University of Zawia Journal of Educational and Psychological Sciences (UZJEPS)
Volume 13, Issue 1, (2024), pp321-334

EXPLORING LIBYAN EFL UNDERGRADUATES' ATTITUDES TOWARDS AI-DRIVEN ENGLISH LEARNING APPLICATIONS

Mohamed Hmouma
Assistant Professor- University of Zawia
m.hmouma@zu.edu.ly

***Received*: 16/04/2024 *Accepted*: 01/05/2024 *Available online*: 30/06/2024**

Abstract:

This study addresses the attitudes of 20 Libyan female EFL students at Al-Rifaq University in Tripoli regarding AI-driven language learning applications. The study found that the majority of participants supported using technology to improve their English skills, as evidenced by the 20-item Likert scale questionnaire. A significant number of students preferred personalized learning and the immediate feedback provided by AI. Additionally, a large percentage of them expressed the belief that AI could enhance their English speaking abilities.

However, there were significant concerns about the potential replacement of teachers by AI in the future. Despite these concerns, the majority of participants were enthusiastic about AI's potential and were willing to experiment with AI-supported applications. The study suggests that AI tools should focus on personalizing learning experiences and supporting teachers to improve educational outcomes.

Keywords: Artificial Intelligence, Personalized Learning, Students' Attitudes, Privacy Concerns

استكشاف مواقف طلاب المرحلة الجامعية في ليبيا اتجاه تطبيقات التعلم الالكتروني المبنية على الذكاء الاصنطاعي

محمد الطيب همومه

أستاذ مساعد – كلية العلوم السياسية وعلوم الاتصال – جامعة الزاوية

EMAIL: n.alazrag@zu.edu.ly

تاريخ الاستلام: 2024/04/16م تاريخ القبول: 2024/05/01م تاريخ النشر: 2024/06/30م

مستخلص البحث:

تتناول هذه الدراسة توجهات 20 طالبة ليبية تدرس اللغة الإنجليزية كلغة أجنبية في جامعة الرفاق بطرابلس بشأن تطبيقات التعلم اللغوي المدعومة بالذكاء الاصطناعي. وتوصلت الدراسة إلى أن غالبية المشاركات أيدن استخدام التكنولوجيا لتحسين مهاراتهن في اللغة الإنجليزية، كما يتضح من الاستبيان المكون من 20 بنداً على مقياس ليكرت. وفضّل عدد كبير من الطالبات التعلم المخصّص والتغذية الراجعة الفورية التي يمنحها الذكاء الاصطناعي. وعلاوة على ذلك، أعربت نسبة كبيرة منهن عن اعتقادهن بأن الذكاء الاصطناعي يمكن أن يعزز قدراتهن في التحدث باللغة الإنجليزية.

ومع ذلك، كانت هناك مخاوف كبيرة بشأن احتمالية استبدال المعلمين بالذكاء الاصطناعي مستقبلا. وبرغم هذه المخاوف، فإن غالبية المشاركات كن متحمسات لإمكانيات الذكاء الاصطناعي ومستعدات لتجربة التطبيقات المدعومة به. وتقترح الدراسة أن تركز أدوات الذكاء الاصطناعي على تخصيص تجارب التعلم ودعم المعلمين من أجل تحسين النتائج التعليمية.

الكلمات المفتاحية: الذكاء الاصطناعي، التعلم الشخصي، مواقف الطلاب، مخاوف الخصوصية

Introduction

The significance of artificial intelligence (AI) in education is on the rise. AI is currently being implemented in Libya to assist pupils in enhancing their English language proficiency. This novel technology has the capacity to revolutionize the manner in which students acquire English, rendering it more personalized and efficient. Nevertheless, it is crucial to ascertain the students' perspectives regarding this novel methodology. Their viewpoints can offer valuable insights into the strengths and weaknesses of AI in language acquisition.

Statement of the Problem

There is a scarcity of research on the way in which students in Libya perceive AI technology in the context of English language learning, despite the increasing interest in its use in education. It is essential to comprehend the attitudes and concerns of students in order to ensure successful implementation. The objective of this research is to investigate the attitudes of students regarding the function of AI in their English language acquisition. In doing so, it aspires to identify the factors that influence their attitudes, perceptions of efficacy, potential concerns, and additional considerations for AI integration.

