

**Research Article****LEVERAGING ARTIFICIAL INTELLIGENCE AND INTERACTIVE LEARNING APPROACHES FOR ENHANCED STUDENT ACHIEVEMENT AND PERSPECTIVES IN A BIOLOGY COURSE****Clauditte T. Tchakoua¹, Lekan Latinwo², Martha Tchounwou¹, Clement G. Yedjou^{2*}, and Hong Liu³**¹College of Science, Engineering and Technology, Jackson State University, 1400 Lynch Street Jackson, MS, 39217, USA²Department of Biology, College of Science and Technology, Florida Agricultural and Mechanical University, 1610 S, Martin Luther King Blvd., Tallahassee, FL 32307, USA³Department of Mathematics, College of Arts and Sciences, Embry–Riddle Aeronautical University, Aerospace Boulevard Daytona Beach, FL 32114, USA**Received 19th October 2023; Accepted 10th November 2023; Published online 29th December 2023**

Abstract

Modern instructional technology holds the potential to deliver effective learner-centered, personalized education for non-traditional and non-residential students worldwide. With artificial intelligence (AI) becoming an integral part of our daily lives, it is transforming education and reshaping how we learn, communicate, interact, and work. Our previous research showcased the positive impact of interactive learning activities on students' performance in an anatomy and physiology course. The objective of this research paper is to underscore the significance of integrating ChatGPT's artificial intelligence (AI) and interactive learning activities into a General Biology course. To accomplish this objective, we developed and implemented ChatGPT's AI and interactive learning activities within the General Biology curriculum. We assessed students' performance and perceptions through various metrics, including class attendance, discussion forums, computerized homework, proctored exams, and the use of classroom technologies. In summary, our study emphasizes the importance of incorporating ChatGPT's AI and interactive learning activities into education. Our findings reveal that students not only enjoyed but also appreciated the innovative approach, as evident by the positive feedback in course surveys. Integrating ChatGPT's AI and interactive learning activities into curriculum ensures that students are not only well-prepared for their academic pursuits but also for future workforce development.

Keywords: General Biology, Artificial intelligence, Interactive activities, Student performance and perception.

INTRODUCTION

Contemporary instructional technology holds the potential to deliver effective learner-centered, personalized education for non-traditional and non-residential students globally. Recent research highlights the positive influence of ChatGPT's artificial intelligence (AI) on education, particularly in the field of biology (Gibson *et al.*, 2023; Pence, 2020; Agathokleous *et al.*, 2023; Nasution, 2023). Developed by OpenAI, ChatGPT belongs to the broader domain of natural language processing (NLP), aiming to imbue computers with the ability to comprehend and interpret human language (Aljanabi, 2023; Rahman & Watanobe, 2023). The integration of ChatGPT's AI into the classroom environment shows promise to streamline tutorial processes, improve grading efficiency, offer prompt feedback on course quality, provide instant responses to students, and introduce virtual human-like characters capable of natural thinking, acting, reacting, and interacting (Hassoun *et al.*, 2021; Xiao *et al.*, 2023). Our previous research has highlighted the positive impact of interactive learning activities on student performance, particularly in an anatomy and physiology course (Yedjou *et al.*, 2022). Interactive learning, an innovative approach, actively involves students in the learning process through collaboration, discussion, and hands-on activities, fostering a friendly classroom atmosphere, boosting learner self-reliance and self-assurance, encouraging engagement, assisting low-achieving students, and promoting

active and continual use of acquired knowledge and experience (Maasthi *et al.*, 2022; Bodzsár-Urbán & Bárczi, 2023; Artal-Sevil *et al.*, 2019). An essential aspect of ChatGPT's artificial intelligence (AI) and interactive learning activities is the social and communicative interaction among students and instructors and between students. Various communication channels, such as discussion boards, collaborative group assignments, email, phone, and live chat, facilitate meaningful interactions. Students often express that this instructional model allows them to learn not only from instructors but also from their peers. Despite students' enthusiasm for leveraging ChatGPT's AI and interactive learning resources (video analysis, animations, YouTube, PowerPoint presentations, etc.), limited studies have explored the advantages of these innovative technologies in a biology course. Therefore, the objective of this research paper is to underscore the significance of integrating ChatGPT's artificial intelligence (AI) and interactive learning activities into a General Biology course.

