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| RESEARCH ARTICLE

The Impact of ChatGPT in Learning Programming Skills among IT Undergraduates in Jordan

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| ABSTRACT
This study aims to verify whether students' performance in programming is affected by using ChatGPT as an assistant tool during learning Java basic skills. To achieve the objective, the researchers used the quasi-experimental design. The sample is (66) undergraduates in Information Technology College in a public university in Jordan; Thirty-three learners in the experimental group and thirty-three learners in the control group. The two groups were taught programming skills in computer labs for (15) weeks during the 2nd term on 2024. The students in the control group were asked to solve coding practices referring only to the textbook and their notes, they didn't have access to the Internet during classes. While the students in the experimental group were allowed and encouraged to use ChatGPT to solve same coding practices. To measure the students' performance in programming, pre-tests and post-tests were applied before and after the treatment. The findings demonstrate that following treatment, the experimental group students' performance improved noticeably. Understanding the positive aspects of ChatGPT, the researchers recommend integrating it into programming courses in universities in a thoughtful manner to fully benefit from its features so positively impact the educational process.

| KEYWORDS

Artificial Intelligence, ChatGPT, Programming Learning, Performance

| ARTICLE INFORMATION

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1. Introduction

The rapid advancements in artificial intelligence applications witnessed nowadays have led to changes in many life aspects, most importantly the educational sector. Students, especially undergraduates, now have direct and quick access to those applications and have begun to use them in many of their daily activities. Therefore, teachers must change their view about using these tools and make the best use of them to attract students' attention and interest, thus effectively achieving learning goals.

Within the discipline of computer science, artificial intelligence (AI) is one of the main tenets of the modern technology sector. The ability of digital devices and computers to perform particular tasks that closely resemble and replicate those performed by humans such as thinking and learning is known as artificial intelligence (Abbass, 2021). The goal of artificial intelligence (AI) is to build intelligent machines that learn and comprehend like people. These systems offer a range of services to its users, such as engagement, education, and guiding (Kamalov et al., 2023).

ChatGPT is one of the latest and most popular artificial intelligence applications. It is so named because it relies on Generative Pre-trained Transformer computer mechanisms that acts with natural language prompts by generating human-like responses, with the ability to understand and process as it describes itself. ChatGPT, or any future version of it, will radically change our lives and society (Welsby and Cheung, 2023).

The process of teaching and learning programming languages, such as Java and more, to create computer programs is known as programming education. It entails gaining the abilities and knowledge on planning, creating, testing, debugging, and maintaining software programs (Philbin, 2023). In the past, programming was seen to be a talent that only a select few should possess, but now, it is a necessary ability in many fields; it is an essential tool for resolving challenging issues and coming up with creative solutions in a variety of industries. Accordingly, learning programming is essential for anyone hoping to succeed in his domain (Kadar et al., 2021).

Through their work as university lecturers, the researchers have observed that learning programming is hard and complex for many undergraduates, especially in their first year. For this reason, some may seek to change their major or abandon programming before successfully completing it. Learners need tailored tutor to learn programming skills successfully; they need to be provided with support and guidance while writing codes, explain their errors and suggest corrections, giving them immediate feedback and work with them step by step according to their level and pace. ChatGPT can be a worthy tutor for learning basic concepts of computing such as data structures, algorithms, programming languages and more (Adeshola and Adepoju, 2024). Thus, in this study, the efficiency of ChatGPT as an assistant tool to learn Java programming skills is evaluated. Basicly, the present study aims to answer the following question: Is learners' performance in programmaing affected by using ChatGPT as an assitant tool to learn programming skills?

2. Literature Review

Despite only recently being made available to the public; on November 30, 2022, ChatGPT has piqued the curiosity of researchers to assess its potentials and challenges in education in several fields. In this section, we introduce some recent studies about the impact of ChatGPT in learning programming.

For instance, Yilmaz and Karaoglan Yilmaz (2023) investigated the students' opinions on using ChatGPT to learn programming skills. The study included (41) undergraduates in the Computer Technology and Information Systems section at a Turkish university. The participants were using ChatGPT to learn Object-Oriented Programming II for eight weeks. The researchers used a form that included open-ended questions to collect students' perspectives and analyzed the answers. The study found that ChatGPT improves students' thinking skills, makes debugging easier, and boosts self-confidence by offering fast and generally accurate replies to inquiries during programming learning. On the other hand, the study revealed that using ChatGPT to learn programming might make students lazier, unable to respond to certain queries, or provide inaccurate or partial responses, which made them anxious about their careers.

