The Effect of Flipped Interactive Learning (FIL) Based on ChatGPT on Students' Skills in a Large Programming Class

Al-Mothana M. Gasaymeh* and Reham M. AlMohtadi

Curriculum & Instruction Department, College of Education, Al-Hussein Bin Talal University, Ma'an, Jordan
Email: almothana.m.gasaymeh@ahu.edu.jo (A.-M.M.G.); Dr.almohtadi@ahu.edu.jo (R.M.A.)
*Corresponding author
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***Abstract*—Flipped Learning (FL) inverts traditional teaching by delivering content online outside the classroom, allowing class time for interactive, hands-on activities. This approach enhances student engagement and understanding. The integration of AI in education has revolutionized traditional teaching methods. Enhancing FL with AI has led to the emergence of what was labeled in this research paper as Flipped Interactive Learning (FIL), which integrates AI-driven tools to support and enrich interactive, personalized learning experiences. This study aimed to examine the impact of the FIL instructional model based on Chat Generative Pre-Trained Transformer (ChatGPT) on students' programming skills in an undergraduate course. The participants in this study were 74 students. This study used a semi-experimental research design; the control group consisted of 36 students, while the experimental group consisted of 38 students. The experimental group received instruction using the FIL method while the control group received instruction using the conventional FL method. The analysis of the collected data showed that using FIL-based ChatGPT contributed significantly to improving students' programming skills. Based on the findings of this study, educational institutions should adopt the FIL instructional model in academic settings in general and programming courses in particular, as it significantly improves student learning outcomes compared to conventional FL methods. In addition, institutions should also evaluate the FIL model's scalability and allocate necessary resources, such as technology infrastructure and support staff, for successful implementation. Further research should identify the most effective components of the FIL model to refine it for broader use. Moreover, continuous student feedback is essential for iterative improvements to meet their needs.**

***Keywords*—flipped interactive learning, ChatGPT, students' skills, programming course**

I. Related Work

In recent years, the use of ChatGPT and other generative AI tools has become popular in educational settings, offering various services for students and educators. Simultaneously, the FL instructional model has emerged as an innovative teaching method that shifts content delivery to pre-class activities, allowing for more interactive and engaging in-class sessions. Combining the strengths of ChatGPT and FL, the Flipped Interactive Learning (FIL) model integrates ChatGPT and FL to support and enrich interactive, personalized learning experiences, potentially leading to significant improvements in student outcomes.

A. ChatGPT in Education

In the last few years, the use of generative Artificial Intelligence (AI) technologies such as ChatGPT has become popular among university students overall the world [1]. ChatGPT offers several services for students and educators. Some of these services include helping students with their homework and study [2]. In addition, ChatGPT can support educators and students in conducting research [3], test preparation [4], language learning [5–8], academic writing [9], creating educational materials [10], and facilitating personalized learning experiences [11].

The literature has shown that university students are aware and familiar with the different aspects of ChatGPT. For instance, previous research studies showed that university students were aware of the associated concept of AI, different types of AI applications e.g., ChatGPT, and the ethical considerations associated with the use of ChatGPT [12, 13]. In addition, they are interested in using ChatGPT for personal and academic purposes [14].

Students and educators have reported several benefits of the use of generative AI writing tools such as ChatGPT for personal and educational purposes. Some of the reported benefits of ChatGPT include enhanced access in terms of providing educational support when traditional resources are unavailable [15], ensuring equity in education in terms of facilitating learning opportunities for all students regardless of their location or financial status [16], enhancing learning experiences in terms of providing interactive, immediate, and engaging responses to their inquiries [17] and facilitating personalized interactions based on their learning needs and styles [18], enhancing communication among students and between students and their instructors through facilitating the compose, rephrase, and share of messages [17], enhancing students' academic productivity in terms of providing instant and corrective feedback and offering quick access to educational resources needed for their studies [19], and stimulating creativity and critical thinking in terms of offering them new ideas and creative approaches to problem-solving as well as chances to evaluate multifaceted information and arguments [20].

