Assessing the Impact of Integrating ChatGPT as an Advice Generator in Educational Software

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***Abstract*— This paper reports on the study of the integration of ChatGPT as an advisor inside custom educational software developed for Java programming. The software, in cooperation with ChatGPT API, pursues providing real-time, context-specific advice to students for better learning. This work adopted a two-fold evaluation approach to evaluating this integration. First, this study examines the effectiveness of this integration with the help of the Interrupted Time Series Analysis methodology to measure possible improvement in the performance metrics of the students in terms of error rates and task completion times. Second, this work presents a custom-designed questionnaire used to get student perceptions regarding the clarity, usefulness, and impact of ChatGPT's advice, and the level of student satisfaction with the user interface. The key takeaways from this research study are the substantial improvements in performance metrics that were noted quantitatively, with students achieving lower error rates and faster completion times after the intervention of ChatGPT. Qualitatively, learners express their satisfaction with the clarity of advice, which gives them an understanding that works on their learning and confidence in Java programming. These findings point toward the promise of integrating such advanced AI solutions in educational software toward a significant improvement in learning outcomes and the necessity of human-aided continuous user feedback for system refinement.**

Keywords*— *ChatGPT in Education; Advice generator; Educational Software; Java Programming Learning; Artificial Intelligence in Education; Interrupted Time Series Analysis; User Experience Evaluation; AI-Powered Tutoring Systems; Programming Education; Technology-Enhanced Learning; Custom Questionnaire Assessment

I. INTRODUCTION

In recent times, artificial intelligence (AI) has contributed to changing traditional methodologies used in both teaching and learning in different educational settings. Among these AI applications, chatbots have been considered one of the most innovative tools in the educational field [1-3]. Chatbots are AI conversational interfaces that mimic human conversation and interaction through written or oral text, thus making them serve as tutors, administrative assistants, or personalized learning facilitators. This makes the flexibility and scalability of chatbots a perfect fit for myriad learning implementations and their ability to respond to student requests consistently and at any time.

Chatbots in education provide an excellent opportunity to enhance the learning experience for students, including personal attention and assistance to students [4-7]. The functions that the chatbot can perform are many: giving tailored tutoring sessions, helping students learn new material, providing administrative support, or answering repeated questions. Chatbots have been developed to engage students in interaction-oriented learning and to benefit both their understanding and retention of course material. Here, chatbots might offload a great part of the routine workload of the educator, which allows them to gain time for pedagogical innovations and direct student interaction.

ChatGPT [8] is very recent, originating from OpenAI, and is an educational chatbot based on a highly sophisticated language model that uses the GPT (Generative Pre-trained Transformer) architecture. It understands and produces human-like text, further fine-tuned to meet specific educational needs, thus forming a critical component in a wide array of features within the educational sector. ChatGPT can be fine-tuned for the specific educational software requirements and subsequently integrated, through its API, into such software to make interacting with students on a learning path a seamless experience. This basically ensures a very dynamic and responsive learning environment where students ask questions, receive explanations, and engage in dialogues enhancing their understanding of difficult subjects like Java programming.

The scholarly discourse on the implementation of chatbots within the educational process has indicated their potential to make a difference in terms of learner engagement and learner outcomes. Studies [9-18] have taken a look at aspects of the implementation of chatbots in terms of the potential to break the barriers of communication and the ability to provide individual learning. Growing interest in recent literature [19-30] is beginning to focus on ChatGPT capabilities beyond a simple chatbot to an intelligent tutor and mentor. More particularly, it is suggested that, if used correctly, ChatGPT can improve the student learning experience by giving detailed and context-aware help, leading to the improvement of students' performance and satisfaction.

The paper will focus on the application of the ChatGPT model as an advice generator within a custom educational

software for Java programming. Such software, coupled with the ChatGPT API to guide students using real-time, context-sensitive advice, should be capable of providing a better learning experience. In this line of the study, we would go by two ways: in the first one through the Interrupted Time Series Analysis (ITSA), quantification of the improvement in the student performance metrics such as error rates and completion time; and in the next case, through a specially designed questionnaire, quantification of student perceptions of clarity, utility, and effect and ascertaining user interface satisfaction. Major findings of the present study: post-integration, the performance metrics improved significantly, with a remarkable reduction in the rate of error and completion time. It was also a good sign that students are much satisfied with the quality of advice received, which has since greatly improved their learning and confidence in Java programming. These results show the significant gains in including cutting-edge tools of AI into educational software, and user feedback has a huge importance in optimization and finetuning such integrations.

