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Evolution of Learning Experience Management in Distance Science Education

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Abstract

Purpose: The primary objective of this research was to integrate ChatGPT, an advanced artificial intelligence language model, into distance science education. By addressing the specific challenges inherent in online learning environments, this study aims to investigate how technological advancements, such as ChatGPT, can effectively enhance the management and overall quality of distance education experiences.

Method: This qualitative, exploratory study aimed to provide a comprehensive understanding of the potential applications of ChatGPT in distance science education. This study identifies the various interactions that can occur in distance education and describes and evaluates the input and output instructions associated with each interaction. The chat bot used is https://chatbot.theb.ai and A biology tutoring platform uses ChatGPT to provide personalized support to students working on biology issues or concepts.

Findings: Based on the results, the artificial intelligence can play an important role in improving distance science education. Furthermore, this study highlights the importance of developing metacognitive skills among learners and encourages educators to seek professional development opportunities to enhance the quality and engagement of distance science education. This study emphasizes the need for careful planning, research, design, evaluation,

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management, and responsible application of AI technology in distance education.

Conclusion: This study was concluded that ChatGPT could be very useful for both learners and educators in distance education. This research showcases the innovative results facilitated by ChatGPT and provides valuable insights and practical guidance for educators, researchers, and policy makers on the effective use of AI technologies in distance science education.

Keywords: Artificial Intelligence, Management, Learning Experience, Biology Tutoring.

Introduction

Despite the high importance of laboratory work and personalized content for science courses, existing laboratories often do not meet favorable conditions. Moreover, skill training and authentic learning in biology courses pose serious challenges in distance education within secondary education systems. This situation highlights issues such as educational inequality, inadequate management, and insufficient student engagement in laboratory experiences and other online activities. Additionally, there is a lack of personalized content, proper feedback, and effective communication between teachers and students.

Technology integration into education has been a transformative force in the 21st century, significantly shaping how we teach and learn (Zakrzewski & Newton, 2022). The rapid advancement of technology, particularly in artificial intelligence (AI), has led to the development of innovative tools and methods that have the potential to revolutionize education. Despite the numerous advantages that technology brings to the educational landscape, some educators resist its adoption, arguing that technology is not always the solution to every pedagogical challenge (Stockman & Nottingham, 2022). However, such resistance may hinder the educational process, as technology can enhance teaching and learning outcomes when applied effectively.

The Covid-19 pandemic has underscored the importance of technology in distance education amid unprecedented challenges. The effectiveness of distance education strongly depends on the appropriate use of technology and its integration into the learning process (McKenzie et al., 2022). Various strategies can be employed to enhance the effectiveness of distance education, and one promising approach is incorporating artificial intelligence (AI) into the learning process (Celik, 2023). AI has significantly impacted various aspects of human life, including education (Lu, 2019). Among emerging AI trends, ChatGPT, a conversational AI developed by OpenAI, has garnered considerable attention for its potential educational applications (Williams, 2023; Tate et al., 2023).

ChatGPT, or Chat Generative Pre-Trained Transformer, is an artificial intelligence tool designed to understand natural language and generate intelligent and relevant responses to user inquiries (OpenAI, 2022). One of the major strengths of ChatGPT is its adaptability to different educational contexts, making it a versatile tool for educators and learners. If used effectively, ChatGPT can revolutionize several aspects of distance

education. Additionally, it can contribute to creating an accessible learning environment. By supporting multiple languages and accommodating various educational needs, this AI-powered tool can help bridge the gap between students from diverse backgrounds and skill levels, thereby enhancing their critical thinking and problem-solving abilities.

Although articles, blogs, and media outlets have discussed the benefits of ChatGPT in education (Zhai, 2022), few have provided implementation guidelines. Given the growing body of research on the benefits of artificial intelligence in education (Lieberman, 2023), it is essential to investigate the practical applications of tools like ChatGPT in real educational environments.

The purpose of this study was to investigate the potential of ChatGPT in distance education with special emphasis on its applications in science education, especially biology. In addition, the researchers investigated the potential benefits of using ChatGPT in biology education. Biology is a complex subject that requires an understanding of various scientific concepts and processes, making it an ideal field to investigate the effectiveness of AI tools such as ChatGPT.

The integration of ChatGPT in distance education, especially in biology education, has great potential to enhance learning experiences management and outcomes. Using its conversational and adaptive capabilities, ChatGPT can provide personalized support, explain complex concepts, provide feedback, and facilitate collaborative learning activities. Considering the impact of emotional presence in virtual education (Jamebozorg, 2022), this interactive collaboration with ChatGPT can promote active learning, stimulate student engagement, and foster a sense of community among distance learners. Therefore, the researcher will investigate the role of ChatGPT in increasing participation, motivation, developing metacognition dimensions such as student self-regulation by analyzing its impact on learning behaviors and promoting a sense of community among distance learners.

In this study, three research questions have been raised:
- Research Question 1: What are the potential roles and uses of ChatGPT in distance science education?
- Research Question 2: How can ChatGPT effectively create personalized and adaptive learning experiences management for students in distance science education?
- Research Question 3: What are the advantages and limitations of using ChatGPT in distance science education and how can they be addressed?

However, it is important to address challenges related to data privacy, algorithmic bias, and the need for human guidance.

