

Relationship Between Chatbots and AI-Powered Gamification on Chemistry Students' Motivation

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Abstract

The study explored the potential of chatbots and AI-powered gamification on students' motivation. Two hypotheses were stated to guide the study. The research design adopted for this study was a survey research design. The instrument for data collection was a questionnaire titled "Artificial Intelligence And Student Motivation Questionnaire" (AISMQ. The sample of 200 students was randomly selected in the study area. Pearson Correlation analysis at 0.05 level of significance was used. The findings revealed that both, Chatbot and AI-powered gamification have a significant relationship with student motivation. In light of these findings, it was recommended among others that students be tutored on how to use AI.

Keywords; Artificial Intelligence, chatbots, AI-powered gamification, students' motivation.

Introduction

Chemistry is the study of matter and its properties. It involves the understanding of the interaction between atoms and molecules and how they combine to form materials we see around us. (Weiss, 2019). Chemistry is the central science that connects many other scientific disciplines, it provides the foundation for many technological advancements that improve our lives. Chemistry is critical for developing the next generation of scientists and innovators and can inspire students to pursue careers in STEM fields and prepare them for the challenges of the future (Kirchhoff, 2017). Many school students struggle with motivation in chemistry due to the perception that the subject is difficult and abstract. (Cooper et al., 2019).

Students' motivation is the drive or desire that students have to learn and achieve academic goals. (Ryan & Deci, 2013). Students motivation is the fuel that drives learning, without it students may struggle to; engage in academic task, persist in the face of challenges, achieve their academic goals. (Svinicki, 2014). Students motivation is a critical Factor in academic success, yet it is a common problem that students lose motivation over time. This can be due to a variety of factors such as, boredom with the subject matter, a perceived lack of relevance to their life outside of the classroom. (Hrabowski II, 2016). Artificial Intelligence (AI) can be said to be the intelligence exhibited by a computer programs that mimic the way a human brain functions and man's intelligence. Artificial intelligence-based systems such as: Personalized Learning, Chatbots, Intelligent Tutoring

System and AI-powered Gamification can play a role in influencing students motivation by providing personalized and adaptive learning experiences, real-time feedback and opportunities for self-directed learning, that are tailored to the unique needs and interests of individual students (Tang et al., 2019).

Chatbots

A computer programs that is designed such that there is a simulation of human conversation, that enhances people to interact with themselves via text or voice interface is termed Chatbots (Nja et al., 2023; Sreenivasu et al., 2023). Chatbots act as virtual tutors providing instant feedback, answering questions and guiding students through their learning journey (Sridhar et al., 2022).

AI-powered gamification

AI-powered gamification is a technique that combines artificial intelligence (AI) and game elements to create engaging and personalized learning experience for students (He et al., 2019). Ai-powered gamification can make assessments more engaging and effective by adding game-like elements. This can motivate students to compete against each other and improve their knowledge retention (He et al., 2019).

Theoretical framework of flow theory (1975)

This theory was propounded by Mihaly Csikszentmihalyi in 1975. According to this theory, Flow is a state of complete immersion and involvement

in an activity where one's skills and abilities are well-matched to the challenge of the activity. Flow occurs when three conditions are met: clear goals, immediate feedback and a balance of skills and challenge. Flow can be hindered by activities that are too easy or too difficult.

According to the flow theory, students become highly motivated and engaged in their learning activity when they have clear goals or objectives to guide their actions, receive immediate feedback about their progress and performance and also balance of their skills and challenges.

AI-based educational system support flow theory by adjusting the Challenge level of learning activities based on learners' performance and skills level, providing immediate feedback and guidance to learners as they work through learning activities, also by using a game based learning technique to make learning activities more engaging and enjoyable for learners.

Statement of the Problem

In an ideal situation, all students would be highly motivated to learn and engage in academic activities. However, in the present situation, many students are lacking motivation in their academic pursuits, there seem to be a lack of active participation and genuine excitement for learning. This trend is troubling because it can lead to lower academic performance, decreased interest in learning, hinders students' ability to fully grasp and retain information. It can also lower self-esteem and confidence in academic pursuits.

To address this problem it is necessary to explore the potential of AI-based educational system in influencing student's motivation. This involves understanding how AI can be leveraged to adapt instructional strategies to individual student needs, and provide real-time feedback and support to foster a sense of accomplishment. This study aim was to explore the potential of AI-based educational systems on students' motivation in chemistry.

Statement of Hypothesis

Four null hypothesis were stated to guide the study:

1. Chatbot does not have a significant relationship with students' motivation.
2. There is no significant relationship between AI-powered gamification and student motivation.