Furthermore, ChatGPT has played a significant role in transforming traditional and innovative teaching methods. ChatGPT can be employed to support students' learning in traditional and teaching methods such as lectures, discussion, drill and practice, demonstration, group work, flipped classroom, project-based learning, blended learning, gamification, problem-based learning, inquiry-based learning, personalized learning, mind mapping and visual learning, and collaborative learning [21]. There are different forms of employment for ChatGPT in these methods. For instance, ChatGPT can be used to provide Question and Answer (Q&A) support, interactive polls and quizzes, simplified explanations,

interactive elements, and personalized learning experiences [22].

Generative AI writing tools in education offer a range of applications that enhance learning and teaching experiences. These tools can assist with various tasks, from creating educational content to providing personalized feedback. There are several studies that employed different types of generative AI writing tools such as ChatGPT to accomplish different educational purposes in different educational fields. For instance, some studies showed that ChatGPT can be used to enhance students' academic motivation [23], self-efficacy [24], engagement [25], self-regulation [26], metacognitive skills [27], and communication and collaboration [18].

Furthermore, other studies focused on using ChatGPT to enhance students' educational achievements and performance in different fields. For instance, Songsiengchai, Sereerat *et al.*, [28] examined the effect of using ChatGPT in English language learning among Thai pre-service teachers. The research followed a quasi-experimental research design in which the 120 students were divided equally into two groups. The experimental group learned with ChatGPT and the control group learned in the traditional way. In addition, the study examined students' perceptions of the use of ChatGPT in the experimental group using interviews. The result showed that the students who interacted with AI significantly improved their language skills. In addition, the results of the interviews showed that the students found the AI-based learning experience more engaging and personalized. They reported that the real-time feedback and interactive exercises offered by Chat GPT helped them understand and apply language concepts more effectively.

In Spain, de Zárate *et al*., [29] explored the effect of using ChatGPT on high school learning chemistry when teachers were unavailable. The researchers used a quasi-experimental research design in which the group of students was divided equally into two groups. The experimental group in which the students were allowed to use ChatGPT at home in a blended learning mode, to solve doubts and correct students' homework, and the control group learned traditionally. The results showed that the students in the experimental group witnessed a substantial improvement in their grades, achieving an increase of 30%, three times higher than that experienced by the control group.

In UAE, Al-Shamsi [30] conducted a study that aimed to examine the effect of ChatGPT on enhancing high school students' Arabic language skills and critical thinking. The researcher used quasi quasi-experimental research design in which the 70 students were divided equally into two groups. The experimental group used ChatGPT in learning the Arabic language and the control group followed a traditional learning methodology. The results showed that using ChatGPT significantly enhanced students' Arabic language skills and critical thinking compared to the use of traditional ways of learning. The study reported that the use of ChatGPT contributes to correcting errors immediately and quickly. It also provides the students with more than one method and source for correcting their errors. In addition, the application contributes to responding quickly to different learning styles.

In Egypt, Morsi and Nadia [31] conducted a study that aimed to examine the effect of designing and using educational platforms based on interactive generative AI tools on students' performance in graduate courses at the Faculty of Arts. The study adopted a pre-experimental research design in which 16 students participated in the study. The results showed that the educational intervention was significant in enhancing their achievement in this course.

The examined previous studies showed that generative AI tools such as ChatGPT have been employed in educational settings and they have shown transformative potential in terms of enhancing various aspects of the learning process across different educational contexts and fields.

B. Flipped Learning

One of the innovative teaching methods is FL which has been widely adopted in higher education [32, 33]. FL was defined as "a pedagogical approach which moves the learning contents taught by teachers' direct instruction to the time before class to increase the chances for the students and teacher to interact. Therefore, teachers would have more time to guide the learning activities and solve students' problems to promote the learning effects" [34], p. 452)". FL is rooted in several pedagogical principles that include constructivism, mastery learning, student-centered learning, active learning, and differentiated instruction [34, 35]. FL has several benefits that include enhancing engagement, improving understanding, better use of classroom time, development of higher-order skills, and providing greater flexibility [36–38].