Literature Review

Blended learning combines face-to-face and online learning experiences to enhance the educational experience (Garrison & Vaughan, 2008), while integrated learning integrates different subject areas into a cohesive curriculum (Rita C Richey, 2013). The integration of AI in education has shown great potential to transform various aspects of the learning process (Lu, 2019). AI applications such as educational agents, intelligent educational systems (ITS), intelligent learning environments, learning analytics, intelligent learning management systems (ILMS), and adaptive learning systems (Joshi, Rambola, & Churi, 2021) have become increasingly common in educational institutions at different levels. These technologies offer tailored learning experiences (Holmes et al., 2019). AI in education (AIEd) has evolved, with AI-based tools developed for classrooms and learning experiences (Holmes et al., 2019). Among these tools, ChatGPT, an advanced language model by Open AI, demonstrates potential applications in numerous educational domains, including distance science education (Sallam, 2023).

ChatGPT has been utilized in various disciplines, such as medical education, engineering education, science education, and bioinformatics education (Qadir, 2022; Cooper, 2023; Shue et al., 2023). These applications can aid students in comprehending complex ideas, enhance their learning experience, and contribute to effective pedagogy across disciplines (Cooper, 2023). ChatGPT has demonstrated the potential to provide personalized and adaptive learning experiences, customized feedback and explanations, and realistic virtual simulations for hands-on learning in science education (Pardos & Bhandaran, 2023).

ChatGPT, as a language model (Open AI, 2022), utilizes deep learning techniques to generate human-like responses to user inputs, enhancing student interaction, and providing support outside the classroom (Jamebozorg, 2023). Distance education has particularly benefited from AI technologies. Online learning platforms can utilize AI tools to provide individualized support to students, ensuring they receive the assistance they need to progress in their learning journey. By offering personalized learning content and adapting to specific learning problems, AI-based technologies make education more accessible and affordable, potentially reducing the achievement gap among students, including those from low-

income families (Luckin et al., 2016).

Educators must demonstrate the ethical use of ChatGPT in teaching and research to address these challenges (Raman et al., 2023; Wen & Wang, 2023). Halaweh argues in favor of incorporating ChatGPT into education and offers strategies and techniques for the successful and responsible implementation of ChatGPT in teaching or research (Halaweh, 2023, pp. 5-9). To ensure that students utilize ChatGPT effectively, educators should also nurture a culture of critical thinking and evidence-based reasoning, helping students determine the reliability and validity of information generated by AI tools like ChatGPT (Wen & Wang, 2023).

Method

This study employed a qualitative, exploratory approach to investigate the potential applications of ChatGPT in distance science education. The main objective was to explore how ChatGPT could be utilized to create personalized and adaptive learning experiences management, as well as to identify the benefits and limitations of its implementation in this particular context (Creswell & Poth, 2018).

To address the research questions, the study began with an extensive literature review to understand the current state of ChatGPT applications and identify gaps in the context of distance science education (Boote & Beile, 2005). Based on the findings, the researcher developed categories for possible integration, focusing on the roles and uses of ChatGPT and the needs and limitations of distance science education. Specific cases and prompts were designed for each category to elicit relevant information from ChatGPT.

Data collection involved providing these prompts to ChatGPT and analyzing the generated responses. An iterative refinement approach was employed, continuously improving the cases and prompts based on the quality and information content of the answers received, ensuring alignment with the study objectives (Creswell & Poth, 2018). This iterative process allowed the researcher to tailor the prompts to obtain more accurate and informative results.

For the benefits and limitations of using ChatGPT in distance science education, the researcher analyzed the content generated by ChatGPT in response to the prompts. This analysis helped identify potential advantages and challenges associated with using ChatGPT in distance science education, informing the development of strategies to address these issues.

Throughout the study, the researcher-maintained reflexivity by

reflecting on their positionality and potential biases that could impact the research process and findings. This practice helped minimize the influence of preconceived notions or expectations on the study's outcomes. The analysis of the collected data involved thoroughly examining the ChatGPT-generated content to identify themes, patterns, and insights related to the research questions. This process allowed the researcher to synthesize the findings, develop a comprehensive understanding of ChatGPT's potential in distance science education, and offer informed implementation suggestions. To ensure the credibility and trustworthiness of the findings, the researcher employed transparent reporting by presenting the entire process from the beginning to the end and directly sharing the obtained results (Birt et al., 2016). This approach provided readers with a clear understanding of the research process and facilitated the assessment of the study's trustworthiness.

In all the cases generated in this study, the text given is copied directly from ChatGPT. The chat bot used is https://chat bot.theb.ai (BAI Chat is a GPT-3.5/ ChatGPT API based chat bot that is free, convenient and responsive). It is important to note that the results below are snapshot responses, meaning that the same questions can be entered into ChatGPT and get a different output. The answers were collected in April 2023.
Furthermore, A biology tutoring platform uses ChatGPT to provide personalized support to students working on biology issues or concepts. AI analyzes each student's performance and learning history, tailoring explanations and feedback to meet individual needs. The platform can also use ChatGPT to create new problems and exercises, ensuring a consistently consistent and engaging learning experience.

Findings
Before identifying ways to integrate ChatGPT into distance learning for science education, a literature review was conducted to determine where distance learning and technology integration needed improvement. Studies indicate that distance education frequently encounters challenges in delivering personalized feedback, developing instructional content and assessments, offering curricular support to teachers, and fostering effective student-teacher interaction (Garrison, 2016). Studies examining the most effective use of technology in teaching and learning were reviewed to understand how technology can be effectively integrated into education. Studies demonstrate that the integration of technology can substantially elevate the educational experience by enabling personalized learning,

captivating students with interactive materials, aiding teachers in curriculum development, and facilitating improved communication between students and educators (Tondeur et al., 2017).

