PRESERVICE TEACHERS' ACHIEVEMENT AND RETENTION OF PROBLEM-SOLVING SKILLS IN PROGRAMMING: A CHATGPT-BASED FLIPPED CLASSROOM ANALYSIS

Rayner Tangkui

Department of Planning, Research and Innovation, Institute of Teacher Education, Keningau Campus, Malaysia
rayner@ipgm.edu.my
Received: October 1, 2024 | Accepted: October 30, 2024 | Published: November 13, 2024
DOI: https://doi.org/10.51200/ijelp.v7i1.5535

ABSTRACT

This pre-experimental study, utilizing a one-group pretest and posttest design, aims to investigate the effects of a ChatGPT-based flipped classroom approach on preservice teachers' achievement and retention of problem-solving skills in programming. The study sample comprised 33 preservice teachers (one intact class) from an Institute of Teacher Education Malaysia in Sabah, Malaysia, selected through cluster sampling. A Computer Programming Achievement Test (CPAT) were used as the research instrument, which were administered during pretest, posttest and delayed posttest. Data analysis was conducted using one-way repeated measures ANOVA. The results showed an increased in problem-solving skills from the pretest (M=16.84, SD=8.35) to the posttest (M=31.25, SD=13.25), indicating significant improvement in preservice' teachers achievement. Additionally, retention of problem-solving skills was evident, with the delayed posttest scores (M=24.43, SD=6.68) significantly higher than the pretest scores, though slightly lower than the posttest scores, suggesting some decay over time but overall retention of the skills learned. This research suggests that integrating artificial intelligence (AI) tools, such as ChatGPT, in educational setting can lead to substantial improvements in learning outcomes, which provides valuable resource for educators aiming to foster advanced problem-solving abilities in their students

Keyword(s): *Flipped classroom, artificial intelligence, ChatGPT, programming, teaching and learning*

INTRODUCTION

Digital technology has become an important component of modern education, especially in fostering an interactive and dynamic learning environment (George & Reddy, 2024) which is able to improve students' performance, improve the effectiveness of teaching and learnin and overcome the shortcomings of conventional teaching methods (Wang et al., 2024). At the same time, the presence of artificial intelligence applications such as ChatGPT has revolutionized and transformed the world of education (Bouschery et al., 2023; Yeruva, 2023) by triggering new learning methods that challenge conventional methods (Sarwar et al., 2024).

Problem Statement

Programming is a subject and skill that has been given priority in the national education system since 2016 (Mazlee Malik, 2019) since programming is able to meet the needs of the 21st century job industry as well as Industry Revolution 4.0 (IR 4.0) which requires a workforce with computational thinking skills such as critical thinking and problem solving (Salleh Hudin, 2024) as well as high-level thinking skills (Voon et al., 2022). However, the achievement of Malaysian students in programming is still at a less encouraging level. A study by Quah et al. (2023) found that community college students obtained low scores in the programming test for the Basic Programming subject which involves theoretical and practical evaluation, where the analysis of the Learning Outcomes Course 1 (HPK 1) of the subject showed that students did not reach a score of 80% for two semester. The study of Abdul Rahman et al. (2024) also found that the number of Universiti Teknologi Mara (UiTM) students who failed in the exam involving the Fundamentals of Computerized Problem Solving course with the course code CSC415 containing programming elements was high, i.e. 35.7%. A study by Maskur et al. (2020) also showed that the achievement score of the programming course for polytechnic students was at a moderate level where of the 76 students who sat the test for the course, as many as 62% of the students obtained a B grade, i.e. scored in the range of 64 to 74 percent, with 10% students obtained a grade of C. Furthermore, Yusof et al. (2023) also found that the achievement of Malaysian students in programming was at a low to moderate level.

With that, there is a need to apply teaching and learning strategies that are able to improve the skills and achievement of students in programming considering that the achievement of students who are at a less satisfactory level in programming is due to weaknesses in the implementation of the teaching and learning of programming by teachers (Yusof et al., 2023). In addition, there is a need to improve the skills and achievements of trainee teachers in programming since trainee teachers also experience difficulties in mastering programming concepts and skills (Gökoğlu & Kılıç, 2023).