FL enhances the learning experience by allowing students to engage with the material at their own pace and then apply their knowledge in interactive, hands-on activities during class time. Several studies employed FL to accomplish different educational purposes. For instance, the FL approach was used to enhance students' academic performance in different fields [39, 40]. In addition, the FL approach was used to enhance students' higher-order thinking skills [41], motivation [42, 43], attitudes toward learning [44], and self-regulated learning [45]. Besides the evident importance of FL, interactivity in in-class and out-class activities is a crucial component of students' learning [46]. Active student engagement is the heart of effective learning [46]. Previous studies have shown that facilitating dynamic and mutual exchange between students and their learning environment would have several benefits that include fostering engagement, enhancing understanding, developing critical thinking, matching diverse student needs, and promoting lifelong learning [47, 48]. From the pedagogy point of view, interactive learning environments would allow students to explore, ask questions, and engage in hands-on activities where that support constructivist theory suggestions that learners construct their understanding and knowledge of the world through experiences and reflecting on those experiences [49]. In addition, interactivity supports experiential learning that focuses on concrete experience, reflective observation, abstract conceptualization, and active experimentation [50]. In addition, guided interactive learning would support cognitive load theory that focuses on the human working memory and the amount of processed information [51], where an interactive learning environment can help manage the cognitive load by breaking down information into manageable chunks and allowing students to

engage with content at their own pace. In addition, an interactive and supportive learning environment would promote deeper learning [52] promoting a higher level of thinking.

In the flipped classroom, a possible criticism of FL is the lack of interactivity in the pre-class educational tasks [35]. Often, these materials, in the form of video lectures or reading assignments, can be passive. This mode of content delivery may not be sufficiently interactive or engaging for all students. Furthermore, while in-class activities can provide opportunities for feedback, delayed interaction in pre-class assignments can limit immediate feedback, which is crucial for effective learning. In addition, students who struggle with pre-class content may not receive the immediate support they need, potentially hindering their learning process.

As with out-of-class activities, in large classes, there is significant criticism of the level of interactivity in FL during in-class activities. The limited individual attention that can be provided becomes a major issue. In such settings, it becomes challenging for the teacher to offer personalized attention to each student, making it harder to address individual learning needs and questions during interactive sessions. This difficulty in personalization can hinder the overall effectiveness of the FL model. For instance, Karabulut-Ilgu, Jaramillo Cherrez, and Jahren [39] pointed out that one of the challenges of FL is the increased instructor workload. Additionally, they noted that during class, a single instructor often must assist many students seeking help. Additionally, the larger the class, the fewer opportunities there are for meaningful interaction between the teacher and each student. This reduced teacher-student interaction can significantly limit the benefits of in-class activities intended to deepen students' understanding and engagement with the material.

Emerging technologies play an integral role in facilitating the development of interactive learning environments. For instance, the implementation of ChatGPT in the in-class and out-of-class educational activities in the flipped classroom would increase the level of interactivity on the interactivity spectrum [53] that ranges from 'authoritative' to 'dialogic', improve class preparation, and data-driven teaching and learning [51]. In addition, the integration of emerging technologies in education is widely accepted by faculty members and students [54–57].

FL is an effective educational strategy that allows students to engage with material at their own pace and apply their knowledge during interactive class activities. Studies have shown success in improving academic performance, higher-order thinking, motivation, and self-regulated learning. Similarly, generative AI tools like ChatGPT enhance educational outcomes by boosting motivation, self-efficacy, engagement, and communication through personalized feedback. Combining these strengths into what was labeled in this research paper as the Flipped Interactive Learning (FIL) model could leverage the benefits of both approaches, potentially leading to greater improvements in students' learning experiences and outcomes. Therefore, the current study aimed to enhance interactivity in the traditional FL approach by providing interactive learning tasks facilitated by ChatGPT in in-class and out-class activities in a large programming class. The interactivity in-class activities were accomplished by the discussion between the instructor and students as well as interaction between students and ChatGPT while the interactivity in out-class activities was accomplished by promoting interaction between students and ChatGPT. Enhancing FL with ChatGPT has led to the emergence of the FIL, which integrates AI-driven tools i.e., ChatGPT to support and enrich interactive, personalized learning experiences. The current study aimed to examine the impact of the FIL instructional model based on ChatGPT on students' skills in large undergraduate programming classes.

II. Method

The current study used a quasi-experimental research design. The participants were divided into two groups. The experimental group received instruction using the FIL method while the control group received instruction using the FL method. The following sections provide an overview of the participants, the used instrument, the study settings and procedure, and the data analysis procedure.