Moreover, Qureshi (2023) evaluated the potentials of using ChatGPT to learn fundamental programming skills among undergraduates enrolled in the Computer Science section at Prince Sultan University in Saudi Arabia. The methodology employed in the study was quasi-experimental. There were twenty students in the sample divided between the experimental and control groups; the participants were given programming challenges to solve; the first group was allowed to use textbooks and notes only, while the second group was encouraged to use ChatGPT. The results show that the performance of students in the experimental group was better.

Further, Kazemitabaar et al. (2023) investigated the ability of (AI) code assistants like OpenAI Codex, GPT-3, ChatGPT and Copilot in helping novice programmers to learn basic skills of Python. The study was conducted on (69) beginners (ages 10-17); they used coding steps provided on a website developed by the authors to learn programming independently. Half of the students had access to the AI-code generators during the training phases of the study. The results indicate that using an AI-code generator improved code authoring performance. Additionally, learners who had access to AI-code generators scored better on the post-tests.

Additionally, Ouh et al. (2023) assess the effectiveness of using ChatGPT to generate Java solutions for coding exercises. The study was applied to undergraduates enrolled in Java programming course in Computer Science and Information Systems sections. The researchers analyzed and evaluated solutions generated by ChatGPT for (80) programming exercises. The findings show that ChatGPT is an effective tool for learning programming skills; it can correctly and accurately generate codes when the input instructions are clear and straightforward. Also, the generated solutions were found readable and well-structured. Additionally, ChatGPT was found efficient to produce alternate and memory-saving solutions.

Furthermore, Vukojičić and Krstic (2023) investigate the efficiency of ChatGPT as a programming assistant in the context of learning Python language. The researchers used the controlled experimental methodology; they divided students into two groups: one had access to ChatGPT to solve coding problems unlike the another, then the students' solutions were analyzed and compared. The results found that using ChatGPT as assistant during learning programming enhanced learners' understanding and performance.

More recently, Silva et al. (2024) examined the feasibility of viability of ChatGPT for the sustainability of programming learning. The investigation was conducted on (40) undergraduates at the Computer Engineering Section at the University of Araucária in Brazil. The perceptions of students about ChatGPT as an instrument for resolving coding problems and challenges during programming classes were evaluated using a Likert scale questionnaire. According to the findings, students found ChatGPT a cutting-edge technology that could be used in a variety of educational environments, such as computer languages and programming.

In addition, Haindl and Weinberger (2024) assessed students' experiences about using ChatGPT to learn Java programming. The study was conducted on (22) undergraduates in the Information Security section at the University of Applied Sciences in Austria who were enrolled in a Java Programming course for five weeks. To collect data, the participants were asked to complete an anonymous online survey after doing their exercises' code. The results found that most students viewed ChatGPT as a potent tool for learning programming syntax and concepts and generating suitable algorithms for their exercises.

Moreover, Groothuijsen et al. (2024) assessed the benefits of ChatGPT in learning programming in the engineering field. The study was applied to (29) students and their teacher of Scientific Computing course that's offered in Master's program of Mechanical Engineering at Eindhoven University of Technology in Netherlands. To collect data, the researchers used questionnaires and semi-structured group interviews. According to the study's findings, students who used ChatGPT to review and debug code showed a deeper understanding of programming concepts, improved generating and optimizing codes, and a better ability to solve mathematical problems.

Every prior work made an effort to assess the leverage of ChatGPT as an assistant tool to learn programing skills whether in different environments considering several programming languages such as Java and Python. The current study's implementation is based on the suggestions made by the majority of earlier studies that promoted investigating the impact of artificial intelligence tools and technologies in classrooms. Like the majority of earlier studies, this one evaluates ChatGPT's efficacy in teaching programming skills using a quasi-experimental approach.

However, this study uses ANCOVA to quantitativly measure learner's performance in programming after using ChatGPT as an assistant tool to learn Java basic skills; to the researcher's knowledge, no previous work used this statistical method; most of the studies used qualitaitive tools such as questionnaires and interviews. In addition, the current research is applied to undergraduates in a public university in Jordan; the researchers did not find a study about the efficacy of ChatGPT in learning programming applied in Jordanian universities while reviewing the previous literature.

3. Methodology

The experimental technique with the quasi-experimental design is the methodology used in this study, since it is the most appropriate for evaluating the efficiency of ChatGPT as an assistant tool for learning programming skills. A collective of students was split into two groups for the study: the experimental group and the control group. Both groups' pre- and post-treatment data were gathered. For fifteen weeks, the experimental group's students were encouraged to use ChatGPT to solve coding exercises, while the control group's students were only permitted to use the textbook and their notes. This treatment reflects learning the fundamentals of the Java programming language.