This research, will be beneficial to learners, educational institution, instructional designers and researchers.

Literature Review

Chatbots and Student Motivation

Computer programs that are designed for the stimulation of human conversation and at the same time providing an automated response to user questions or commands are called Chatbots (Kapoor, 2021). Studies by Pappas(2020);Xie et al.(2021) on the the impact of chatbots on student motivation reported that chatbots positively influence student motivation by providing personalized feedback, offering support, and creating a sense of interaction and engagement. Research by Romero-Hall (2020) examined the use of chatbots in first-year online and face-to-face composition courses. The results suggest that students perceive chatbots as supportive and motivational tools that provide timely feedback, encourage self-reflection, and enhance writing-related motivations.

Powered gamification and student motivation

AI-powered gamification refers to the use of AI algorithms and techniques in designing educational games to improve learning experiences and outcomes. This approach combines elements of game design, such as rewards, challenges, and interactive features, with AI capabilities to personalize learning and provide adaptive feedback..

Smith and Brown (2022) conducted a longitudinal study to examine the effectiveness of AI-powered gamification in enhancing students' retention and knowledge acquisition. The findings revealed that students who experienced AI-powered gamified learning exhibited higher retention rates and better knowledge retention over time, thereby keeping them motivated. The clarity of learning objectives and their alignment with gamification elements significantly impact student motivation. When students understand the relevance of gamified activities to their learning goals, their motivation to engage and persist in the tasks increases (Kapp, 2012).

AI-Powered gamification systems may present technical challenges, such as compatibility issues, system complexity, and maintenance requirements. Educators and developers need to consider the infrastructure, scalability, and interoperability aspects to ensure a seamless implementation and smooth user experience (Kapp, 2012; Dicheva et al., 2015)

The reviewed literature highlights the positive impact of chatbot and AI-powered gamification student motivation. By promoting autonomy, relevance, feedback, mastery, collaboration, and adaptability. However, some research evidence on the variables under review were with foreign cultural backgrounds, very few indigenous works exists. It is therefore, the desire of the researcher to carry out this study in Calabar, Nigerias to bridge the gap in knowledge in that area.

Research Method

Research Design

The research design for this study was a survey research design. This design was considered appropriate because of its ability to collect data from a large number of respondents efficiently, allowing for generalizability and examination of relationship between variables. (Sarantakos, 2013).

The population of the study comprises of all Chemistry Education Students in the Department of Science Education, University of Calabar, 2021/2022

Results

Academic Session. A random sampling procedure was adopted to select the students per level. A total of 200 students across the four levels which represents 80% of the population of 251 students were sampled for use in the study

Instrumentation

A Questionnaire. titled ‘Artificial Intelligence And Student Motivation Questionnaire’ (AISMQ) was the instrument used in this study. It consisted of 25 items to which respondents were meant to indicate their level of agreement or disagreement based on the four points likert-type scale to measure. Face and content validity was carried out on the instrument. The reliability of the research instrument was done using theCronbach alpha reliability method. The reliability coefficients ranges from 0.7-0.83. The questionnaire was administered online to the 200 students by sharing a link to them, through the online platform<https://forms.gle/1wsjfaxhWGqaWCvVA> ‘WhatsApp’.

TABLE 1: Mean, Standard deviation and Pearson Moment Correlation coefficient between chatbot and student motivation (SPSS 22) N=200

Descriptive Statistics			
Variable	Mean	Std. Deviation	N
CHATBOT	16.2900	3.05492	200
MOTIVATION	15.4650	3.66277	200

Correlations			
Variable		CHATBOT	MOTIVATION
CHATBOT	Pearson Correlation	1	.556**
	Sig. (2-tailed)		.000
	N	200	200
MOTIVATIO	Pearson Correlation	.556**	1
	Sig. (2-tailed)	.000	
	N	200	200

*(P <.05) Df=198; calculated r= .556

The result of the analysis as presented in Table 1 shows that the calculated r-value was .566 at 198 degree of freedom and a p-value of .000 at 0.05 level of significance. The p-value of .000 was lower than the

significance value of .05 (P < .05) needed to make a decision. The null hypothesis was rejected while the alternative hypothesis was accepted. This implies that chatbot significantly related to student motivation.