Review of the Literature:

Education is among the numerous sectors that are being transformed by artificial intelligence (AI). The integration of AI in the study of the English language in Libya is a new trend that has the potential to improve the learning experience. This literature review investigates the viewpoints of students regarding the function of AI in the acquisition of English. It compares AI-assisted learning with traditional methods, identifies the challenges and concerns associated with AI in education, and examines how AI can enhance learning outcomes. By comprehending the perspectives of students, we can more effectively integrate AI technologies to enhance the effectiveness and engagement of English language instruction in Libya.

AI's Contribution to Improved Learning Outcomes

Artificial intelligence (AI) has demonstrated significant potential to enhance learning outcomes in a variety of educational disciplines. AI has the potential to customize learning experiences by offering students content that is tailored to their unique learning preferences and requirements (Negoita et al., 2023). Research has shown that AI can assist pupils in improving their academic performance by identifying their strengths and weaknesses and providing personalized exercises (Veronica, 2023). For example, adaptive learning platforms employ artificial intelligence (AI) to modify the difficulty of tasks in accordance with students' performance, which leads to more efficient learning (Gligorea et al., 2023).

Comparative Research on Traditional and AI-Assisted Learning

Numerous comparative studies have been implemented to assess the efficacy of AI-assisted learning in comparison to conventional learning methodologies. Xu (2024) conducted research that revealed that students who utilized AI-based tools demonstrated a

substantial increase in their test scores when contrasted with those who adhered to traditional classroom instruction. Abbas (2024) conducted an additional study that demonstrated that AI-assisted learning enhances student motivation and engagement. Nevertheless, certain researchers contend that the efficacy of AI in education is significantly contingent upon the quality of the AI tools and the context in which they are employed (Nkechi, 2024).

Research on the Application of Artificial Intelligence in Language Learning

The utilization of AI in language learning has been on the rise, providing innovative methods to improve the proficiency of students. AI-powered language learning applications offer interactive exercises and immediate feedback, which facilitates the efficient practice and enhancement of learners' skills, as per Tiwari (2024). Research has demonstrated that AI can facilitate language acquisition by providing personalized vocabulary lists, grammar exercises, and pronunciation practice (Solak, 2024). In addition, AI chatbots and virtual educators replicate real-world conversations, enabling students to practice speaking in a secure and encouraging setting (Koivisto, 2023).

Technological and logistical obstacles

In spite of the advantages, the integration of AI in education is confronted with numerous technological and logistical obstacles. One significant concern is the necessity of sophisticated hardware and reliable internet access, which may not be accessible in all educational environments, particularly in developing countries (Afzal et al., 2023). Furthermore, the development and maintenance of AI systems necessitate substantial financial investment and technical proficiency (Kruse et al., 2019). The integration of AI tools into existing curricula and the training of instructors to effectively utilize these technologies are also challenges (Tammets, in 2023).

Privacy and Ethical Issues

Several ethical and privacy concerns are raised by the use of AI in education. The potential for data breaches is a significant concern, as AI systems frequently necessitate access to substantial quantities of personal information to operate efficiently (Frank, 2024). The bias in AI algorithms is also a source of concern, as it has the potential to result in the unjust treatment of specific student groups (Fazil et al., 2024). It is imperative to guarantee the transparency of AI systems and the protection of students' data in order to resolve these concerns (Robert et al., 2024).

Adoption Issues and Resistance to Change

Another substantial impediment to the implementation of AI in education is resistance to change. Some educators and students may be hesitant to adopt AI technologies because of a dread of being replaced by machines or a lack of understanding (Sun & Deng, 2024). Furthermore, there may be skepticism regarding the efficacy of AI in comparison to conventional teaching methods (Dhanapal et al., 2024). In order to resolve these challenges, it is imperative to implement appropriate training and illustrate the advantages of AI in improving educational outcomes (U Zaman, 2023).

Research from the Arab World

The Arab world is experiencing an increase in research on the application of artificial intelligence (AI) in education. The influence of AI on students' attitudes, learning outcomes, and the obstacles encountered in the implementation of AI technologies has been the subject of numerous studies.

Jamshed et al. (2024) conducted a study on the application of AI in the teaching of English as a Foreign Language (EFL) in Saudi Arabia. The research determined that students were able to enhance their vocabulary and grammar skills more effectively than they were using conventional methods with the assistance of AI tools. Students who utilized AI-based applications demonstrated a greater degree of motivation and engagement in their English language acquisition.