Drawing on literature findings on distance education challenges and technology integration, the researcher identified four categories that ChatGPT can help in distance science education. The process of identifying these categories involved a systematic literature review of the challenges ahead in distance education, particularly in the realm of science education, as well as an analysis of the current state of technology integration in education (Wingo et al., 2017).

First, the literature on the challenges of distance education was analyzed, focusing on recurring themes and concerns that emerged across multiple studies. This analysis highlights student engagement, quality of learning experiences, accessibility and barriers to technology use (Stefanidou and Mandrikas, 2023). Next, the literature on technology integration in education was reviewed and special attention was paid to the advances in artificial intelligence and how they are used in different educational contexts (Papamitsiou and Economides, 2014). Having identified the key challenges and potential of AI in education, the capabilities of ChatGPT as an AI-based tool were explored and how it could address these challenges. Through a thorough analysis of ChatGPT features and capabilities, the researcher was able to identify four categories in which ChatGPT integration could potentially contribute to distance science education (Figure 1).

Figure 1. four categories studied in this research

These categories were developed based on the understanding that integrating ChatGPT into these critical areas can address gaps in distance science education and harness the power of artificial intelligence to improve teaching and learning experiences (PM, 2023). The following sections provide examples for each category, showing how ChatGPT can be effectively integrated into distance science education.

Providing Personalized Feedback
- Diagnostic Assessment and Personalization: Identifying Learning Needs

ChatGPT can create diagnostic tests to perform diagnostic assessments for students, analyze their responses and provide personalized feedback based on their individual strengths and weaknesses. The results of ChatGPT regarding the topic of the structure of biomolecules, their types, and their constituent monomers are as follows.

Table 1. ChatGPT as Learning Needs Identifier and Tutor

Prompt	ChatGPT as Learning Needs Identifier and Tutor
I'm a student who needs help with Biomolecules. Can you assess my prior knowledge and create a personalized tutoring session based on my strengths and weaknesses?	Of course! I'd be happy to help you with biomolecules. To better assist you, let's start by assessing your prior knowledge. Please answer the following questions: - What are the four major types of biomolecules? - What do you know about monomers and polymers in the context of biomolecules? Once you've answered these questions, I'll be able to evaluate your strengthsand weaknesses and design a personalized tutoring session to help you further
- The four major types of biomolecules are: Proteins, Nucleic Acids, Carbohydrates and Lipids. - I'm not sure about monomers and polymers.	Strengths: The student correctly identified the four major types of biomolecules. Weaknesses: The student expressed uncertainty about monomers andpolymers in the context of biomolecules.
Based on my answers, can you provide the necessary information and teach me about the topic?	That's correct! The four major types of biomolecules are proteins, nucleic acids, carbohydrates, and lipids. Proteins: Amino acids are the monomers of proteins. Nucleic Acids: Nucleotides are the monomers of nucleic acids.

	Carbohydrates: Monosaccharides (simple sugars) are the monomers of carbohydrates. Lipids: Lipids do not have true monomers and polymers.

- Concept Reinforcement and Skill Development and friendly encouragement

ChatGPT can create learning materials such as explanations, practice problems, and interactive activities to reinforce concepts and develop problem-solving skills. ChatGPT outcomes are as follows in the topic of DNA helix.

Table 2. ChatGPT as Concept Explainer with Personalized Explanation, Interactive Visualization

Prompt	ChatGPT as Learning Needs Identifier and Tutor
Explain DNA helix and create personal explanations and interactive visualizations for me.	Sure! I'd be happy to explain DNA helix and provide you with interactive visualizations and practical problems. Let's start with the explanation: The DNA helix is a structure found in living organisms that carries genetic information. Now, let's move on to interactive visualizations: Interactive Visualization: For an interactive visualization of the DNA helix, you can use various online tools or software.
Can you ask me a question about that DNA topic?	Of course! Here's a question for you: What is the function of DNA polymerase in DNA replication?
DNA polymerase is an essential enzyme involved in DNA replication.	Yes, you're correct!
Thank you. Can you form me another problem?	Of course! Here's another problem related to the structure, Function, Types and Stability of RNA.
RNA is a double major.	No, but it is expected that you confuse about that. Do not worry! Here is the step-by-step guidance. - Structure: RNA is typically a single-stranded molecule.

	- Function: RNA plays various roles in gene expression and protein synthesis - Types: The main types include mRNA, tRNA, and rRNA. - Stability: RNA is generally more labile.

- Monitoring student progress: Evaluation and continuous improvement
ChatGPT can create tests, quizzes and assignments to measure student progress and mastery of biology topics. The results of ChatGPT are as follows.

Table 3. ChatGPT as Quiz Preparer

Prompt	ChatGPT as Quiz Preparer
Can you prepare a quiz for me on the topic of genome?	- What is a genome? - How many copies of each chromosome are present in a human somatic cell?
Correct answers were given to all questions.	- Correct! The complete set of genes present in an individual or organism. A genome is the complete set of genetic material or DNA present in an organism. - Correct! answer is 23 pairs.
Incorrect answers were given to all questions.	- Incorrect! To learn about the concept of genomes, it is helpful to start with some fundamental steps :Study DNA, explore genes and chromosomes, Understand genome sequencing. - Incorrect! To avoid confusion: Somatic cells in humans normally have 46 chromosomes arranged in 23 pairs.