TABLE 2: Mean, Standard deviation and Pearson Moment Correlation coefficient between AI-powered gamification and student motivation (SPSS 22) N=200

Descriptive Statistics			
Variable	Mean	Std. Deviation	N
Gamification	16.4050	3.00769	200
MOTIVATION	15.4650	3.66277	200
Correlations			
Variable		Gamification	Motivation
AIGAME	Pearson Correlation	1	.610**
	Sig. (2-tailed)		.000
	N	200	200
MOTIVATION	Pearson Correlation	.610**	1
	Sig. (2-tailed)	.000	
	N	200	200

*(P .05) Df=198; calculated r= .610

The result of the analysis as presented in Table 2 shows that, the calculated r value was .610 at 198 degree of freedom and a p-value of .000 at 0.05 level of significance. The null hypothesis was rejected while the alternative hypothesis was accepted. This implies that AI-powered gamification is significantly related to student motivation.

Discussion of Findings

The discussion of the findings that emerged from the analysis are presented. The discussion is presented hypothesis by hypothesis.

The first hypothesis states that, There is no significant influence between Chatbot and student motivation. The result from the data analysis of hypothesis two showed that, There is significant influence between Chatbot and student motivation. Chatbots have a remarkable influence on student motivation, revolutionizing the way students engage with educational content. By providing instant and personalized assistance, chatbots create a supportive and accessible learning environment. Students often feel more at ease asking questions and seeking clarification from a virtual entity, reducing anxiety that might arise when interacting with teachers or peers. This freedom to inquire without fear of judgment encourages a proactive approach to learning and fosters a sense of curiosity and exploration.

The findings of this study aligns with a study by Xie, et al., (2021) which Investigated the impact of chatbots on student motivation, The findings indicate

that the presence of chatbots positively influences student motivation. The findings also agrees with the findings of Bixby & Ito, (2021) which stated that chatbots respond promptly and provide relevant information, students perceive them as helpful and engaging, leading to increased motivation and positive attitudes towards the learning process.

Hypothesis Two

The second hypothesis states that, There is no significant influence between AI-powered gamification and student motivation. The result from the data analysis of hypothesis three showed that, There is significant influence between AI-powered gamification and student motivation. AI-powered gamification has a profound impact on student motivation, infusing learning with elements of challenge, competition, and reward. By integrating game mechanics and artificial intelligence, educational experiences become more engaging and interactive. Students are drawn to the immersive nature of gamified content, where they embark on quests, solve puzzles, and achieve goals within a virtual environment. The AI element further enhances this engagement by adapting the difficulty level based on individual performance, ensuring a balanced level of challenge that keeps learners engrossed and invested in their progress.

The findings of this study is in line with a study conducted by Johnson et al. (2021) which investigated the impact of AI-powered gamification on student motivation and engagement, The results showed a

significant increase in student motivation, active participation, and improved learning outcomes. The findings also agree with Landers et al., (2019) which stated that the autonomy and mastery experiences provided by gamified learning environments contribute to increased motivation.

Conclusion

This study concluded that chatbots and AI powered gamification enhanced students motivation in the study of chemistry concepts.

Recommendations

Based on the findings of the study, the following recommendations were made:

1. Encourage collaboration between teachers and AI systems to leverage the strengths of both.
2. Develop AI algorithms that can adapt the content and curriculum based on students' interests, prior knowledge, and learning styles.
3. Incorporate AI technologies that can provide emotional support and facilitate social interaction among students.
4. Integrate gamification techniques and interactive elements into AI-based educational systems
5. Implement AI algorithms that can dynamically adjust the difficulty level of tasks or assessments based on students' performance.

Suggestion for Further Studies

The following suggestions were made for further studies

After three (3) years another research should be carried out on this same topic to determine if there will be any change with time. The study should be carried out using a larger sample size to promote more generalization of findings. The study should be carried out in other study areas.

A study of this nature with other AI-based systems, different from the ones used in this study should be conducted.