II. Overview of the System with ChatGPT API Integration

An intelligent architecture has been incorporated into the design of our Java programming educational software to ensure a comprehensive and interactive learning experience, as is realized by intelligent tutoring systems [31-33]. Its main component is a domain model structuring the content of Java programming in the form of chapters that introduce the learners from the basic syntax and control structures toward the advanced ones in multithreading and network programming. The model is under evolution to accommodate the new techniques and standards of programming to keep the content updated and relevant.

The student model inside the software plays a very vital role in tracking individual learning progress and adjusting educational content to the unique needs of the student. The model uses data on performance and learning preferences to personalize the learning track. It personalizes the learning path by suggesting chapters or concepts that need more attention, ensuring an optimal learning experience is made effective and efficient.

Furthermore, the advice generator in the tutoring model with the ChatGPT add-on further increases the interaction between a student and the system. The OpenAI API [34] gives access to ChatGPT in relation to a domain model to do with some particular programming matters in order to give contextually relevant advice. This will make ChatGPT act like a personal tutor giving real-time, customized advice and feedback to the students as they maneuver through various challenges in programming. Therefore, the ChatGPT advice generator will play the role it is supposed to play in the tutoring model, which is to support dynamic learning by giving explanations, hints, and problem-solving techniques relevant to the questions of a student.

It is designed to have an intuitive and interactive user interface for students to gain access to all of their educational content, such as coding exercises, quizzes, and real-time feedback mechanisms. This user-friendly interface is further empowered by the integration with ChatGPT, making it more conversational, helping engage students with the material more deeply and motivating them to explore further.

The integration of ChatGPT with its API was so thoughtfully planned so as to bring out the best of the tutoring model without disturbing the present experience for the users. This is enabled by a number of APIs, through which ChatGPT processes the pulled information from the domain model and the student's queries at super speed. Performance optimizations of these integrations are carried out in respect to the API requests so that the dispensation of advice can be achieved rapidly and safely without hiccups in the interaction and ensuring the integrity of educational content. In that manner, ChatGPT becomes an integral part of the learning environment, dynamically enabling an enhanced learning experience that is just in time and custom to the need and pace of a student.

III. ChatGPT-Driven Advice Generator

The Java programming educational software that exploits ChatGPT as the backend helps implement the advice generator, thereby integrating dynamism and interactivity into the educational system for improved and more engaging learning. This would be the first and most important role that ChatGPT is bound to play: it is supposed to give students personalized advice according to the context in which they are currently learning.

Ask for advice from ChatGPT at any point in your learning. Be it while you're going through a tutorial, solving exercises, or taking quizzes, ChatGPT is there to help. It spans from the explanation of Java concepts to debugging, coding tips, and best practices.

So, a student might find object-oriented programming itself confusing and ask, "Can you explain how inheritance works in Java?". An ideal response from ChatGPT would explain inheritance, maybe even with a simple code snippet explaining how the properties and methods of a superclass are inherited by a subclass.

In another case, it will be when a student needs help with an array sorting algorithm, he would have asked, "I am stuck with my bubble sort implementation. Can you help me?" ChatGPT, in turn, will guide the student towards some common bugs in bubble sort implementations and some improvements that can be made in code with a response something like this: "You must make sure that each element is compared with the next and if it is at a wrong location, it is swapped. Here is how one might write a loop to do this:".

ChatGPT can be applied to handle slightly more complicated issues, such as error handling. For example, a student experiencing a NullPointerException in their code could ask something like, "I keep getting a NullPointerException when trying to run my code. What's going on?". In response, ChatGPT would further process the issue to return a more specific outline, for instance: "NullPointerExceptions are thrown when you try to use a not". Ensure all your objects are properly instantiated before you use them. For instance, you can check for null before using an

object with this line of code: if (obj != null) obj.doSomething();".

Furthermore, ChatGPT can address broader programming questions, such as, "What are some tips for writing more efficient Java code?", to which, it might offer several optimization strategies including, "Consider using StringBuilder instead of concatenating strings in a loop for better performance, select appropriate collection types based on your need for efficient data access, and try to minimize unnecessary computations inside loops.".