Providing personalized content for Lessons and Assessments
- Virtual biology laboratory
Science education has greatly benefited from advancements in technology, particularly with the integration of virtual laboratories (Hatami et al., 2018; Sahafi, 2024). A virtual biology lab uses ChatGPT to guide students through lab experiments and procedures. ChatGPT can provide real-time support and feedback and increase student understanding and participation in lab activities. This example can be integrated into biology education in

three ways.

--Pre-lab preparation: creating content and support

ChatGPT can create sample pre-lab tests to assess students' understanding of concepts and methods before the lab session. ChatGPT results are as follows.

Table 4. ChatGPT as Pre-Lab Helper

Prompt	ChatGPT as Pre-Lab Helper
Generate a pre-lab tutorial explaining the procedure, necessary equipment, and safety precautions for blood group experiment.	Pre-Lab Tutorial: Blood Group Experiment Introduction: In this tutorial, we will discuss the procedure, necessary equipment, and safety precautions for conducting a blood group experiment. The aim of this experiment is to determine the blood type of an individual. Procedure: - Necessary Equipment: Sterilized Lancets, Alcohol Swabs, Cotton Balls, Glass Slides, Applicator Sticks. - Collecting Blood Samples: Disinfect the puncture site with an alcohol swab and allow it to dry. Use a lancet to puncture the skin. - Performing the Blood Typing Test - Safety Precautions: Personal Protective Equipment (PPE), Proper Disposal of Sharps, Universal Precautions.

-- During the laboratory test

Guidance and assistance in real time: As students' progress through the virtual lab, they can refer to ChatGPT for guidance on test procedure, operating the virtual lab equipment, and troubleshooting. The results of ChatGPT in the role of real-time laboratory assistance with the example of a blood group diagnosis test are as follows.

Table 5. ChatGPT as Real-Time Lab Assistance

Prompt	ChatGPT as Real-Time Lab Assistance
Provide guidance on determining the unknown blood grouping	Determining an unknown blood grouping typically involves performing a series of tests to identify the presence or absence of specific antigens on the surface of red blood cells. Here are some steps you can follow to determine the unknown blood grouping: Collect a blood sample, Perform ABO typing, Forward typing, Reverse typing, Determine Rh factor, Confirmatory testing.

-- Post-Lab Analysis and Reflection

Assessment and Feedback: After completing the lab experiment, students can submit their lab reports to ChatGPT for an initial review, receiving feedback on their methodology, data analysis, and conclusions. The results of ChatGPT are as follows.

Table 6. ChatGPT as Lab Report Analyzer

Prompt	ChatGPT as Lab Report Analyzer
I am a student doing the blood group test. Provide feedback and suggestions to improve the performance of blood group tests.	Excellent! Here are some specific feedback and suggestions to improve the performance of your blood group tests: Clear explanation of the ABO system, Accurate sample identification, Standard blood group reagents, Appropriate positive and negative controls, Standard Operating Procedure, Careful handling and documentation, Follow safety protocols.

- Flipped classroom model

The flipped classroom model involves students having access to pre-recorded lectures and supplementary materials before participating in class sessions (Tucker, 2012). Previous studies unanimously indicated that the flipped learning technique has positive effects on learning and learner motivation (Jafarkhani & Jamebozorg, 2020).

-- Pre-class preparation

Content creation and management**:** ChatGPT can help the teacher create pre-recorded video lectures, slides, or reading materials to cover essential biology concepts. It can also create quizzes, exercises, or interactive activities for students to complete before participating in virtual classroom sessions. The results of ChatGPT are as follows.

Table 7. ChatGPT as Pre-Class Helper

Prompt	ChatGPT as Lab Report Analyzer
Generate a pre-recorded video lecture script that covers the basics of enzyme action in a biochemical reaction.	[Pre-recorded Video Lecture Script: Basics of Enzyme Action and Specificity] Title: Understanding Enzyme Action and Specificity Lecture Script: - Introduction - Enzymes and Biochemical Reactions - Reaction Specificity and Substrate - Reaction Mechanism Interactive Simulation Scenario

-- In-Class Engagement

Virtual Teaching Assistant: ChatGPT can facilitate communication between students and teachers during virtual class sessions by answering questions and clarifications and offering real-time support. It can also help manage breakout sessions, monitor student progress, and generate discussion prompts to encourage active participation. ChatGPT outcomes are as follows in the topic of predict the product of a hydrolase enzyme.

Table 8. ChatGPT as Virtual Teaching Assistant

Prompt	ChatGPT as Virtual Teaching Assistant
I am currently a student in an online class session on regulation of enzyme activity. In class we are working on a problem solving activity to predict the product of a hydrolase enzyme. Can you help me understand the effect of increasing free energy on the progress of the reaction?	Of course! In a hydrolase enzyme reaction, the reaction can be represented as: Substrate + H2O ⇌ Product 1 + Product 2. The relationship between free energy and the progress of a reaction is described by the principle of thermodynamics, specifically the Gibbs Free Energy equation: $\Delta G = \Delta H - T\Delta S$ To predict the product, consider the structure of the substrate and identify the bond that is likely to be cleaved by the hydrolase enzyme. The hydrolase enzyme will break this bond, resulting in two product molecules.