RESEARCH DESIGN AND METHODS

A General Biology course supported by Gates-Study was taught in the Department of Biological Science at FAMU during the Fall 2023. The total enrollment in the course was 50 students. Students had the freedom to self-enroll in the course according to their individual schedules, intrinsic or extrinsic motivations, and familial commitments. To access the perceptions of innovative and instructional technologies, course management, and instructor involvement, a comprehensive end-of-semester survey was administered, featuring a 19-statement questionnaire rated on a five-point

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scale (ranging from strongly disagree to strongly agree) as outlined in Table 1 and Table 2. Table 1 illustrates the student's perceptions on the beneficial application of the ChatGPT's artificial intelligence in the classroom. Table 2 illustrates the interactive activities implemented throughout the course, designed to actively engage students, enhance their understanding of General Biology concepts, provide them with real-world applications, and ultimately boost their academic success. The course evaluation consisted of 12 lectures, 8-unit assessments, 4 discussion forums, and 2 proctored exams (comprising of one mid-term examination and one final examination), all under the guidance of the same instructor.

Figure 1 illustrates the comprehensive integration of artificial intelligence (AI) and interactive learning activities within a General Biology course. The incorporation encompasses various dynamic elements, including announcement and emails, PowerPoint presentation, computerized homework, interactive animations, video analysis tools, practice tests, and self-assessment modules. This symbiotic blend enriches the learning experience, fostering engagement and deeper understanding among students navigating the intricacies of the biological sciences.

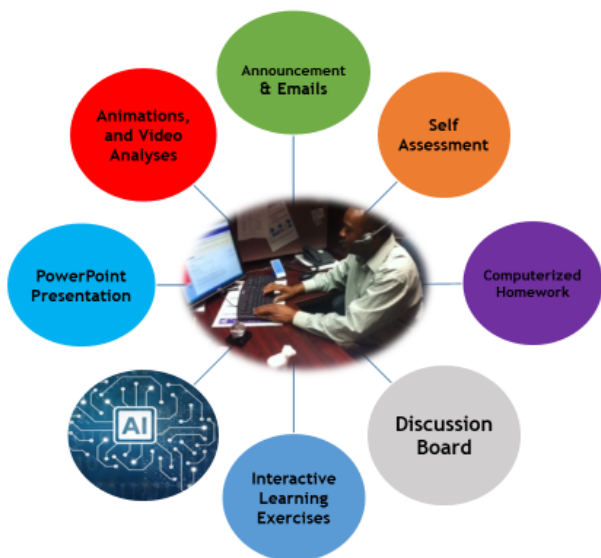


Figure 1. Computerized course activities used to engage students in a General Biology course

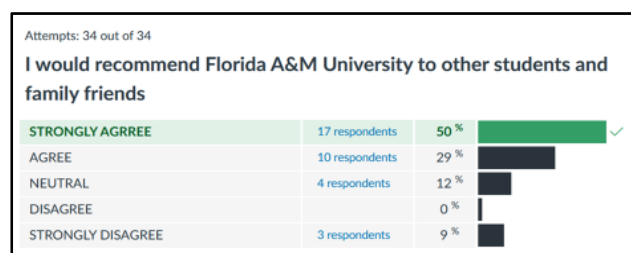
Students enjoyed the flexibility of accessing course materials at their convenience and from any location that suited their learning preferences. They had equitable opportunities to engage with both their peers and the instructor. Communication with the instructor was made convenient through options such as telephone, Canvas email, scheduled office hours, and online audio chat. In preparation for each scheduled assessment or examination, review sessions were conducted in the classroom and announcements were posted on Canvas to ensure that students were well-prepared and received academic guidance.

Data analysis

Statistical analysis of the assessment of the course delivery method was done using a one-way analysis of variance (ANOVA). *P*-values less than 0.05 were considered statistically significant. We only evaluate students' perceptions about innovative technologies in this course.