Research Objectives

The objectives of this study are to identify the effectiveness of ChatGPT-based flipped classroom in enhancing achievement and facilitating the retention of problem-solving skills among preservice teachers in programming.

Research Questions

Based on the objectives of the study, the research questions are : i) Does ChatGPT-based flipped classroom method affect the achievement of preservice teachers in programming compared to conventional methods? and ii) Does ChatGPT-based flipped classroom method facilitates the retention of problem-solving skills among preservice teachers in programming?

Research Hypothesis

$H_0$1: There is no significant difference between the mean scores of the pretest, posttest and delayed posttest of preservice teachers who were taught using ChatGPT-based flipped classroom involving the achievement in programming

$H_0$2: There is no significant difference between the mean scores of the pretest, posttest and delayed posttest of preservice teachers who were taught using ChatGPT-based flipped classroom involving the retention of problem-solving skills in programming

LITERATURE REVIEW

Flipped classroom is an instructional method that "flips" the conventional learning environment, where students prepare in advance before attending class by exploring, understanding and learning a topic through self-directed study pre-class. The in-class instructional sessions are then filled with activities designed to strengthen students' understanding and skills related to the topic (Gutierrez-Gonzalez et al., 2023). Students participate in numerous activities promoting active learning, such as discussions, case studies, simulations, hands-on exercises and group projects instead of passively taking in lectures (Ha et al., 2019). According to Güler et al. (2023), the flipped classroom method promotes active learning among students as it fosters student-centered instructional sessions that provide a learning environment that supports autonomy. Autonomy in a flipped classroom refers to the freedom and responsibility given to students to manage and control their own learning processes (Ettien & Touré, 2023). Teachers, on the other hand, do not need to spend much time explaining the topic to be learned by students, but instead, use the in-class sessions to focus on activities that can reinforce and enhance students' understanding and knowledge of the topic. The teacher's role in a flipped classroom changes from that of the single source of knowledge to that of a facilitator or guide, fostering an encouraging and engaging learning environment that enable dialogues, offer feedback and promote greater comprehension of the material (Al-Samarraie et al., 2020). At the same time, the adoption of instructional videos as pre-class learning materials is a widespread pedagogical practice in a flipped classroom environment, also known ad video-based flipped learning (Liao & Wu, 2023; Yu & Gao, 2022). However, Mennega and Mawela (2024) found that instructional videos may not provide immediate explanations or feedback if students encounter any questions or issues during self-directed learning, and may not sufficiently facilitate personalized learning. The content of the instructional videos is limited and depends solely on what the teacher provides. Therefore, there is a need to explore the potential of ChatGPT as an artificial intelligence (AI) technology to enhance the implementation of the flipped classroom method, especially to address the limitations of using instructional videos in a flipped classroom environment.

ChatGPT, which stands for Chat Generative Pre-trained Transformer, is a language model developed by OpenAI that uses AI technology to understand and generate text responses based on input provided by users (Roumeliotis & Tselikas, 2023). A language model refers to a program designed to analyze, understand, generate and manipulate human language automatically. This program uses natural language processing (NLP) and machine learning technology to analyze large amounts of human-generated data, such as text and speech, enabling it to understand and respond to the data it receives. Natural language processing allows the program to read and understand natural language input, which enables humans to interact with machines using natural language. ChatGPT is a generative a AI technology, which is a form of AI that can produce content such as text, images, audio and video. ChatGPT works by processing user text input and generating relevant responses using machine learning analysis, particularly through deep learning modeling (Jo & Park, 2024). ChatGPT can generate responses in various formats, including short answers, long essays, and dialogue-based interactions (OpenAI, 2023) using human-like text. This ability has enable ChatGPT to facilitate multiple functions in the workplace (Orrù et al., 2023) such as drafting content, provides answers to queries and aids in brainstorming sessions (Verma,

2023) and this has become evident in the field of education. The use of ChatGPT in education has generated widespread interest and attention due to its potential to enrich students' learning experiences (Rudolph et al., 2023). ChatGPT not only assists in preparing assessments, generating essays, and translating languages but is also capable of answering a wide range of questions, summarizing texts and interacting with users as a peer. However, more in-depth empirical studies are needed on the integration of ChatGPT in flipped classrooms (Dung, 2024), as current research on its impact on learning outcomes are still limited, particularly in the context of computer science and programming education (Keong & JiMei, 2024).