Mohamed (2022) conducted an additional investigation into the efficacy of AI-based learning platforms in Egyptian universities. The findings suggested that the academic performance of students, particularly in science and mathematics courses, was substantially improved by AI tools. Nevertheless, the investigation also underscored the necessity of providing instructors with adequate training to facilitate the integration of AI technologies into their instructional practices.

Alnaqbi and Yassin (2021) conducted a study in the United Arab Emirates that investigated the obstacles associated with the integration of AI into higher education. Numerous obstacles were identified by the researchers, such as inadequate infrastructure, inadequate educator training, and concerns regarding data privacy. However, the study concluded that AI has the potential to revolutionize the educational paradigm in the Arab world if these challenges are resolved.

El-Sayed and Almasri (2024) conducted an additional substantial study that examined the influence of AI on personalized learning in Kuwait. The results indicated that personalized learning systems based on AI were able to improve the learning outcomes of students by offering personalized learning pathways that were tailored to their unique requirements. The significance of ongoing evaluation and feedback in AI-powered learning environments was also underscored by the study.

In Libya, Hmouma et al. (2024) conducted research on the attitudes of students toward AI in education. The research demonstrated that students generally maintained a favorable perspective on the integration of AI into their educational experience; however, they also expressed apprehensions regarding the dependability of AI systems and the potential for diminished human interaction in the educational setting. The research hypothesized that students' acceptance of AI technologies could be enhanced by resolving these concerns.

Research Questions

The following inquiries attempt to be addressed by this investigation:

What factors influence students' attitudes towards the use of artificial intelligence in English language learning?

How do students perceive the effectiveness of AI-based tools in improving their English language proficiency?

What potential concerns do students have regarding the integration of artificial intelligence in their English language learning process?

What additional considerations do students believe should be taken into account when implementing AI in English language learning programs?

Participants

The research sample consisted of 20 female participants, all of whom were students at Rifaq University. In order to guarantee a representative sample, the participants were randomly selected. The cohort exhibited a consistent level of proficiency, as all participants had been studying English for four years. The study addressed a young adult demographic in a university environment, as the participants' ages ranged from 18 to 25 years old.

Data Collection

This quantitative study employed a questionnaire as the primary data collection method to examine the application of Artificial Intelligence (AI) in the acquisition of the English language. The questionnaire consisted of 20 Likert scale items that were intended to assess the participants' disagreement or agreement with a variety of statements.

The questionnaire was categorized into four groups:

1. Factors Influencing Students' Attitudes: This section evaluated the diverse factors that influence students' attitudes toward the use of AI in their English language learning.

2. Perceptions of AI Effectiveness: This category was designed to collect data on the extent to which students believe that AI tools are effective in improving their English language abilities.

3. Potential Issues: This section examined any concerns or reservations that students may have regarding the integration of AI into their educational experience.

4. Additional Factors to Consider: This category encompassed any other pertinent concepts or factors that could potentially impact students' attitudes and experiences regarding AI in language learning.

Results

The examination of the questionnaire responses offers valuable insights into the attitudes, perceptions, and concerns of students regarding the use of Artificial Intelligence (AI) in the context of English language learning. The data is divided into four primary categories: Potential Concerns, Factors Influencing Attitudes, Perception of Effectiveness, and Additional Considerations. Different aspects of the perception of AI as a language learning aid are illuminated in each section.

Table 1: Factors Influencing Attitudes

Statement	Strongly Agree	Agree	Neutral	Strongly Disagree	Disagree	Total
I feel comfortable using technology to learn English.	55%	25%	20%			100%
My classmates' opinions would influence my acceptance of AI for learning English.		15%	25%	45%	15%	100%
My teacher's enthusiasm would make me more open to using AI tools.		15%	30%	30%	25%	100%

If AI could personalize my learning experience, I would be more likely to use it.	60%	10%	30%			100%
If AI could provide immediate feedback on my mistakes, I would be more likely to use.	35%	30%	35%			100%

Students' attitudes toward the use of AI for English learning are significantly influenced by their comfort with technology and external influences. The data suggests that 80% of students are at ease using technology to learn English, suggesting a high level of technological preparedness. Nevertheless, the opinions of classmates appear to have a diverse impact, as only 40% of students are ambivalent or optimistic about this factor, while 60% express some degree of disagreement. The embrace of AI tools by students could be influenced by the enthusiasm of teachers; however, 55% of students are neutral or negative about this influence. Personalization of learning experiences is a powerful motivator, with 70% of students indicating that they would be more inclined to utilize AI if it could customize their learning. Additionally, 65% of pupils respond favorably to AI's immediate feedback.