Reference

- Bixby, J. C., & Ito, T. A. (2021). The effects of chatbot responsiveness on student motivation, attitudes, and learning in online educational settings. *Computers in Human Behavior*, 119, 106786.
- Cooper, M. M., Caballero, M. D., Ebert-May, D., Fata-Hartley, C. L., Jardeleza, S. E., Krajcik, J. S., ... & Stains, M. (2019). Challenges and opportunities for improving science education in diverse settings: An introduction to the Special Issue. *CBE—Life Sciences Education*, 18(1), fe1.
- Csikszentmihalyi, M. (1975). Beyond boredom and anxiety: Experiencing flow in work and play. San Francisco: Jossey-Bass.
- Dicheva, D., et al. (2015). Gamification in education: A systematic mapping study. *Educational Technology & Society*, 18(3), 75-88.
- Gillani, N., Mubin, O., & Shahid, S. (2020). A Review of Design and Development of Empathic Conversational Agents. *ACM Transactions on Human-Robot Interaction*, 9(4), 1-45.
- He, W., Xu, X., Chen, Y., & Zhao, X. (2019). An AI-powered gamified assessment system for STEM education. *International Journal of Emerging Technologies in Learning (iJET)*, 14(18), 4-21.
- Hrabowski III, F. (2016). How to motivate students in science. *The Chronicle of Higher Education*. Retrieved from <https://www.chronicle.com/article/how-to-motivate-students-in-science/>
- Johnson, A., et al. (2021). Enhancing student engagement and academic performance through AI-powered gamification. *Journal of Educational Technology*, 25(2), 123-140.
- Kapoor, S. (2021). An Empirical Investigation on the Adoption of Chatbots in Customer Service. In *Handbook of Research on Emerging Business Models and Managerial Strategies in the Nonprofit Sector* (194-209). IGI Global.
- Kapp, K. M. (2012). *The gamification of learning and instruction: Game-based methods and strategies for training and education*. Wiley.
- Landers, R. N., et al. (2019). Creating engaging learning in gamified online courses: Testing the effects of different reward types on student outcomes. *Journal of Educational Psychology*, 111(1), 130-149.
- Landers, R. N., et al. (2020). A meta-analysis of gamified e-learning: Empirical evidence from diverse contexts. *Educational Psychology Review*, 32(4), 1005-1038.
- Nja, C.O., Idiege, J.K., Uwe, U.E. Meremikwu, A.N., Ekon, E.E., Erim, C.M., Ukah, J.U., Eyo, E.O., Anari, M.I., Cornelius-Ukpe, B.U. (2023). Adoption of artificial intelligence in science teaching: From the vantage point of the African science teachers. *Smart Learning Environments*. 10 (1) 1-19

- Pappas, C. (2020). 4 Benefits of Chatbots in Personalized eLearning. eLearning Industry. Retrieved from <https://elearningindustry.com/benefits-of-chatbots-in-personalized-elearning>
- Romero-Hall, E., Kimmons, R., & Veletsianos, G. (2020). A preliminary examination of chatbots in first-year online and face-to-face composition courses: Assessing student experiences, perceptions, and writing-related motivations. **Computers & Education**, 145, 103733.
- Ryan, R. M., & Deci, E. L. (2013). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American Psychologist*, 55(1), 68-78.
- Sarantakos, S. (2013). *Social research* (4thed.). Palgrave Macmillan.
- Shrivastava, Anurag, Suji Prasad, S. J., Yeruva, Ajay Reddy, Mani, P., Nagpal, Pooja, & Chaturvedi, Abhay. (2023). IoT Based RFID Attendance Monitoring System of Students using Arduino ESP8266 & Adafruit. *Io on Defined Area. Cybernetics and Systems*, 1-12.
- Shute, V. J., Ke, F., & Wang, L. (2016). Assessment and learning analytics using artificial intelligence. *Handbook of Research on Educational Communications and Technology*, 1, 229-242.
- Smith, R., & Brown, L. (2022). AI-powered gamification: Longitudinal study on retention and knowledge acquisition. *International Journal of Educational Technology*, 32(4), 567-584
- Sreenivasu, S. V. N., Sathesh Kumar, T., Bin Hussain, Omer, Yeruva, Ajay Reddy, Kabat, SubashRanjan, & Chaturvedi, Abhay. (2023). Cloud Based Electric Vehicle's Temperature Monitoring System Using IOT. *Cybernetics and Systems*, 1-16
- Sridhar, K., Yeruva, Ajay Reddy, Renjith, P. N., Dixit, Asmita, Jamshed, Aatif, & Rastogi, Ravi. (2022). Enhanced Machine learning 9 algorithms Lightweight Ensemble Classification of Normal versus Leukemic Cel. *Journal of Pharmaceutical Negative Results*, 496-505.
- Svinicki, M. (2014). *Learning and Motivation Strategies: Your Guide to Success* (2nded.). Pearson.
- Tang, J., Li, Y., Li, Y., & Li, L. (2019). Artificial intelligence in education: A review. *IEEE Access*, 7, 10005-10020.
- Weiss, P. (2019). Why study chemistry? *Chemical & Engineering News*, 97(15), 3.
- Xie, X., Diao, Y., Xu, J., & Liang, E. (2021). The impact of chatbots on student motivation in online learning. **Computers in Human Behavior**, 118, 106675