The Digital Education Policy, launched by the Malaysian Minister of Education, Fadhlina Sidek, on November 28th, 2023, is the Ministry of Education's (MOE) proactive initiative which aims to guide all stakeholders in navigating the digital era, recognizing that today's teaching and learning environment is driven by digital literacy (Bahagian Sumber dan Teknologi Pendidikan, 2023). According to Salleh Hudin (2024), the teaching and learning of programming, which is a form of digital literacy, is gaining increased attention, particularly at the primary school level. This shift in focus aligns with the demands of the Fourth Industrial Revolution of Industry 4.0 as well as the widespread influence of AI in daily life. The ability to master programming is essential for students to enhance their digital literacy skills needed to navigate the challenges of the 21st century, particularly among Malaysian students as studies by Yusriza Mohd Yusof et al. (2021), Quah et al. (2023), Abdul Rahman et al. (2024), Maskur et al. (2020) and Yusof et al. (2023) clearly shows that Malaysian students struggle to master programming. At the same time, the challenges faced by preservice teachers in mastering the concepts and skills of programming remains underexplored. Therefore, this study is necessary to identify the effectiveness of the ChatGPT-based flipped classroom method in addressing the challenges faced by preservice teachers in programming especially in regards to achievement and retention of problem-solving skills.

The teaching and learning of programming has become a priority across many countries, driven by the need to prepare students for a future where digital literacy has become essential. Programming is not only a technical skill but also a means of developing problem-solving abilities, logical thinking and creativity. Guzdial & Shreiner (2021) emphasizes that the inclusion of programming in K-12 education is crucial to foster computational thinking, a skill set that is necessary for success in a variety of modern professions. For preservice teachers, achieving proficiency in programming is not just about understanding how to write code; it is about developing the ability to teach these concepts in a way that is accessible and engaging for students.

As educational systems worldwide place a growing emphasis on STEM (Science, Technology, Engineering and Mathematics) education, the ability of teachers to achieve competency in programming is essential. A solid achievement in programming among teachers has a direct impact on their teaching effectiveness as teachers who are proficient in programming are more confident in their ability to deliver content, design meaningful learning experiences and support students in overcoming challenges. In regards to preservice teachers, although Erol and Kurt (2017) stated that achievement in programming among preservice teachers lead to improved effectiveness in teaching coding to students, studies by Quah et al. (2023), Abdul Rahman et al. (2024), Maskur et al. (2020) and Yusof et al. (2023) highlighted the challenges faced by Malaysian students in achieving proficiency in programming. It is therefore crucial to shift the focus towards understanding the programming achievement of Malaysian preservice teachers, who will guide the next generation of students through the complexities of coding and computational thinking in programming.

Problem-solving skills are fundamental in programming, particularly for preservice teachers who will be responsible for teaching these skills to future generations. The ability to achieve and retain these skills is crucial not only for their success as educators but also to pass it to their students. In the context of programming, problem-solving skills are essential for understanding and writing code, debugging and generating solutions, where complex problems are broken down into manageable parts before being solved. For preservice teachers, mastering these skills are important as they will need to teach these concepts effectively to their students. As stated by Dong et al. (2024), problem-solving is a key component of computational thinking, which is an element of programming, and is seen as an essential 21st century skill. Their study highlighted the importance of developing these skills particularly for those who will become educators, as it lays the foundation for teaching programming effectively. Retention of problem-solving skills is equally important as retaining these skills ensures that preservice teachers can continue to apply and teach programming concepts effectively throughout their careers. In regards to programming, teachers who retain strong problem-solving skills are more adaptable to changes in programming languages and technologies (Lionelle et al., 2022), which is essential in a field that is constantly evolving. The ability to retain problem-solving skills also impacts the quality of education that students receive. Adeoye & Jimoh (2023) stated that teachers who retain their problem-solving skills are more likely to create learning environments that encourage exploration, creativity and resilience among students. This is particularly important in programming, where students often face challenges that require persistent problem-solving efforts. However, the dynamic nature of programming and rapid technological advancements pose challenges to retaining problem-solving skills and there is limited research on how these changes affect preservice teachers and their ability to retain problem-solving. Therefore, there is a need to conduct this study to determine the effectiveness of the ChatGPT-based flipped classroom method in addressing the challenges faced by preservice teachers in programming especially in terms of achievement and retaining problem-solving skills.