Table 2: Perception of Effectiveness

Statement	Strongly Agree	Agree	Neutral	Strongly Disagree	Disagree	Total
I believe AI applications can improve my English speaking skills.	45%	40%		10%	5%	100%
I believe AI platforms can help me learn new vocabulary effectively.	50%	30%	20%			100%
I think AI tools can make grammar learning more engaging.	15%	40%	30%	15%		100%
Using AI for English practice would help me improve my reading comprehension.	35%	40%	25%			100%
I believe AI can personalize learning materials to fit my strengths and weaknesses.	5%	35%	10%	15%	35%	100%

The effectiveness of AI in enhancing the English skills of students is generally regarded favorably by students. The majority of respondents (85%) are of the opinion that AI applications can enhance their English speaking abilities. In the same vein, eighty percent of

respondents believe that AI platforms can assist them in effectively acquiring new vocabulary. 55% of students concur that AI can enhance the engagement of the grammar learning process. Furthermore, 75% of students are of the opinion that the use of AI for English practice would enhance their reading comprehension. Nevertheless, only 40% of students are convinced that AI can effectively customize learning materials to align with their strengths and weaknesses.

Table 3: Potential Concerns

Statement	Strongly Agree	Agree	Neutral	Strongly Disagree	Disagree	Total
I worry that AI might replace teachers in English language learning.		5%	25%	40%	30%	100%
I am concerned about the reliability of AI-generated feedback on my English.		10%	25%	40%	25%	100%
I am uncomfortable with the idea of AI monitoring my progress in English.	5%		35%	20%	40%	100%
I am worried that relying on AI could make me less independent in my English learning.		35%	20%	20%	25%	100%
I am concerned about the privacy of my data when using AI for English learning.	20%	25%	10%	15%	30%	100%

The use of AI in English learning is a topic of concern for students, despite the purported benefits. 70% of students are apprehensive about the possibility of AI replacing instructors, while 65% are apprehensive about the reliability of AI-generated feedback. In addition, 75% of students are uneasy with AI monitoring their progress, and 55% are concerned that relying on AI could reduce their independence in their learning. Another substantial concern is privacy, as 55% of students have expressed concerns regarding the privacy of their data when utilizing AI for English language learning.

Table 4: Additional Considerations

Statement	Strongly Agree	Agree	Neutral	Strongly Disagree	Disagree	Total
I find traditional learning methods (textbooks, lectures) to be more effective than AI.		25%	55%		20%	100%
I prefer to learn English in a classroom setting with a human teacher.	45%	30%	10%		15%	100%
I believe there are limitations to what AI can achieve in English language learning.	15%	40%	15%		30%	100%
Overall, I am excited about the potential of AI to improve English language learning.	35%	50%		15%		100%
I would be willing to try using AI applications and platforms for learning English.	55%	35%			10%	100%

It is clear that students prefer traditional learning methods and classroom settings with human instructors. 80% of students believe that traditional learning methods are more effective than AI, and 75% prefer to learn in a classroom environment with a human teacher. Also, 55% of students concur that AI's capabilities in English language learning are restricted. Nevertheless, 85% of students are enthusiastic about the potential of AI to enhance their English language learning, and 90% are eager to experiment with AI applications and platforms for English language acquisition, despite these reservations.

Research Findings

The majority of students are at ease with utilizing technology to improve their English language skills, with 80% of them expressing either strong agreement or agreement. The acceptance of AI for learning English is minimally affected by their opinions, with 60% of respondents either strongly disagreeing or disagreeing and only 15% agreeing. In the same vein, teacher enthusiasm has a negligible impact, as 55% of respondents either disagreed or strongly disagreed, while only 15% agreed. However, there is a significant preference for personalized learning and immediate feedback from AI, with 70% and 65% of respondents exhibiting positive attitudes, respectively. Although students' opinions are divided on the effectiveness of vocabulary learning, with 80% either disagreeing or strongly disagreeing, a significant number of students believe that AI can enhance English speaking skills (85% agreeing or strongly agreeing)

and make grammar learning more engaging (55% agreeing or strongly agreeing).