RESULTS

Out of 50 enrolled students, 34 completed the survey for the course evaluation. The results, as illustrate in Table 1, showcase the percentage of students who either agreed or strongly agreed with specific statement regarding the course. For statements # 1 –2, an overwhelming 61% to 76% respondents expressed satisfaction with the course, their classmates, and the instructor. These statements also highlighted increased interaction among students and professor, emphasizing that the course was not solely reliant on self-study. Moving to statements # 3 – 5, an impressive 61% to 79% of students indicated their willingness to recommend the course, instructor, and FAMU to their peers, friends, and family. Here is an illustrate of statement # 5 (Table 1).



Statements # 6 – 10 indicated a favorable response, ranging from 61% to 91%, towards various interactive learning activities. These activities included discussion groups, practice tests (pre-tests and post-tests), computerized homework, Interactive art quizzes, video analysis, and multimedia resources, all of which significantly contributed to their learning experiences. Here is an illustrate of statement # 10 (Table 1).



Similarly, statements # 11 – 16 revealed a positive response, ranging from 33% to 52%, regarding the integration of ChatGPT's artificial intelligence into General Biology. Students found this integration beneficial and supportive of their learning process. Furthermore, 58% of students expressed their willingness to recommend ChatGPT's artificial intelligence to other students. Moreover, 73% of students acknowledged the value of ChatGPT's artificial intelligence as a technological resource. However, they also recognized that it serves as a complement rather than a replacement for other resources like PowerPoint, animations, videos, etc., which they utilize for their study. Here is an illustrate of statement # 18 (Table 1).

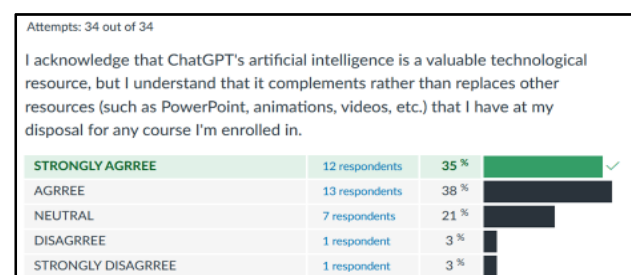


Table 1 highlights the response of students to each statement about their perceptions on artificial intelligence and interactive learning activities in a General Biology course

Table 1. Evaluating Students' Perceptions on the Beneficial Integration of the Artificial Intelligence and Interactive Learning Activities into a General Biology

Numbers	Statements	% of Agree & Strongly Agree
Satisfaction of the course and instructor		
1	Satisfied with the course.	61
2	Satisfied with the amount of interaction with the professor.	76
Recommendation of the course, instructor, and institution		
3	I would recommend FAMU to other students and family friends.	79
4	I would recommend this professor to other students	61
5	I would recommend this course to other students	73
Integration of the interactive learning activities		
6	Having the course available on Canvas gives the feasibility to access the course materials anytime and anywhere.	91
7	Computerized homework helped my learning.	76
8	Discussion assignment helped my learning	61
9	Interactive art quizzes, video analysis, and multimedia helped my learning.	70
10	Practice tests (pre-tests and post-tests) helped my learning.	76
Integration of the ChatGPT's artificial intelligence		
11	ChatGPT's artificial intelligence assists me in comprehending course content.	52
12	I plan to persist in utilizing ChatGPT's artificial intelligence as part of my educational journey.	44
13	ChatGPT's artificial intelligence enhances my engagement in the course	47
14	ChatGPT's artificial intelligence tailors my learning experience to be more personalized.	47
15	I employ ChatGPT's artificial intelligence to locate accurate answers.	40
16	The artificial intelligence of ChatGPT has significantly enhanced my writing and communication skills.	33
17	I would suggest ChatGPT's artificial intelligence to fellow students.	58
18	I acknowledge that ChatGPT's artificial intelligence is a valuable technological resource, but I understand that it complements rather than replaces other resources (such as PowerPoint, animations, videos, etc.) that I have at my disposal for any course I'm enrolled in.	73