METHODS AND SAMPLING

This quantitative study uses a pre-experimental one-group pretest and posttest design. 33 preservice teachers from an intact class at the Institute of Teacher Education Malaysia, Sabah campus was chosen as the study sample. According to Kar and Ramalingam (2013), a sample size of around 30 is sufficient for study purposes.

A Computer Programming Achivement Test (CPAT) was used as the research instrument, which was adapted from the study by Omeh and Olelewe (2021). The CPAT used in this study contains 35 multiple-choice items which were developed to measure the achievement and retention of problem solving skills of preservice teachers in programming. The instrument was administered during the pretest, posttest, and delayed posttest using the same items to ensure consistent comparison. However, the items in the posttest and delayed posttest were rearranged.

The face and content validity of the research instrument were evaluated through consultation with two lecturers: one an expert in programming and the other an expert in language studies. A pilot test was conducted involving 30 preservice teachers who were not part of the study samples to determined the pretest's realiability. The reliability of the pretest was determined using Kuder-Richardson 20 (KR-20) analysis, which is suitable for evaluating multiple-choice items. KR-20 is specifically designed to measure the internal consistency of tests with dichotomous variables, such as multiple-choice items (Thomas et al., 2022). According to Vrotsou et al. (2018), a KR-20 value of 0.70 or higher indicates a good and acceptable reliability. In this study, the KR-20 value was 0.96, demonstrating that the adapted CPAT has high reliability.

This study was carried out for ten weeks. The pretest was administered in the first week, the posttest in the eighth week and the delayed posttest in the tenth week. Teaching and learning sessions were conducted over six weeks starting from the second to the seventh week, during which the study samples were exposed to the teaching and learning of programming using the ChatGPT-based flipped classroom method.

Data were analyzed using one-way repeated measures ANOVA to determine the differences in mean scores between the pretest, posttest and delayed posttest, evaluating the effect of the ChatGPT-based flipped classroom method on the teaching and learning of programming. This analysis aims to identify the achievement and retention of problem-solving skills among the study samples.

RESULTS/FINDINGS & DISCUSSION

Before the analysis was carried out, the assumptions of data normality must be met. With that, the Shapiro-Wilk statistical test was used to analyze the normality of the pretest, posttest and delayed posttest shown in Table 1.

Table 1
Data Normality Analysis

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Pretest	.20	32	.06	.87	32	.08
Posttest	.21	32	.06	.86	32	.06
Delayed posttest	.14	32	.19	.93	32	.49

The Sig. value in the Shapiro-Wilk test is .08 for the pretest, .06 for the posttest and .49 for the delayed posttest. Since all three values are greater than the significant value of .05, the data for the pretest, posttest and delayed posttest are normally distributed. With that, one-way repeated measures ANOVA can be used to analyze the data.

$H_0$1: There is no significant difference between the mean scores of the pretest, posttest and delayed posttest of preservice teachers who were taught using ChatGPT-based flipped classroom involving the achievement in programming

Table 2 shows the pretest mean score (M=16.84, SD=8.35), the posttest mean score (M=31.25, SD=13.25) and the delayed posttest mean score (M=24.43, SD=6.68). Based on the table, the posttest mean score is higher than the pretest mean score and the delayed posttest mean score. This indicates that preservice teachers experienced an improved and optimal achievement score when exposed to the use of ChatGPT-based flipped classroom in the teaching and learning of programming.

