
- Combining (AI) and human expertise can create a collaborative environment where teachers and AI work together to optimize the educational experience.
- it is necessary to acknowledge that (AI) is a tool and not a substitute in human teachers. The expertise, empathy, and guidance of teachers are irreplaceable.
- By embracing a balanced approach that combines AI and human expertise, we can harness the benefits of both to create a more practical and engaging education system.

Study recommendations: In the age of artificial intelligence (AI), education and learning approaches are rapidly evolving. One emerging concept is "question engineering," which focuses on designing practical questions to enhance learning outcomes. This article provides practical recommendations in implementing question engineering techniques in educational settings. The study offers the following recommendations:

1. **Understand the Power of Questions:** Recognize the profound impact of questions on the learning process. Questions drive curiosity, critical thinking, and knowledge retention. Embrace the idea that well-crafted questions can shape and enhance learning experiences.

2. Align Questions with Learning Objectives: Clearly define the learning objectives before designing questions. This alignment ensures that questions effectively target the desired knowledge and skills. Consider Bloom's Taxonomy to create questions that cover a range of cognitive levels, including remembering, understanding, applying, analyzing, evaluate, and creating.

3. Foster Open-Ended and Socratic Questioning: Encourage open-ended questions that stimulate deeper thinking and allow in multiple perspectives. Socratic questioning, characterized by probing and exploring ideas, promotes active engagement and higher-order thinking skills. Incorporate these types of questions into learning activities and discussions.

4. Leverage AI for Adaptive Questioning: Use (AI) technologies to personalize the learning experience. Adaptive question generation systems can dynamically adjust the difficulty and content of questions based on learners' performance and progress. Implementing (AI)-powered platforms can provide tailored challenges and support individualized learning paths.

5. Promote Collaborative Questioning: Encourage collaborative learning environments where students can create and share questions. Platforms or tools facilitating collaborative question generation can enhance engagement, teamwork, and peer-to-peer learning. Emphasize the importance of constructive feedback to refine questions and deepen understanding.

6. Embed Questions Across Learning Materials: Integrate questions

strategically throughout learning materials, such as textbooks, online resources, and presentations. Well-placed questions help maintain learners' focus, check comprehension, and encourage active reading. Use visual aids, interactive elements, and multimedia formats to enhance the effectiveness of questions.

7. Provide Timely Feedback: Ensure prompt and constructive feedback on learners' responses to questions. Feedback is crucial in self-assessment, reinforcing correct understanding, and addressing misconceptions leverage (AI)-based systems to automate feedback when possible, allowing in immediate guidance and support.

8. Continuously Evaluate and Iterate: Regularly assess the effectiveness of questions and question engineering techniques. Collect feedback from learners, instructors, and educational researchers to identify areas of improvement. Adapt and refine question design based on insights gained by evaluation.

9. Embrace Ethical Considerations: As AI becomes more prevalent in education, address ethical considerations surrounding question engineering. Ensure fairness, transparency, and accountability in (AI)-powered question generation systems. Guard against biases and ensure questions promote inclusivity and diversity.

10. Encourage Lifelong Learning: Promote the development of questioning skills as an essential lifelong learning competency. Equip learners with the ability to ask meaningful and insightful questions independently. Cultivate a learning culture that values curiosity, inquiry, and the pursuit of knowledge.

In conclusion, question engineering is a valuable approach in the age of artificial intelligence, enhancing learning outcomes and promoting critical thinking. By following these practical recommendations, educators can harness the power of questions to create engaging and practical learning experiences in students in the (AI) era.

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