-- Consolidation after class

Reinforcement and evaluation**:** ChatGPT can provide personalized feedback on student performance in class, highlight areas for improvement and reinforce concepts. ChatGPT can create follow-up assignments or projects to further strengthen students' understanding of biology topics. ChatGPT can also create assessments to measure student mastery and inform the teacher of their progress. The results of ChatGPT are as follows.

Table 9. ChatGPT as Practice Teacher

Prompt	ChatGPT as Practice Teacher
Create a set of problems and practice tests that cover the classification of enzymes such as hydrolase, hydratase. I want to test myself.	[Here are the practice problems. - Practice Problem 1: What type of reaction does a hydrolase enzyme catalyze? - Practice Problem 2: What type of reaction does a hydratase enzyme catalyze? Quiz: - What is the primary function of hydratase enzymes? - True or False: Hydrolases catalyze the cleavage of chemical bonds by adding water molecules.

The correct answer given to practice problem	Great card, You've correctly understood classification and primary function of enzymes.

Supporting Teachers in Curriculum Development
- Professional Development for biology Teachers

A professional development program for biology teachers incorporates ChatGPT to support the learning process. AI helps teachers explore new pedagogical approaches, teaching strategies, and classroom management techniques. ChatGPT can also assist in creating lesson plans, assessments, and learning materials tailored to the teachers' specific contexts, fostering an adaptive and practical professional development experience. This example can be integrated into biology education in four ways.

-- Exploration of Pedagogical Approaches

Pedagogy Consultant and Resource Provider: ChatGPT can introduce teachers to new pedagogical approaches, teaching strategies, and classroom management techniques. ChatGPT outcomes are as follows in the topic of the 5E instructional model for teaching biochemical reactions.

Table 10. ChatGPT as Pre-Class Helper

Prompt	ChatGPT as Pre-Class Helper
I am a biology teacher looking to learn more about the 5E instructional model for teaching biochemical reactions.	Certainly! The 5E instructional model is a constructivist-based approach. It provides a framework for designing effective and engaging lessons. - Engage: The Engage phase aims to capture students' attention, activate prior knowledge, and stimulate curiosity. - Explore: In the Explore phase, students actively explore the topic through inquiry-based activities. - Explain: In the Explain phase, students acquire conceptual understanding by connecting their explorations to scientific concepts - Elaborate: The Elaborate phase encourages students to apply their understanding in new contexts and deepen their knowledge. - Evaluate: In the Evaluate phase, you assess students' learning outcomes and provide feedback.

-- Lesson Plan and Assessment Development

Lesson Plan and Assessment Advisor: ChatGPT can assist teachers in creating lesson plans, assessments, and learning materials tailored to their specific contexts. It can offer suggestions and best practices for

incorporating innovative teaching methods and technologies into the curriculum. ChatGPT outcomes are as follows.

Table 11. ChatGPT as Lesson Plan and Assessment Advisor

Prompt	ChatGPT as Lesson Plan and Assessment Advisor
I am a biology teacher planning a lesson on the process of mitosis. Can you help me create a lesson plan and create questions and exercises about the stages of mitosis.	Certainly! Here is a basic structure for your lesson plan: - Objectives of the lesson - Educational strategies - Activities: Group activity - Individual practice - Evaluations: Formative

-- Classroom Management and Teaching Strategies

Classroom Management and Strategy Consultant: ChatGPT can guide effective classroom management techniques and offer advice on addressing common challenges biology teachers face. It can also suggest teaching strategies that promote student engagement, motivation, and understanding of biology concepts. The results of ChatGPT are as follows.

Table 12. ChatGPT as Consultant

Prompt	ChatGPT as Consultant
As a biology teacher, I look for strategies to manage a diverse classroom and make abstract concepts like how chromosomes separate in higher plant cells without a centriole. Can you guide me?	Certainly! Managing a diverse classroom and making abstract concepts more relevant and understandable can greatly enhance the learning experience for your students. Here are some strategies you can use to achieve these goals: - Differentiated Instruction - Real-World Examples - Hands-On Activities - Visual Aids and Technology - Cooperative Learning - Relate to Prior Knowledge

-- Reflective Practice and Continuous Improvement

Reflective Practice Facilitator and Feedback Provider: ChatGPT can encourage teachers to engage in reflective practice by posing thought-provoking questions and offering insights based on their experiences. It can provide constructive feedback on teachers' practices and suggest areas for improvement or further professional development. ChatGPT outcomes are as follows in the topic of diffusion laws.

Table 13. ChatGPT as Facilitator

Prompt	ChatGPT as Facilitator
My students' assessment performance was not as high as I expected. Can you help me?	Of course! To improve your instructional practices, you can: - Incorporate more hands-on activities - Adjust the pacing - Provide additional practice opportunities - Seek feedback from students

Facilitating student-teacher communication

ChatGPT can act in this field as follows:
- Communication Tool
- Answering Student Questions
- Virtual Classroom Support

The following was created based on the ChatGPT facilitator role.

- Collaborative learning platform

An online learning platform utilizes ChatGPT to enhance collaborative learning in biology projects and group assignments. The AI system assists in moderating discussions, guiding project tasks, and facilitating group problem-solving. Additionally, ChatGPT can generate personalized study materials and resources tailored to the specific needs and interests of each student group.

This example can be integrated into biology education in four ways.

-- Group formation and resource allocation

Group coordinator and content producer: ChatGPT can help form groups based on interests, skill levels, or learning goals. ChatGPT Can produce customized materials, resources, and study guides for each group, catering to members' specific needs and interests. The results of ChatGPT are as follows.