DISCUSSION

Our research employs Canvas and its array of technologies to create diverse computer-based applications and course activities, including quizzes, tests, assignments, discussion groups, and more. Canvas facilitates easy access to course materials like syllabi, presentations, and audio clips while offering personalized feedback to students, promoting engagement and improving academic performance. Through this, we showcased how interactive elements effectively engage students, such as discussion forums fostering collaborative learning and AI assistance provided by ChatGPT for homework and skill enrichment. The crux of innovative classroom technology lies in fostering social and communicative interactions among students and instructors. Platforms like Canvas enable communication via discussion boards, collaborative assignments, emails, and live chat, enabling students to learn not just from instructors but also from their peers. Studies indicate that technology enhances learning by supporting active engagement, group participation, regular interaction, positive feedback, and real-world connections, offering flexibility aligned with students' learning goals and lifestyles (Wei *et al.*, 2018), (Hajhashemi *et al.*, 2017), (Juanda *et al.*, 2021). When integrated as a supplement to traditional instruction, technology in education is particularly impactful. Research underscores that multimedia technology approaches help develop basic abilities, encouraging active participation and problem-solving among students (Gokcearslan, 2020), (Overland, 2018), (Blacer-Bacolod, 2022), (Emilbekova & Umotali kyzy, 2021). Moreover, students tend to prefer hands-on tasks over traditional instruction methods, indicating a preference for learning within synthetically programmed environments (Hartman *et al.*, 2019). Consistent with broader findings, reports demonstrate that technology integration enhances cognitive and creative skills in student-centered environments (Yedjou *et al.*, 2022).

Notably, in previous Biology lab courses, students positively acknowledged that virtual labs enhanced analytical thinking, creativity, and technical competence (Yedjou *et al.*, 2009). Innovative technologies in the classroom, coupled with hands-on activities like AI interaction, animations, video analyses, and collaborative projects, enrich students' learning experiences. These activities, especially prominent in STEM fields, play a pivotal role in improving learning abilities and fostering critical thinking. There exists a substantial body of research comparing traditional and online teaching methods across various components, including homework, lectures, assessments, and discussions (Maki & Maki, 2002), (Rivera *et al.*, 2002), (Maurino, 2007).

Limitations

This research study is subject to certain limitations. Firstly, it only focused on the outcomes of one class taught by a single professor, which may not fully represent the diversity of educational contexts and instructional methods. Our research was based on self-reported data, which could potentially lack a certain degree of confidentiality and objectivity, as participants may have provided information influenced by their perceptions and biases. The students enrolled in this course exhibited varying levels of proficiency in using Canvas and its associated technologies, which could have influenced the study's findings and generalizability. Artificial intelligence (AI) alone cannot fully address the diverse needs of students. Therefore, the crucial role of teachers becomes apparent in delivering a comprehensive learning experience. Furthermore, the integration of AI in education poses some challenges, including issues related to bias, privacy, possible job loss due to automation, security risks from hacking, lack of human-like creativity and empathy. Despite these limitations, the present study has provided valuable insights for instructors and administrators to inform future educational practices. It has offered students the opportunity to self-assess and gain insights

into their career decision-making, learning preferences, study skills, personality traits, and readiness for technology-assisted learning.

Conclusion

The integration of ChatGPT's AI and interactive learning activities into the General Biology classroom environment emerges as a pivotal educational tool, significantly contributing to the enhancement of teaching and learning experiences. This transformative approach not only captivates students but also fosters improvement in their academic processes, facilitates a deeper understanding of concepts, and cultivates a broader array of skills and competencies. The findings from our survey underscore the significance of incorporating innovative technologies as a primary factor in improving student academic success. Our study identifies several key determinants that influence student success. Among these, student self-motivation emerges as a critical factor, alongside the attitudes of instructors and their active involvement, the availability of course resources, and dedicated time for computer-based work. Scientific literature strongly supports the pivotal role of motivation in shaping students' academic achievements, work ethic, enthusiasm for learning, and perseverance (Hattie, 2008; Plante *et al.*, 2013; Williams, 2021; "Handb. Motiv. Sch.," 2016). Motivation, therefore, stands out as the driving force behind students' high performance in the classroom. Building upon these insights, our future initiatives aim to further elevate student learning outcomes. We plan to implement an even more extensive array of innovative technologies, complemented by active learning activities, particularly in the realm of biology courses. This forward-looking approach aligns with our commitment to continually enhance the educational journey and success of our students through the thoughtful integration of cutting-edge tools and pedagogical strategies.

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