A. Participants

The participants were 74 university students from the College of Education at a university in Jordan. They were enrolled in a course under the name "Computer Application in Education" in the second semester of the 2023/2024 academic year. The participants were students in three different majors that were: class teacher, special education, and Kindergarten. The great majority of the participants were in their third and fourth academic year. The participants were between the ages of 18 and 22 which represents the typical age of bachelor students.

B. Instrument

The current study involved the use of pre-/posttests. The post-test was the same test as the pretest. The test was developed by the researcher. The test was developed to measure students' students' skills in Visual Basic 6 programming language. The test consisted of questions that aimed to measure students' programming skills.

C. Study Settings and Procedure

The study took place in the second semester of the 2023/2024 academic year. The selected course for the experiment was the "Computer Application in Education" course. The course was offered to students in the College of Education at a university in Southern Jordan. In this course, the students met twice a week for one hour and a half. FL and FIL were introduced as the instructional models, and they were used for 8 weeks.

The experiment started in the eighth week of the semester. The instructor explained to the participants the purpose of the study and the use of FL and FIL as instructional models. The study began with the use of the pre-test to measure students' preliminary skills in Visual Basic 6 programming language. After that, the FL and FIL instructional models were introduced as instructional models. Then, the post-test was administered to re-measure students' skills in Visual Basic 6 programming language. The conventional FL and FIL instructional models involve the use of 10 instructional videos that were developed to enhance students' skills in Visual Basic 6 programming language. The average duration of the

videos was 15 to 20 minutes. The videos provided students with practical demonstrations of programming in Visual Basic 6. The videos were posted on the instructor's YouTube channel. Students were instructed to view the videos before class, but they also had the option to watch them during class.

To enhance interactivity, students in the FIL group were encouraged to engage with generative AI writing tools i.e., ChatGPT, both in class and outside of class to support their learning. In out-of-class educational activities, the students were asked to solve a set of exercises with the aid of ChatGPT before and after watching the instructional videos. In addition, the students were asked to engage with ChatGPT for pre-class preparation. In in-class educational activities, besides conventional interaction with the instructor, the students were asked to chat with ChatGPT to clarify and deepen their understanding of the educational topics. Table 1 shows the used procedure in the FL and FIL instructional models.

Table 1. Fl and FIL instructional models

Type of activities	FL Instructional model	FIL instructional model
Out-of-class activities	Students were asked to watch instructional videos.	Students were asked to watch instructional videos. Students were asked to solve a set of exercises related to programming in Visual Basic 6 with the aid of ChatGPT before and after watching the instructional videos. Students were encouraged to use ChatGPT to deepen their understanding of the educational content and to clarify any educational points in the videos.
In-class activities	The instructor delivered a short lecture. The instructor and the students review the content through Q&A sessions. Students were encouraged to ask the instructor to clarify and deepen their understanding of the educational topics.	The instructor delivered a short lecture. The instructor utilized ChatGPT to review the content through Q&A sessions. Students were encouraged to chat with ChatGPT to clarify and deepen their understanding of the educational topics.

D. Data Analysis

Paired t-tests for dependent samples were conducted to compare participants' skills in Visual Basic 6 programming language before and after the use of the conventional FL and FIL instructional models for the students in the control and experimental groups. To test the initial equivalence among groups, the t-test for independent samples was used to examine the difference between the mean of the pretest results of the students in the control and experimental groups. To determine the effects of FIL i.e. using ChatGPT to enhance interactivity with students in the experimental group, the t-test for independent samples was used to examine the difference between the mean of the posttest results of the students in the control and experimental group.

III. Results and Discussion

To examine the effect of the use of the conventional FL and FIL instructional models on students' skills in Visual Basic 6 programming language, t-tests for dependent samples were performed. Table 2 shows that, for the participants in the control group, the mean of the pretest scores (M = 3.86, SD = 2.03) was significantly different than the mean of the posttest scores (M = 7.56, SD = 1.84), t (35) = −9.06, p = 0.00. In addition, for the experimental group, the mean of the pretest scores (M = 3.89, SD = 2.32) for the participants was significantly different than the mean of the posttest scores (M = 8.34, SD = 1.42), t (37) = −10.28, p = 0.00.