Table 2
Statistics of Pretest Mean Score, Posttest Mean Score and Delayed Posttest Mean Score

	Pretest	Posttest	Delayed posttest
N	33	33	33
Mean (M)	16.84	31.25	24.43
Standard deviation (SD)	8.35	13.25	6.68

N = Number of samples

$H_0$2: There is no significant difference between the mean scores of the pretest, posttest and delayed posttest of preservice teachers who were taught using ChatGPT-based flipped classroom involving the retention of problem-solving skills in programming

To determine if the ChatGPT-based flipped classroom method can effectively retain problem-solving skills, a homogeneity of variance test needs to be conducted to determine the suitability of using one-way repeated measures ANOVA. Based on the Tests of Homogeneity of Variances in Table 3, the value of p = .68, which is greater that the significant value of .05, shows that the data variance is homogenous. This indicates that one-way repeated measures ANOVA can be used to analyze the data and evaluate the effectiveness of ChatGPT-based flipped classroom to retain problem-solving skills.

Table 3
Tests of Homogeneity of Variances

		Levene Statistic	df1	df2	Sig.
Test series	Based on mean	.25	2	39	.68

Based on Table 4, p = .001 is lower that the significant value of .05. Therefore, the null hypothesis is rejected. There is a significant difference between the mean scores of the pretest, posttest and delayed posttest. Since the one-way repeated measures ANOVA analysis showed that there is a significant difference between the three test series, further tests were performed to identify those differences based on the combinations of the test series.

Since the variance of the data is homogeneous, the Post Hoc Bonferroni test was used to identify the difference in combination of the test series. Table 5 shows that there is a significant difference in the mean score between the pretest, posttest and delayed posttest since all the Sig. value is lower than the significant value of .05 for each combination of test series. Thus, the null hypothesis is rejected. This indicates that the use of ChatGPT-based flipped classroom in the teaching and learning of programming is able to effectively retain problem-solving skills.

Table 4
One-Way ANOVA Analysis

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	506.11	2	254.03	343.97	.001
Within Groups	29.02	42	.72		
Total	51.91	44			

Table 5
Bonferroni Post Hoc Analysis

		Mean Difference	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Pretest	Posttest	-14.41*	.31	.00	-8.16	-6.59
	Delayed posttest	-7.59*	.31	.02	-1.34	.17
Posttest	Pretest	14.41*	.31	.00	6.59	8.15
	Delayed posttest	6.82*	.31	.00	6.01	7.57
Delayed posttest	Pretest	7.59*	.31	.02	-.18	1.33
	Posttest	-6.82*	.31	.00	-7.58	-6.00

Findings of the study indicate that the ChatGPT-based flipped classroom method shows significant improvements in both increasing preservice teachers' achievement and retention of problem-solving skills in programming, highlighting the potential of integrating AI-based tools into modern educational instructions.

In regards to achievement in programming, this study showed a notable increase in mean achievement scores from the pretest (M=16.84, SD=8.35) to the posttest (M=31.25, SD=13.25), indicating that the ChatGPT-based flipped classroom method significantly enhances preservice teachers' achievement in programming. This improvement in achievement aligns with recent research which suggests that that AI-supported learning environments can facilitate deeper understanding and better academic performance by providing personalized, adaptive learning experiences (Ray & Sikdar, 2024). The integration of ChatGPT into the flipped classroom environment has further enhanced the effectiveness of personalized learning, providing preservice teachers with instant feedback and tailored support that promotes deeper understanding and engagement in programming concepts, in line with the study by Li (2023). This in turn promotes active learning, such as discussions, collaborative coding and problem-solving activities, which leads to a deeper understanding of programming concepts, thereby boosting preservice teachers' achievement. Furthermore, ChatGPT acts as an effective scaffolding tool by offering tailored hints and guiding questions that help preservice teachers advance from basic to more complex levels of programming concepts. This structured, step-by-step support ensures that preservice teachers develop a solid conceptual foundation of programming, leading to improved achievement, as stated in the study by Lee & Zhai (2024).