3.1 Study Sample

Sixty-six male and female first-year students from a public university in Jordan make up the study sample. There are thirty three students in each of the two groups—control and experimental. The participants were enrolled in "Programming Fundamentals I" course during the 2nd term on 2024. They are from two sections: Computer Science and Software Engineering in Infromation Tecnology College. All participants have prior experience and knowledge of programming, as they have completed the "Programming Skills" course, which is about C++, in their first semester.

3.2 Tools for Collecting Data

3.2.1 Performance tests

The learning objectives of "Programming Fundamentals I" course students should achieve at the end of the course are :

1) Understand and use Java syntax and structure for variables, data types, operators, expressions, and control statements.

2) Implement decision-making using if, else, and switch.

3) Apply loops such as for, while, and do-while effectively.

4) Declare, initialize, and manipulate arrays and strings

5) Handle input and output of data using Java's Scanner class and basic I/O methods.

6) Implement simple methods, calling and passing parameters to methods.

To make sure that both groups (control and experimental) have similar knowledge and experience about the above learning objectives, before the treatment, both groups were given a pre-test that includes (30) MCQs. The scores of students are collected and saved in a spreadsheet.

Then, the students in each group were given a post-test to measure the degree of achieving the aforementioned learning objectives. The post-test was applied during and after the treatment consists of five subtests as shown in table 1.

Table (1): Post-tests Design

Post-test	Time	Learning Objectives	Questions	Scores
Subtest # 1	At the end of week 3	1	10 MCQs	10
Subtest # 2	At the end of week 6	2,3	20 MCQs	20
Subtest # 3	At the end of week 9	4	10 MCQs	10
Subtest # 4	At the end of week 12	5	10 MCQs	10
Subtest # 5	At the end of week 15	1,2,3,4,5,6	40 MCQs	40
Score Total = 90 normalized to 30 ; Lowest score = 0 and Highest score = 30				

At the end, the total of each student's scores in the subtests was calculated and divided by (3); so each student has one score for the pre-test and another for the post-test, out of (30) for each.

3.2.2 Validity of tests

To confirm the validity of the tests, a committee of four arbitrators reviewd them and suggested some comments. The committee includes two professors at the Faculty of Educational Sciences (specializing in educational technology) and two professors at the Faculty of Information Technology (specializing in computer science) and have good experience in teacheing Java Fandamentals I course. Following consideration of the arbitrators' feedback, a few issues were revised and tests are accepted in their final form.

3.3.3 Reliability of tests

Applying the Kuder Richardson equation (KR-20), the internal consistency of the pre-test and post-test was determined to be (0.662) and (0.793), respectively. These values are significant at the level (α<= 0.01), suggesting that the tests are dependable and suitable for data collection.

4. Results and Discussion

In order to answer the study's question, which is "Is learners' performance in programmaing affected by using ChatGPT as an assitant tool to learn programming skills?", students in each group—control and experimental—were given a pre-test prior to treatment, and students in both groups were given a post-test during and after the treatment. The averages and standard deviations (σ) of the students' scores are displayed in Figure (1).

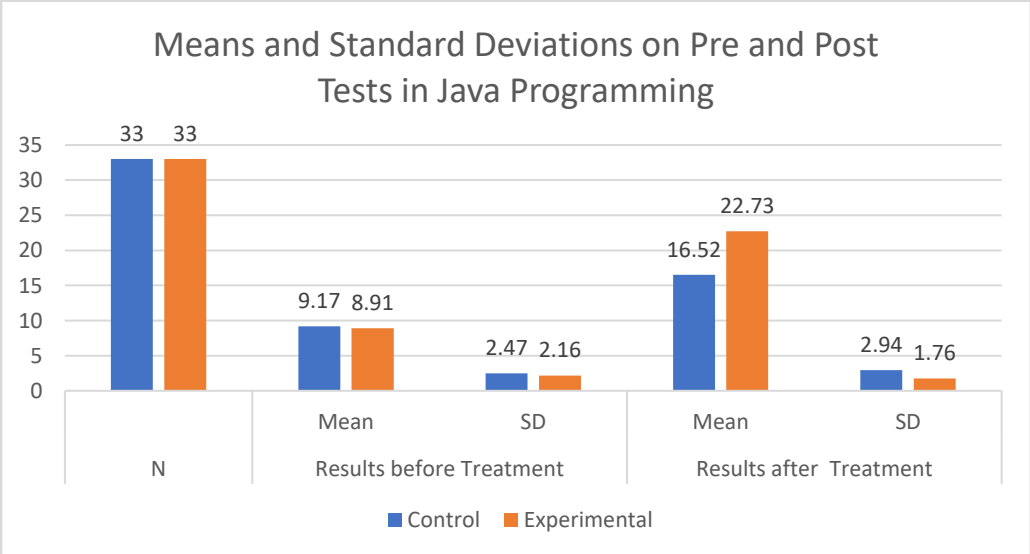

Figure 1 : Means and Standard Deviations on Pre and Post Tests in Java Programming

As shown in the figure, following the treatment, the experimental group's mean scores on the post-test in Java programming improved noticeably, rising from 8.91 to 22.73. While for the studnets in the control group, it was (9.17) and became (16.52). Analysis of Covariance (ANCOVA) was used to assess if these differences have statistical significance at ($\alpha<=0.05$). Table (2) presents the findings.