Table 14. ChatGPT as Pedagogy Consultant

Prompt	ChatGPT as Facilitator
I have a group of students work on a project about DNA replication. Can you help me organize them into groups based on their learning styles and prior knowledge?	Absolutely! Based on the students' learning styles and prior knowledge, I've organized them into the following groups: - Group 1: Visual Learners with Basic Knowledge - Group 2: Kinesthetic Learners with Intermediate Knowledge - Group 3: Auditory Learners with Advanced

	Knowledge - Group 4: Mixed-ability learners - Group 5: Prior knowledge variation

-- Project development and task management

Project coach and work facilitator: ChatGPT can help students define project goals, define tasks, and assign responsibilities among group members. ChatGPT Can provide guidance on project assignments, support group problem solving, and answer questions related to molecular biology content. As for biochemical process, the ChatGPT results are below.

Table 15. ChatGPT as Project Mentor

Prompt	ChatGPT as Project Mentor
As a biology teacher, my students are working on a group project to design an environmentally friendly biochemical process. Can you guide them?	Of course! I'd be happy to guide your students. Here's a step-by-step plan they can follow: -Research - Brainstorming - Concept Development - Environmental Impact Assessment - Proposal Development - Presentation

-- Communication and Collaboration

Discussion Moderator and Collaborative Support: ChatGPT can facilitate communication among group members, moderating discussions, encouraging participation, and ensuring a respectful and inclusive learning environment. It can also help resolve conflicts or misunderstandings during group work. The following are the results of the ChatGPT.

Table 16. ChatGPT as Discussion Moderator

Prompt	ChatGPT as Discussion Moderator
I am a biology teacher and my students are working on a project on photosynthesis reactions. Can you help search online and make sure everyone in the group has a chance to contribute and provide clarification if needed?	Certainly! As a discussion moderator and collaborative support, I can help in the following ways: - Encourage participation - Provide clarification - Address misconceptions - Maintain a respectful environment - Research Assistance

-- Assessment and Feedback: Evaluator and Feedback Provider
- ChatGPT can assess the quality of group projects or assignments, providing constructive feedback on individual and collective performance.
- It can also generate follow-up tasks or learning activities to address areas for improvement and further strengthen students' understanding of biology concepts. ChatGPT outcomes are as follows.

Table 17. ChatGPT as Evaluator and Feedback Provider

Prompt	ChatGPT as Evaluator and Feedback Provider					
In the next lesson, my students give a group lecture about the properties of medicinal plants, and I give feedback to the class by listening to them. Can you give me a sample rubric on this topic?	Certainly! Here's a sample rubric for evaluating a group lecture on the properties of medicinal plants:					
	Criteria	Excellent	Good	Poor	Poor	Very Poor
	Content Knowledge	✔				
	Presentation Organization		✔			
	Delivery and Engagement			✔		
	Visual Aids and Supporting Materials					✔
	Collaboration	✔				
	Overall Presentation	✔				
	Please note that this is just a sample rubric, and you can modify it according to your specific requirements and preferences.					
How many percentages are each of the indicators?	Based on the criteria you provided, here's the breakdown of the percentages for each indicator: - Content Knowledge: 20% - Presentation Organization: 15% - Delivery and Engagement: 20% - Visual Aids and Supporting Materials: 15% - Collaboration and Teamwork: 10% - Overall Presentation: 20% Please note that the percentages assigned to each indicator are subjective and may vary depending on the specific context or evaluation criteria used.					

After students complete a group presentation on the properties of medicinal plants, ChatGPT evaluates their work based on a rubric provided by the teacher. It gives constructive feedback on their research, analysis, presentation skills, and teamwork, helping the students to learn from the experience and improve their future projects (Chart 1).
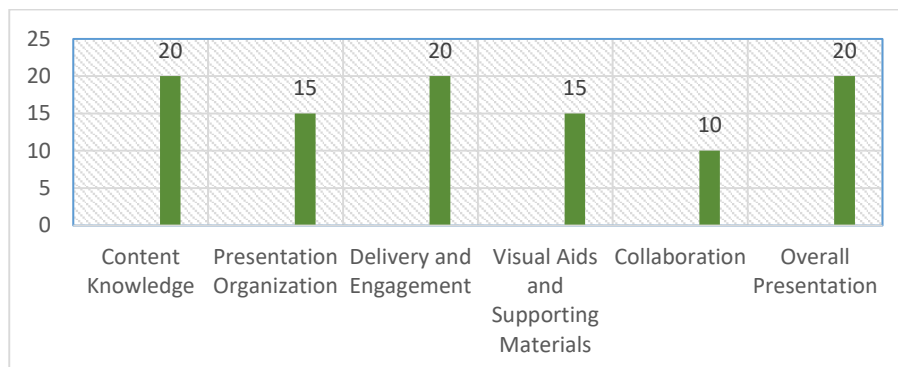
Chart 1. ChatGPT Feedback

Exploring the Benefits and Limitations of ChatGPT-Assisted Learning

This analysis explores the potential benefits and limitations of using ChatGPT in distance education for various biology-related applications. By examining these specific cases, valuable insights were gained into the benefits and limitations of integrating AI-assisted learning in the educational landscape.

- Providing Personalized Feedback

AI tools can potentially revolutionize how we approach distance education with their ability to analyze student data and generate customized feedback (Casillo & Powell, 2023). This section will examine the advantages and disadvantages of utilizing ChatGPT to deliver tailored feedback in distance education, emphasizing examples.