Findings of the delayed posttest scores (M=24.43, SD=6.68) shows that the retention of problem-solving skills, while slightly lower than the posttest scores, remained significantly higher than the pretest scores. This suggests that the skills acquired through the ChatGPT-based flipped classroom were largely retained over time, despite some decay. Programming is basically a problem-solving activity. Retaining problem-solving skills enables preservice teachers to effectively apply their knowledge to new and unfamiliar challenges, ensuring they can adapt and find solutions in various contexts. The ChatGPT-based flipped classroom method facilitates the retention of problem-solving skills in programming by providing personalized practice, instant feedback and scaffolding complex problems. It promotes active learning and continuous reinforcement, ensuring preservice teachers effectively internalize and retain problem-solving abilities over time as proven through the study by Quinstein (2024).

When preservice teachers participate actively in the teaching and learning process, particularly by focusing and paying close attention to the lecturer's instruction, the lecturer can

effectively guide them in solving programming issues that require the use of problem-solving skills. Over time, this active engagement fosters the development and retention of problem-solving skills, which was proven through the findings of the delayed posttest where despite having completed the teaching and learning of programming using ChatGPT-based flipped classroom for two weeks, the preservice teachers were still able to apply the problem-solving techniques they had learned, as proven by their sustained performance in the delayed posttest. This indicates that the skills acquired during an AI-assisted instruction, particularly ChatGPT-based flipped classroom sessions ,were not only effectively learned but also retained over time, demonstrating the lasting impact of active engagement and guided instruction on the retention of problem-solving skills as highlighted by Quinstein (2024).

CONCLUSION

To conclude, the ChatGPT-based flipped classroom method has demonstrated significant benefits for preservice teachers in programming instructions particularly in improving achievement as well as enhancing the retention of problem-solving skills. Further research should be carried out to compare and explore how traditional flipped classroom and ChatGPT-based flipped classroom impact preservice teachers' achievement and retention. By comparing and exploring both methods, a clearer understanding of how ChatGPT enhances learning outcomes compared to traditional methods could be achieved. This would provide valuable insights into creating a more supportive and effective learning environments for sustaining preservice teachers' achievement and promoting long-term retention of problem-solving skills.

REFERENCES

Abdul Rahman, N., Hashim, N., Yusof, R., Mohd Yunus, S. Y., & Aziz Fadzillah, N. A. (2024). *Kesan Kaedah Pengajaran dan Pembelajaran (PdP) Terhadap Penguasaan Pelajar Bagi Kursus Pengaturcaraan*.

Adeoye, M. A., & Jimoh, A. (2023). Problem-Solving Skills Among 21st-Century Learners Toward Creativity and Innovation Ideas. *Thinking Skills and Creativity Journal*, 6(1), 52-58.

Al-Samarraie, H., Shamsuddin, A., & Alzahrani, A. I. (2020). A flipped classroom model in higher education: a review of the evidence across disciplines. Educational Technology Research and Development, 68, 1017-1051.

Bahagian Sumber dan Teknologi Pendidikan. (2023). *Dasar Pendidikan Digital*. Kementerian Pendidikan Malaysia.

Bouschery, S. G., Blazevic, V., & Piller, F. T. (2023). Augmenting human innovation teams with artificial intelligence: Exploring transformer-based language models. *Journal of Product Innovation Management*, *40*, 139-153.

Dong, W., Li, Y., & Sun, L. Developing pre-service teachers' computational thinking: a systematic literatur review. *International Journal of Technology and Design Education*, 34, 191-227.

Erol, O., & Kurt, A. A. (2017). The effects of teaching programming with scratch on pre- service information technology teachers' motivation and achievement. *Computers in Human Behavior*, 77, 11-18.

Ettien, A., & Touré, Y. E. J. (2023). Theoritical Foundations of the Flipped Classroom. *European Journal of Educationa and Pedagogy*, *4*(6), 53-57

George, G., & Reddy, R. (2024). Digital Empowerment in Education: Exploring the Dynamics and Significance of ICT – A Review. *International Journal of Scientific Research in Engineering and Management*, *8*(1), 1-10.