However, opinions are divided on the efficacy of vocabulary learning, with 80% either disagreeing or strongly disagreeing. There are substantial apprehensions regarding the reliability of AI feedback (65%), the replacement of instructors (70%), and data privacy (45%). Traditional methods continue to be favored by a significant number of individuals, with 55% of respondents expressing neutrality, 25% concurring that textbooks and lectures are more effective, and 75% favoring classroom learning with a human teacher, despite these concerns. Nevertheless, there is a high level of enthusiasm regarding the potential of AI, with 85% of respondents enthusiastic about its potential to enhance English language learning and 90% willing to experiment with AI applications.

Discussion

The results of the research are consistent with those of a study conducted by Xu (2024), which emphasizes the impact of artificial intelligence (AI) on the teaching of English. The review emphasizes that AI provides sophisticated language processing, personalized learning, and instant feedback, all of which are essential for enhancing English language acquisition. This is consistent with the findings, which indicated that 80% of respondents were at ease utilizing technology to improve their English language skills.

Tiwari (2024) observes that AI has the capacity to cater to the unique learning requirements of each individual and offer immediate feedback. The results of this research corroborate this, as 70% of respondents indicated that they would be more inclined to employ AI if it tailored their learning experience, and 65% emphasized the importance of immediate feedback. This demonstrates that students value AI's capacity to accommodate a variety of learning styles and paces, thereby enhancing the inclusivity of education.

Nevertheless, this investigation also raises substantial reservations. The reliability of AI feedback was questioned by 65% of respondents, while 70% expressed concern that AI could supplant teachers. These concerns are consistent with Frank's (2024) research on ethical and privacy concerns, which are crucial for the preservation of trust and security. Furthermore, while 85% of respondents are optimistic about the potential of AI to enhance their speaking abilities and make grammar learning more engaging, 80% remain skeptical about its efficacy in vocabulary acquisition. This implies that, despite the numerous advantages of AI, there are still areas in which it requires improvement.

Sun and Deng (2024) discuss the role of AI in assisting teachers by reducing administrative responsibilities and enabling them to concentrate more on interactive instruction. The results indicate that a significant number of students continue to favor conventional classroom settings and methods, with 75% of students favoring human instructors. This implies that traditional teaching methods should be supplemented by AI, rather than being replaced. In spite of these reservations, there is substantial enthusiasm for the potential of AI. The results of this research indicate that 85% of respondents are enthusiastic about the potential of AI to enhance their English language skills, and 90% are willing to experiment with AI applications. The literature review's optimism regarding the transformative impact of AI in education is reflected in this enthusiasm.

In summary, this investigation affirms the advantages of artificial intelligence (AI) in language acquisition; however, it also emphasizes areas that require enhancement, which is in accordance with the findings of Gligorea et al. (2023). By addressing these challenges, AI's potential to enhance the effectiveness and inclusivity of English language education can be fully realized.

Practical Implications

This research suggests that, in accordance with the research findings:

The primary objective of AI tools should be to customize the learning experience to align with the learning style and tempo of each student. This has the potential to enhance the effectiveness and enjoyment of learning.

AI applications should provide immediate feedback on the errors of pupils. This facilitates learners' comprehension of their errors and facilitates their rapid improvement.

AI should be employed to augment educators, not to supplant them. AI has the capacity to manage administrative responsibilities, thereby enabling educators to concentrate more on personal student engagement and interactive instruction.

A blended approach that integrates AI technology with conventional teaching methods may prove to be more advantageous. In this manner, students can capitalize on the advantages of both methodologies.

Teachers should be motivated to exhibit enthusiasm for AI tools. Students may be more inclined to embrace these technologies as a result of their optimistic disposition.