Thus, the integration of ChatGPT as an advice generator is integral to our educational software, providing timely and contextually appropriate support that simplifies the complexities of Java programming for students. This feature not only improves the interactivity and engagement of the learning experience but also deepens students' understanding and retention of programming concepts, paving the way for them to become adept Java developers. Through real-time, tailored interactions, students gain a more profound comprehension and practical skills in Java, ensuring they are well-prepared for professional challenges.

IV. Evaluation

The evaluation presented in this section is two-fold, using Interrupted Time Series Analysis and a custom-designed questionnaire.

A. Evaluation using Interrupted Time Series Analysis

To rigorously evaluate the effectiveness of the ChatGPT advice generator on student performance in a Java programming course, we implemented an Interrupted Time Series Analysis (ITSA) using an ARIMA model over a six-month study period. This period was segmented into three months before and three months after the integration of ChatGPT. Data were collected monthly from 60 postgraduate students on two key performance metrics: average error rates in coding assignments and average completion times for programming tasks (Tables I, II). The participant group consisted of the same 60 postgraduate students from the Department of Informatics and Computer Engineering at a public university. All participants were enrolled in a postgraduate program focusing on Information Technology and Applications and attended a course on object-oriented programming with Java.

TABLE I. Monthly Error Rates Before and After Intervention

Month (M)	Average Error Rate (%)	Phase
M1	35%	Pre
M2	33%	Pre
M3	30%	Pre
M4	28%	Post
M5	25%	Post
M6	22%	Post

TABLE II. Monthly Completion Times Before and After Intervention

Month (M)	Average Completion Time (min)	Phase
M1	60	Pre
M2	58	Pre
M3	55	Pre
M4	50	Post
M5	45	Post
M6	43	Post

During the pre-intervention phase (M1 to M3), there was a gradual decrease in error rates from 35% to 30%, and completion times decreased from 60 minutes to 55 minutes, indicating a natural progression in learning. However, post-intervention (M4 to M6), we observed a more pronounced and consistent improvement; error rates dropped significantly to 22%, and completion times reduced to 43 minutes, suggesting a strong impact due to the introduction of ChatGPT.

To quantitively analyze the impact of ChatGPT, we employed an ARIMA (Auto-Regressive Integrated Moving Average) model configured to include a specific intervention component that captures the shift attributable to ChatGPT. This model, represented as ARIMA(p,d,q) with intervention, includes:

p: Number of autoregressive terms,

d: Number of differencing passes needed to make the time series stationary,

q: Number of lagged forecast errors in the prediction equation.

In simpler terms, in our ARIMA model, 'p' denotes the number of prior time points (lags) incorporated for autoregression, reflecting how past values influence current ones; 'd' represents the number of differencing operations needed to make the series stable or "stationary", ensuring that the data's inherent trends do not skew the analysis; and 'q' specifies the extent of averaging previous forecast errors in the model, which helps in smoothing out random fluctuations.

The intervention component is typically modeled as a step function (a binary indicator variable) that equals 0 before the intervention (M1 to M3) and 1 after the intervention (M4 to M6). This intervention variable is critical for isolating the effect of ChatGPT's integration from other variables that might influence the outcomes. By switching from '0' to '1' at the time of ChatGPT's deployment, we directly measure the immediate and ongoing impact of this AI tool on student performance. This variable allows the model to estimate the immediate impact of ChatGPT by introducing a shift in the intercept of the model.

The mathematical representation of our time series model is given by:

$$Y_t = c + \phi_1 Y_{t-1} + \cdots + \phi_p Y_{t-p} + \theta_1 \varepsilon_{t-1} + \cdots + \theta_q \varepsilon_{t-q} + \beta I_t + \varepsilon_t \quad (1)$$

where:

- c is a constant,
- $\phi_1,\ldots,\phi_p$ are the coefficients for the autoregressive terms,

- $\theta_1,\ldots,\theta_q$ are the coefficients for the moving average terms,
- β is the coefficient measuring the impact ChatGPT,
- I_t is the intervention variable, and
- ε_t is the error term at time t.