Gökoğlu, S., & Kılıç, S. (2023). Programming learning and teaching of pre-service computer science teachers: Challenges, concerns and solutions. *E-Learning and Digital Media*, *20*(5), 498-518.

Güler, M., Kokoç, M., & ÖnderBütüner, S. (2023). Does a flipped classroom model work in mathematics education? A meta-analysis. *Education and Information Technologies, 28*(1), 57-79.

Gutierrez-Gonzalez, R., Zamarron, A., Royuela, A., & Rodriguez-Boto, G. (2023). Flipped classroom applied to neurosurgery in undergraduate medical education. *BMC Medical Education*, *23*, 170.

Guzdial, M., & Shreiner, T. (2021). *Integrating Computing through Task-Specific Programming for Disciplinary Relevance*. Computational Thinking in Education. Routledge.

Ha, A. S., O'Reilly, J., Ng, J. Y., & Zhang, J. H. (2019). Evaluating the flipped classroom approach in Asian higher education: Perspectives from students and teachers. Cogent Education, 6(1), 1638147.

Jo, H., & Park, D.-H. (2024). Effects of ChatGPT's AI capabilities and human-like traits on spreading information in work environments. *Scientific Report*, 14, 7806.

Kar, S. S., & Ramalingam, A. Is 30 the Magic Number? Issues in Sample Size Estimation. *National Journal of Community Medicine*, 4(1), 175-179.

Keong, T. C., & JiMei, G. (2024). Analyzing Flipped Classroom Themes Trends in Computer Science Education (2007–2023) Using CiteSpace. *Journal of Applied Sciences and Engineering Technology*, *46*(1), 15-27.

Lee, G., & Zhai, X. (2024). Using ChatGPT for Science Learning: A Study on Pre-service Teachers' Lesson Planning. IEEE Transactions on Learning Technologies, 17, 1683-1700. 10.1109/TLT.2024.3401457

Li, H.-F. (2023). Effects of a ChatGPT-based flipped learning guiding approach on learners' courseware project performances and perceptions. *Australasian Journal of Educational Technology*, 39(5), 40-58.

Liao, C.-H., & Wu, J.-Y. (2023). Learning analytics on video-viewing engagement in a flipped statistics course: Relating external video-viewing patterns to internal motivational dynamics and performance. *Computers & Education, 197*, Article e104754. https://doi.org/10.1016/j.compedu.2023.104754

Lionelle, A., Ghosh, A., Say, B., & Beveridge, J. R. (2022). Increase Performance in CS 2 via a Spiral Redesign of CS 1. In Proceedings of the 53rd ACM Technical Symposium on Computer Science Education - Volume 1 (Providence, RI, USA) (SIGCSE 2022). Association for Computing Machinery, New York, NY, USA, 502–508

Maskur, H., Abdul Mutalib, R., & Abdullah, N. (2020). Hubungan Sikap Pelajar dan Pengajaran Pensyarah Terhadap Pencapaian Kursus Pengaturcaraan di kalangan Pelajar Politeknik. *Proceeding International Multidisciplinary Conference (IMC 2020)*. Annual Conference of the Southern African Computer Lecturers' Association.

Mazlee Malik. (2019). Guru Perlu Bersedia Tempuh Cabaran Revolusi Industri 4.0. *Berita Harian Online*.https://www2.bharian.com.my/berita/pendidikan/2019/05/563340/guru-perlu-bersedia-tempuh-cabaran-revolusi-industri

Mennega, N., & Mawela, T. (2024). Exploring Flipped Learning in an Introductory Programming Module: A Literature Review. *In: Van Rensburg, H.E., Snyman, D.P., Drevin, L., Drevin, G.R. (eds) ICT Education*. SACLA 2023. Communications in Computer and Information Science, vol 1862. Springer, Cham.