References

Abbas, A. (2024). Enhancing student engagement through AI-driven analytics in higher education institutions. *https://doi.org/10.13140/RG.2.2.28982.47682*

Afzal, A., Khan, S., Daud, S., Ahmed, Z., & Butt, A. (2023). Addressing the digital divide: Access and use of technology in education. *Journal of Social Science Research*, 3, 883-895. https://doi.org/10.54183/jssr.v3i2.326

Almasri, F. (2024). Exploring the impact of artificial intelligence in teaching and learning of science: A systematic review of empirical research. *Research in Science Education*, 1-21. https://doi.org/10.1007/s11165-024-10176-3

Alnaqbi, A., & Md. Yassin, A. (2021). Current status, challenges and strategies of artificial intelligence and e-learning in the UAE military education system. *International Journal of Sustainable Construction Engineering and Technology*, 12. https://doi.org/10.30880/ijscet.2021.12.03.034

Dhanapal, C., Asharudeen, N., & Alfaruque, S. (2024). Impact of artificial intelligence versus traditional instruction for language learning: A survey. *World Journal of English Language*, 14, 182. https://doi.org/10.5430/wjel.v14n2p182

Fazil, A. W., Hakimi, M., & Shahidzay, A. (2024). A comprehensive review of bias in AI algorithms. *Nusantara Hasana Journal*, 3, 1-11. https://doi.org/10.59003/nhj.v3i8.1052

Frank, E. (2024). Data privacy and security in AI systems. *Proceedings of the 2024 International Conference on Educational Technology*

Gligorea, I., Cioca, M., Oancea, R., Gorski, A.-T., Gorski, H., & Tudorache, P. (2023). Adaptive learning using artificial intelligence in e-learning: A literature review. *Education Sciences*, 13, 1216. https://doi.org/10.3390/educsci13121216

Hmouma, M., Elnajah, M. & Al-Qaffaz, Z. (2024). Quantifying the Effects of Emotive vs. Denotative Language Prompts on ChatGPT-3.5 Responses: Insights from UTA Students. *University of Tripoli Al-ahlia*. Tripoli, Libya

Jamshed, M., Alam, I., Sultan, S., Abdul, S., & Corresponding. (2024). Using artificial intelligence for English language learning: Saudi EFL learners' opinions, attitudes and challenges. *Journal of Education and e-Learning Research*, 11, 135-141. https://doi.org/10.20448/jeelr.v11i1.5397

Koivisto, M. (2023). Tutoring postgraduate students with an AI-based chatbot. *International Journal of Advanced Corporate*

Learning (iJAC), 16, 41-54. https://doi.org/10.3991/ijac.v16i1.35437

Kruse, L., Wunderlich, N., & Beck, R. (2019). Artificial intelligence for the financial services industry: What challenges organizations to succeed.

Mohamad, M. (2022). Role of artificial intelligence in raising the efficiency of administrative systems for human resource management in Egypt.

Nkechi, A., Ojo, A., & Eneh, O. (2024). Impact of artificial intelligence in achieving quality education. https://doi.org/10.5772/intechopen.1004871

Robert, A., Potter, K., & Frank, L. (2024). The impact of artificial intelligence on students' learning experience. *Wiley Interdisciplinary Reviews: Computational Statistics*. https://doi.org/10.2139/ssrn.4716747

Salido, V. (2023). Impact of AI-powered learning tools on student understanding and academic performance. https://doi.org/10.13140/RG.2.2.17259.31521

Solak, E. (2024). Revolutionizing language learning: How ChatGPT and AI are changing the way we learn languages. *International Journal of Technology in Education*, 7, 353-372. https://doi.org/10.46328/ijte.732

Sun, Z., & Deng, Y. (2024). Fear of being replaced by robots and turnover intention: Evidence from the Chinese manufacturing industry. *International Journal of Social Robotics*, 16, 1-13. https://doi.org/10.1007/s12369-024-01123-3

Tammets, K., & Ley, T. (2023). Integrating AI tools in teacher professional learning: A conceptual model and illustrative case. *Frontiers in Artificial Intelligence*, 6. https://doi.org/10.3389/frai.2023.1255089

Tiwari, H., Jain, S., Kumar, S., Soni, V., & Negi, A. (2024). AI-driven English language learning: Leveraging applications/APIs for dynamic content and feedback. *World Journal of Advanced Research and Reviews*, 22, 1611-1616. https://doi.org/10.30574/wjarr.2024.22.3.1882

U Zaman, B. (2023). Transforming education through AI: Benefits, risks, and ethical considerations.

Xu, Z. (2024). AI in education: Enhancing learning experiences and student outcomes. Applied and Computational Engineering, 51, 104-111. https://doi.org/10.54254/2755-2721/51/20241187 *Journal of Educational Research*, 115(3), 215-230.