Strengths/Benefits

- Fostering learner autonomy: Personalized feedback from AI tools can empower students to take charge of their learning journey, promoting self-directed learning.

- Enhanced student learning and motivation: Tailored feedback can address individual learning needs, improving understanding and retention of concepts. It can also help overcome challenges and foster student motivation.

- Increased efficiency in providing feedback: AI tools like ChatGPT can save educators time by automatically generating individualized student feedback, allowing them to focus on higher-level tasks and in-person interactions.

Limitations/Weaknesses

- Limited capacity for empathy: AI tools may not fully understand or consider a student's emotional state or personal circumstances when providing feedback, potentially overlooking important factors that impact learning.
- Difficulty detecting nuances: AI tools may struggle to perceive subtleties in students' comments or comprehend the underlying reasons for their confusion, leading to potential misinterpretations and erroneous feedback.
- Potential for inaccurate feedback: AI tools can sometimes provide incorrect or misleading explanations or solutions, which may lead to student misunderstandings or confusion.
- Reliance on adequate input data: The effectiveness of personalized feedback relies on the quality and comprehensiveness of the input data provided to AI. Incomplete or incorrect data may limit the AI's ability to properly understand a student's learning requirements and provide effective feedback.

It is important to consider these limitations and weaknesses while implementing AI tools for providing personalized feedback. Educators should use AI-generated feedback as a valuable resource but also complement it with human judgment and involvement to ensure a holistic and comprehensive approach to student support and education.

Generating Content for Lessons and Assessments

Educators can provide consistent, up-to-date, and engaging content that responds to varied student requirements by employing AI. This section will explore the benefits and limitations of utilizing ChatGPT to produce material for lessons and assessments.

Strengths/Benefits

The benefits of generating content for lessons and assessments using AI include:

- Increased efficiency: AI can significantly save educators' time and effort by automating the process of content creation. This allows teachers to focus on other important aspects of teaching and providing support to their students, leading to improved work-life balance and reduced burnout.
- Adaptive lesson plans: AI can generate lesson plans that cater to the diverse needs and interests of students, enhancing the learning experience. This adaptability ensures that students with varying levels of

understanding are provided with multiple entry points and appropriate scaffolding.

- Engaging assessments: AI-generated content can create assessments that engage students and test their understanding in various ways. By offering different types of questions and interactive elements, AI can promote active learning and application of knowledge in different contexts.

It is important for educators to be aware of both the limitations and benefits of AI-generated content and to exercise caution and critical judgment when utilizing such technology in educational settings.

Limitations/Weaknesses

On the other hand, the weaknesses or limitations of generating content for lessons and assessments using AI, such as ChatGPT, include:

- Potential for inaccuracies: AI-generated content may sometimes contain errors or misleading information, which can hinder students' understanding of concepts.
- Lack of personalization and cultural sensitivity: AI may not always account for the individual needs, backgrounds, and learning preferences of students or diverse groups. This lack of personalization and cultural sensitivity can lead to a less engaging and relevant learning experience.
- Ensuring content alignment: AI-generated content may not always align with curricular requirements or instructional objectives. Educators need to carefully review and modify the generated material to ensure it meets the intended learning goals and follows curriculum guidelines.

Supporting Teachers in Curriculum Development

Effective curriculum creation ensures kids get a well-rounded, relevant, and exciting education. This section will examine the advantages and disadvantages of utilizing ChatGPT in curriculum creation.

Strengths/Benefits

- Enhanced Efficiency: AI tools like ChatGPT can assist teachers in saving time and effort by providing them with valuable resources, suggestions, and insights, allowing them to focus more on other aspects of teaching.
- Access to Diverse Resources: ChatGPT can help educators discover a wide range of high-quality resources, including articles, videos, research papers, and lesson plans, enabling them to access the latest and most effective teaching strategies.
- Collaboration and Professional Development: AI tools foster

collaboration and create opportunities for educators to share ideas, discuss best practices, and continuously improve their teaching methods. This can lead to enhanced professional development and improved teaching quality.
- Personalized Support: ChatGPT can analyze specific curriculum gaps and provide personalized recommendations based on individual needs, allowing teachers to tailor their lessons and address student learning gaps more effectively.

Limitations/Weaknesses
Weaknesses/Limitations of Supporting Teachers in Curriculum Development:
- Lack of Human Expertise: AI tools may not possess the same level of expertise and contextual understanding as human educators. They may struggle to fully grasp the unique needs and circumstances of a particular educational setting, requiring additional collaboration with teachers and experts.
- Potential Overreliance on Technology: Relying too heavily on AI-generated support may diminish educators' autonomy and creativity in curriculum development. It is crucial to strike a balance between leveraging AI tools and maintaining the expertise and insights that come from human experience.
- Dependence on Accurate Input: The effectiveness of AI-generated suggestions depends on the accuracy and completeness of the input data. If the information provided is incomplete or outdated, the recommendations may be less relevant or effective.
- Ethical Considerations: Using AI tools in curriculum development raises ethical concerns such as data privacy and algorithmic bias. Safeguarding data privacy and ensuring AI-generated suggestions are free from biases or stereotypes is essential to maintain fairness and inclusivity in education.

Facilitating Student-Teacher Communication
Effective communication between students and teachers is vital for a successful learning experience. This section will discuss the benefits and limitations of using ChatGPT to facilitate student-teacher communication.