OpenAI. (2023). *ChatGPT: optimizing language models for dialogue*. https://openai.com/blog/chatgpt/

Omeh, C. B., & Olelewe, C. J. (2021). Assessing the Effectiveness of Innovative Pedagogy and Lecture Method on Students Academic Achievement and Retention in Computer Programming. Education Research International, *2021*(3), 1-11.

Orrù, G., Piarulli, A., Conversano, C. & Gemignani, A. Human-like problem-solving abilities in large language models using ChatGPT. *Frontiers in Artificial Intelligence, 6.* https://doi.org/10.3389/frai.2023.1199350

Quah, W. B., Banua, N. M., & Zulkifle, Z. (2023). Pembelajaran Berasaskan Permainan Bagi Kursus Asas Pengaturcaraan: Ketahui Sikap dan Minat Pelajar. *Journal of ICT in Education, 10*(1), 14-25.

Quinstein, M. (2024). Forget Forgetting: AI-Driven Strategies for Learning Retention. https://trainingindustry.com/articles/artificial-intelligence/forget-forgetting-ai-driven strategies-for-learning retention/#:~:text=Artificial%20intelligence%20(AI)%20can%20be,,acquire%20trans lates%20into%20lasting%20skills

Ray, S., & Sikdar, D. P. (2024). AI-Driven Flipped Classroom: Revolutionizing Education Through Digital Pedagogy. *British Journal of Educational Learning*, 7(2), 169-179.

Roumeliotis, K. I., & Tselikas, N. D. (2023). ChatGPT and Open-AI Models: A Preliminary Review. *Future Internet*, *15*(6), 192.

Rudolph, J., Tan, S., & Tan, S. (2023). ChatGPT: Bullshit Spewer or the End of Traditional Assessments in Higher Education? *Journal of Applied Learning and Teaching*, *6*(10)1-22.

Salleh Hudin, S. (2024). A Pilot Study in Southern Region Primary School: Are Design and Technology Teachers Ready to teach Programming? *Online Journal for TVET Practitioners*, *9*(1), 112-121.

Sarwar, M. A., Saima, M., & Gul, A. (2024). The Role of Artificial Intelligence in Shaping the Future of Education at Higher Secondary Level. *Journal of Education and Social Studies*, *5*(1), 34-45.

Thomas, F. C., Coulombe, S., Girard, T. A., Hart, T. L., Doherty, S., Dass, G., Wickramage, K., Siriwardhana, C., Surenthirakumaran, R., & McShane, K. (2022). Displacement-related stressors in a Sri Lankan war-affected community: Identifying the impact of war exposure and ongoing stressors on trauma symptom severity. *SSM – Mental Health*, 2.

Verma, M. (2023). Integration of AI-based chatbot (ChatGPT) and supply chain management solution to enhance tracking and queries response. *International Journal for Science and Advance Research in Technology,* 6(16), 60-63.

Vrotsou, K., Ávila, M., Machón, M., Mateo-Abad, M., Pardo, Y., Garin, O., Zaror, C., González, N., Escobar, A., & Cuéllar, R. (2018). Constant-Murley Score: systematic review and standardized evaluation in different shoulder pathologies. *Quality of Life Research*, *27*(9), 2217-2226.

Voon, X. P., Wong, S. L., Wong, L.-H., Mas Nida Md. Khambari & Sharifah Intan Sharina Syed-Abdullah. (2022). *International Journal of Information and Education Technology*, *12*(6), 529-538.

Yeruva, A. R. (2023). Providing A Personalized Healthcare Service To The PatientsUsing AIOPs Monitoring. *Eduvest-Journal of Universal Studies*, 3(2), 327-334.

Yu, Z., & Gao, M. (2022). Effects of video length on a flipped English classroom. *SAGE Open, 12*(1), 1-14. https://doi.org/10.1177/21582440211068474

Yusriza Mohamad Yusof, Afida Ayob & Mohamad Hanif Md Saad. (2021). Penggunaan Teknologi Kejuruteraan dalam Pendidikan STEM Bersepadu. *Jurnal Kejuruteraan*, *33*(1), 1-11.