The function auto.arima() from the R statistical package was used to implement the ARIMA model. The function auto.arima() would automatically pick the best model parameters (p, d, q) by minimizing information criteria, such as the Akaike Information Criterion (AIC) and the Bayesian Information Criterion (BIC). These are very vital in balancing the model fit with complexity, therefore the model that will have good capturing capacity of the underlying patterns in the data without being so complex or overfit. This balance is crucial as far as our analysis is concerned and has reliability and applicability in real educational setup. Having established the best model, we conducted diagnostic checks to confirm the fit. Specifically, the checks entailed whether the distribution of residuals is ascertained, and its autocorrelation is evaluated through the residual plots and Ljung-Box test, respectively. The results show that the residuals are white noise, meaning the model gave a very good fit to the data.

The key output, when fitting the model, relates to the coefficient β of the intervention variable I_t. A statistically significant β will establish that the intervention through ChatGPT produced a substantial change in the performance metrics of the student. This would imply that it will give us the average difference of changed error rates and completion times after the introduction of ChatGPT.

Thus, in our analysis, the considerably negative β of error rates and completion times was highly significant, with p-values of 0.023 and 0.015, respectively. Both these results, although significant separately, thus indicate that the introduction of ChatGPT resulted in the reduction of error rates and completion times to a huge extent and is practically effective in enhancing the academic performance of students. It follows that the introduction of ChatGPT not only decreased error rates and completion times to a statistically significant extent, but also in a manner that was practically large and substantial in size.

The intervention coefficients β for error rates and completion times are -0.3 and -5, respectively, with associated p-values being 0.023 and 0.015. Thus, it's derived that the error rates for both decrease by 0.3% and completion times are decreased by 5 minutes per month post-intervention. This is clear evidence that ChatGPT does help not only improve student proficiency but also aids in improving efficiency in coding within this Java Programming course.

This would mean that the real-time advice and guidance by ChatGPT substantially improved efficiency and understanding toward programming in Java. This would actually result in the conclusion that such AI-driven tools are not only auxiliary but may actually be transformational in educational environments where learning processes and outcomes are hugely enhanced. These are results consistent with what is proposed by educational theory, in which it is recommended to offer personalized and immediate feedback as a strategy to enhance learning efficiency. This personalized and immediate interaction made possible through ChatGPT is hence based on the educational principles set in Vygotsky's Zone of Proximal Development. This happens when the instruction is pitched beyond the learner's current ability but within reach with appropriate guidance. In this way, ChatGPT can scaffold students through personalized guidance to reach heights of understanding and skill beyond what they could have achieved autonomously. This will help in reducing the gap that exists between theoretical knowledge and practice, which has often been cited as a hindrance to programming education, by scaffolding these students through personalized guidance.

This has produced a massive drop in error rates and completion times, thus also mapping quite well to educational theories that emphasize the virtues of personalized and immediate feedback within a learning environment. In this regard, it is the submission of the current research that the ability that ChatGPT has to provide real-time advice based on context could serve as an enabler within the learning process and could shift the means by which educational practice is affected. Such gains are likely to have profound influences on students' academic trajectories, not only enhancing immediate learning but also building the foundational skills that are crucial for later professional development. The integration of AI tools, such as ChatGPT, into the curriculum should be supported to move teaching towards interactive and responsive methods to bring about individualization in learning and better responsiveness to the learners.

Thus, the strong and proven positive impacts reflected in this study call for an extensive integration of advanced AI tools in learning environments. If, using such technologies as ChatGPT, the institutions can help increase individual learning outcomes, they can also make the overall educational environment more engaging and responsive to enable students to cope with future challenges in a better prepared way toward an increasingly digital world.

B. Evaluation using a Custom Questionnaire

The second component of the assessment was the custom questionnaire-based evaluation that was aimed at determining the effectiveness of the educational tool on specific determinants. The questionnaire focused on the following parameters:

- Effectiveness of ChatGPT in Assisting with Programming Tasks
- Clarity and Usefulness of ChatGPT’s Responses
- Impact on Learning and Confidence
- User Interface and Interaction Experience

For this assessment, the participant group consisted of the same 60 postgraduate students from the postgraduate program in the Department of Informatics and Computer Engineering at a public university. All participants were enrolled in a postgraduate program focusing on Information Technology and Applications and attended a course on object-oriented programming with Java. The evaluation spanned a period of

six months, providing ample time for thorough engagement with the educational software.