Strengths/Benefits
Increased accessibility and inclusivity: ChatGPT can offer alternative formats and adapt language complexity to cater to the diverse needs of students, making communication more accessible for all.

- Improved efficiency: ChatGPT can provide quick and accurate responses to student inquiries, reducing the workload on educators and allowing for efficient communication.
- Prompt and effective support: ChatGPT can offer real-time assistance during virtual classroom sessions, enhancing the learning experience by providing immediate help when needed.
- Encouraging peer collaboration: ChatGPT can facilitate student collaboration, fostering a sense of community and shared learning by moderating discussions, suggesting resources, and supporting group problem-solving.

Weaknesses/Limitations
- Loss of personal connection: Relying solely on ChatGPT for communication may result in a loss of personal relationships between students and educators, potentially impacting the quality of the learning experience.
- Potential for miscommunication: ChatGPT may not always accurately interpret or convey the intended meaning, leading to misunderstandings or confusion. Educators must monitor and clarify communication to ensure effectiveness.
- Inappropriate content generation: There is a risk of ChatGPT inadvertently generating inappropriate or offensive content, requiring monitoring and moderation to maintain a respectful and inclusive learning environment.
- Limitations in empathy and social skills: ChatGPT may struggle to understand emotional nuances and social dynamics in student-teacher communication. Educators should prioritize personal connections with students and address their emotional and social needs alongside academic concerns.

Conclusion
Innovating distance learning refers to the process of introducing and implementing new technologies, strategies, and approaches to enhance the effectiveness and quality of remote education. It involves leveraging innovative tools, such as AI technologies like ChatGPT, to transform the teaching and learning experiences management in online or remote science education.

Some examples of innovating distance learning with AI tools like ChatGPT include: Personalized Feedback, Content Generation,

Curriculum Development, Improved Communication.

By embracing innovation in distance learning and incorporating AI tools, educators can create adaptive, personalized, and inclusive learning environments (Luckin et al., 2016). This approach has the potential to bridge the digital gap (Ritzhaupt et al., 2020), enhance educational equity, and ensure that every student, regardless of their background or access to resources, has equal opportunities to succeed in science education and participate fully in virtual lab experiences and other online learning activities (Boudreau, 2023).

However, it is essential to address ethical and practical concerns associated with the use of AI in education (Boddington, 2017). Responsible implementation, privacy protection, transparency, and ongoing research and development are crucial to realizing the full potential of AI tools while mitigating any potential risks or biases they may introduce.

The study's outcomes imply that overcoming hurdles to typical lab experiences in distance scientific education requires innovation, flexibility, and multiple digital technologies. Despite the lack of actual lab settings, virtual labs, simulations, and other interactive materials can effectively provide students with valuable hands-on experiences (Wu et al., 2022). Furthermore, these digital alternatives may help reduce traditional lab activities' environmental impact (Boudreau , 2023).

The findings, however, emphasize the need to evaluate the potential ethical consequences of utilizing AI technologies in science teaching (Perrigo, 2023).

The findings of this study shed light on the various effects of distance education on the quality and engagement of science education.

- Distance education in science has both challenges and opportunities. While there were obstacles, it also presented potential for innovation and adaptation in science education.

- Evidence-based explanations are critical in distance science education, and educators need to be aware of the limitations of AI technologies like ChatGPT.

- The effectiveness of distance education in science depends on contextual conditions and educators' ability to customize their approach to students' needs.

- Educators should be mindful of algorithmic biases and limited framing of truth in AI-generated information (Darics & Poppel ,2023).

- Building a community culture among students is important in online

science education, which can be achieved through increased peer-to-peer communication, online discussion forums, and group activities (Wu et al., 2022).

- Continuous professional development for educators is essential in improving the quality of distance science education. This includes instruction in the effective use of digital tools, instructional tactics, and ethical considerations.

The study's outcomes imply that overcoming hurdles to typical lab experiences in distance scientific education requires innovation, flexibility, and multiple digital technologies. Despite the lack of actual lab settings, virtual labs, simulations, and other interactive materials can effectively provide students with valuable hands-on experiences. Digital alternatives may help reduce the environmental impact associated with traditional lab activities. Equal access to technology and materials is crucial to reducing barriers in distance science education. Integrating real-world applications and problem-solving activities is significant in distance science education to deepen student knowledge and cultivate an appreciation for the relevance of science in daily life. ChatGPT can assist educators in their work by providing countless examples and making it more manageable.

In summary, AI has the potential to revolutionize distance science education by offering personalized learning experiences, creating interactive environments, and supporting students' critical thinking skills. Ethical considerations, ongoing research, and thoughtful policy development are essential to harnessing the full potential of AI in science education. Educators must adapt their teaching methods and practices using technology and digital resources available for distance learning science. Cultivating a sense of community and cooperation among students can increase interaction and learning outcomes. Policymakers and educational institutions must ensure equitable access to technology and resources for all students and invest in the professional development of educators to keep pace with technological advances.

By addressing these challenges and integrating AI technologies such as ChatGPT with appropriate instructional strategies, distance science education can be enhanced and lead to improved student learning experiences management and outcomes.

In terms of future research, extending the studies to other subject areas beyond the sciences could provide valuable insights into the

effectiveness of distance learning across disciplines. Investigating the potential of AR and VR in distance education and investigating the impact of collaborative learning in online environments can also help to enhance distance science education. Assessing the long-term outcomes of distance science education and understanding the role of technology in shaping these outcomes would be valuable for further improvement.

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