Table (2): ANCOVA Results for the Post-test

No.	Source of variation	Sum of Squares (SS)	DF	Mean of Squares (MS)	F	P-Value	Partial η^2
1	Treatment (Group)	635.192	1	635.192	108.199	0.0000	0.6283
2	Error	375.718	64	5.871			

ANCOVA shows that F=108.199 which is a high statistical value indicating a high impact of the treatment, P-value = 0.0000 which is significant at ($\alpha<=0.05$) and partial $\eta^2=0.62$ which means that about (63%) of the variance in post-test scores between control and experimental groups can be referred to using ChatGPT as an assitant tool during learning Java programming skills ; which is a considerable impact.

Furthermore, the corrected mean scores and standard error for the experimental and control groups on the post-test are displayed in table (3). It is clear that the experimental group's mean, as corrected using ANCOVA is higher: (22.42).

Table (3): Adjusted means scores and standard error on the post-test

No.	Group	N	Adjusted Mean	Std. Error
1	Control	33	16.12	0.422
2	Experimental	33	22.42	0.422

In light of the researchers' perspective, the substantial effect of using ChatGPT in enhancing students' performance in programming skills may be attributed to it's adaptability offering individualized learning routes based on the needs and unique qualities of each learner, taking into account their level. Also, ChatGPT enables learners to learn at their own pace, ask questions as many as they need and recieve answers in different forms. Moreover, ChatGPT provides immediate explanations, hints, corrections and suggestions for learners in clear and interactive way reducing the need for a human teacher. Further, learners may ask ChatGPT to generate custom practices, quizzes, or projects to enhance learning process and offer something different from textbooks. On the psychological side, some learners feel more comfortable when they get support and help in an environment free from embarrassment or judgment which may boosts their self-confidence.

4.1 Matching the findings of the current study with those of earlier ones

The findings of this investigation align with those of: (Qureshi, 2023), (Kazemitabaar et al., 2023), (Ouh et al., 2023), (Vukojičić and Krstic, 2023), (Silva et al., 2024), (Haindl and Weinberger, 2024) and (Groothuijsen et al., 2024); All of these investigations discovered that using ChatGPT as an assistant tool during learning programming had a beneficial impact on learners.

However, Yilmaz and Karaoglan Yilmaz (2023) found that using ChatGPT during the learning process might make students lazier, unable to respond to certain queries, or provide inaccurate or partial responses, which made them anxious about their careers. On the other hand, they found improvement in students' thinking skills and self-confidence attributed to using ChatGPT.

5. Study Limitations

After taking into account the following factors, the findings of this investigation can be broadly applied:

– A sample of sixty-six first-year undergraduates was used in the study.

– The study was carried out for fifteen weeks during the 2nd term on 2024 at Jordanian public university.

– The impact of the independent variable, ChatGPT, on the dependent variable, students' performance in programming, was ascertained through statistical analysis of the students' scores using ANCOVA.

– The nature of the technique, the characteristics of the study participants, the study instruments, and the extent of validity and reliability of tests, all place restrictions on the results of the current investigation.

6. Conclusion

Learning programming need support and guidance while writing codes; learners need an assistant to correct their errors immediately and provide explanations and suggestions, most learners need a tailored tutor to learn programming skills effectively.

For that, ChatGpt, a model built on artificiel intelligence, was used during learning basic programming skills among first-year undergraduates, and its impact in students' performance in programming was investigated. The study was applied on two groups of learners: the first group was allowed and encouraged to use ChatGPT to solve coding practices, while the second group was allowed to use only textbook and their notes. The researchers found that using ChatGPT had a signinficant impact on learners' performance among the experimental group according to ANCOVA results.

Considering the results of the present investigation, the authors strongly advise educators to allow and encourage students to use ChatGPT during learning programming, especially undergraduates as they are aware and responsible. Additionally, it is recommended to consider (AI) tools to deliver dynamic, interactive and learner-centered content. The researchers also suggest that teachers need to change their perspectives about using (AI) tools during the learning process, as these tools are now readily available to students and are used in most of their learning activities. Therefore, as teachers, we must keep pace with this change in learning style to achieve educational goals efficiently and effectively and create an educational environment that suits the needs and characteristics of our students.

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