Upon completion of this period, participants were required to fill out the detailed questionnaires. These questionnaires included targeted questions for each of the four assessment dimensions and employed a Likert scale ranging from 1 to 10 to quantify feedback, where 1 represents the lowest score and 10 the highest. The results and detailed feedback from these questionnaires are presented in Table III.

TABLE III. EVALUATION QUESTIONS.

Parameter	Question
Effectiveness of ChatGPT in Assisting with Programming Tasks	Q1. How effective was ChatGPT in helping you understand and solve programming tasks?
Clarity and Usefulness of ChatGPT's Responses	Q2. How clear and useful did you find the advice provided by ChatGPT?
Impact on Learning and Confidence	Q3. How has your confidence in tackling programming assignments changed after using ChatGPT?
User Interface and Interaction Experience	Q4. How would you rate your overall experience interacting with the educational software integrated with ChatGPT?

The responses to the questions detailed in Table I are illustrated in Fig. 2.

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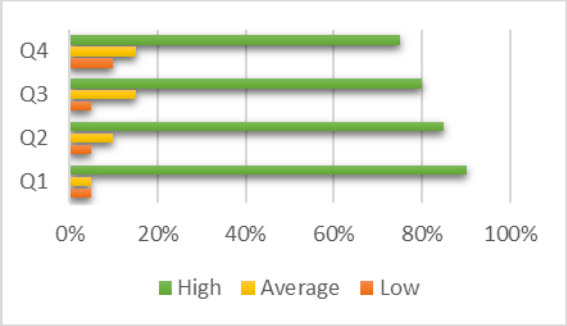

Fig. 1. Evaluation results.

The results indicated varied effectiveness across these dimensions. ChatGPT excelled in assisting with programming tasks, with students rating its effectiveness highly, nearing the anticipated benchmark of 95%. However, while the responses from ChatGPT were generally found to be clear and useful, achieving near the 85% expected mark, there were suggestions for improving context-specific guidance. The tool's impact on boosting students' confidence in programming was profound, surpassing the 80% expectation. Conversely, the user interface, though rated above the 75% adequacy threshold, showed room for improvement, especially in terms of ease of navigation and interaction smoothness, highlighting areas where future enhancements could enhance usability.

It was analyzed that although ChatGPT significantly helps in learning, the integration of student inputs to fine-tune the tool would increase the educational value a step further. Fast, individual feedback in learning programming was favored by the students. This goes in accordance with many educational theories that propose a personal learning environment to enhance understanding and confidence. However, to extract full benefit out of ChatGPT, the nuances of user interaction and correctness in response have to be worked upon. Improvements will mean that the user experience gets improved, and ChatGPT remains a necessity and useful in the changing scenario of educational technology, a scenario that is fostering an environment that needs to adapt to individual learning needs and a better understanding of a topic that is complex. There is a need for such constant adaptation and upgradation, based on user feedback, so that relevancy and effectiveness are maintained in an ever-emerging educational scenario.

V. CONCLUSIONS

A full two-tier evaluation has been presented in this paper regarding the inclusion of ChatGPT as an advice generator into educational software. The first part deals with the realization of quantitative improvements using an ARIMA model, aimed at showing significant performance enhancement with the student's error rates and completion times metrics. The second part of the evaluation was conducted with a custom questionnaire in order to measure qualitative aspects of the tool, effectiveness, user interface satisfaction, clarity of responses, and the effect on students' confidence in learning. These two research methodologies presented a two-dimensional view regarding the impact of the tool, merging rigorous statistical analysis with insightful user feedback to portray the ChatGPT with multifaceted benefits in an educational setup.

The results show that ChatGPT produced a remarkable improvement in learning programming, with a phenomenal decrease in the rate of making errors and the pace of performing tasks. In addition, feedback from the users showed that ChatGPT not only augmented the level of understanding and confidence in students but also played an effective helping and catalytic role in educational growth.

Future studies can be conducted in the sense of the scale at which ChatGPT can function in terms of other educational backgrounds and subject areas; it is tested for its adaptability and effectiveness in numerous learning environments. Future studies can also include a longitudinal analysis to study the long-term effects of ChatGPT on learning and retention in the students. Another important direction for future research is to bring AI capacities closer to the development of advice on actions sensitive to the context and personal—for example, using adaptive learning technologies that adjust content and pedagogical strategies to student needs. This will further increase the effectiveness of educational tools like ChatGPT and bring the potential for more personal and engaging learning experiences to educational landscapes.

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