Table 2. T-test for Dependent Samples for the Pretest and Posttest of the Control and Experimental Groups

		M	N	SD	t	df	Sig. 2-tailed
Control Group	Pretest	3.86	36	2.03	−9.06	35	0.00
	Posttest	7.56	36	1.84			
Experimental Group	Pretest	3.89	38	2.32	−10.28	37	0.00
	Posttest	8.34	38	1.42			

Both instructional models, conventional FL and FIL, were effective in enhancing students' skills in Visual Basic 6, as evidenced by the significant increase in post-test scores compared to pretest scores. However, both methods demonstrated substantial effectiveness in improving programming skills, as indicated by the very low p-values, which confirm that the observed improvements were statistically significant. A possible explanation of the results is that the employment of both models in teaching programming language has promoted active engagement, personalized learning, and instructor support, which contribute to better understanding and retention of programming concepts. In addition, enhanced motivation, repeated exposure to the material, and opportunities for peer collaboration further explain the significant improvements observed in both groups. These results underscore the effectiveness of student-centered learning approaches, particularly those incorporating interactive elements, in teaching technical subjects like programming. The effectiveness of FL and FIL instructional models in enhancing students' programming skills aligned with the findings of previous studies that showed the effectiveness of different forms of FL in enhancing students' educational performance [38, 39].

The experimental group using FIL showed a slightly higher mean posttest score compared to the control group, suggesting that the FIL model might be more effective than the conventional FL model. The FIL model, with its added interactive elements and real-time feedback, potentially offers even greater benefits, as evidenced by the slightly higher post-test scores in the experimental group. However, to further evaluate the effectiveness of the FIL model compared

to the conventional FL model on students' skills in the Visual Basic 6 programming language, a t-test for independent samples was conducted. Table 3 shows that the mean of the pretest scores for the participants in the control group (M = 3.86, SD = 2.03) was not significantly different from the mean of the pretest scores for the participants in the experimental group (M = 3.89, SD = 2.32), t (72) = -0.066, p = 0.95. But the mean of the post-test scores for the participants in the control group (M = 7.56, SD = 1.84) was significantly different than the mean of the post-test scores for the participants in the experimental group (M = 8.34, SD = 1.42), t (72) = -2.063, p = 0.04. The mean of the post-test scores for the participants in the experimental group was higher than the control group. This demonstrates that the experimental group showed statistically significant improvement compared to the control group, suggesting the effectiveness of the FIL instructional model administered to the experimental group.

Table 3. T-test for independent samples for the pretest and posttest of the control and experimental groups

		M	N	SD	t	df	Sig. 2-tailed
Control Group	Pretest	3.86	36	2.03	−0.066	72	0.95
Experimental Group	Pretest	3.89	38	2.32			
Control Group	Posttest	7.56	36	1.84	−2.063	72	0.04
Experimental Group	Posttest	8.34	38	1.42			

A possible explanation for these results is the integration of ChatGPT, which has enhanced interactivity. This aligns with previous literature that emphasizes the importance of interactive learning environments for fostering engagement, understanding, and critical thinking [44–47]. Generative AI tools like ChatGPT have been shown to significantly elevate the level of interactivity and improve class preparation [51]. Such enhancements can lead to a more engaging and interactive learning environment, both inside and outside the classroom within the context of flipped learning. In addition, the implementation of ChatGPT provides personalized attention to each student. ChatGPT might serve as an additional resource for students to ask questions and receive tailored explanations, ensuring that individual learning needs are met. The effectiveness of the FIL instructional model based on ChatGPT in enhancing students' programming skills aligned with the findings of previous studies that showed the effectiveness of the different forms of employment ChatGPT enhancing students' educational performance [28–31].

IV. Conclusion and Recommendations

The study aimed to examine the effect of conventional FL and FIL instructional models on enhancing students' skills in Visual Basic 6 programming language. The results indicate that both instructional models significantly improved students' skills, as evidenced by the significant difference between pre-test and post-test scores in both the control group (conventional FL) and the experimental group (FIL). However, the findings suggest that while both instructional models are effective in improving students' Visual Basic 6 skills, the FIL model demonstrates a superior effect compared to the conventional FL model. Based on the study's findings, it is recommended that educational institutions consider adopting the FIL model in programming courses. The significant improvement observed in the experimental group indicates that the FIL model can enhance student learning outcomes more effectively than conventional FL methods.

Further research is needed to explore the specific components of the FIL model that contribute most to its effectiveness. Understanding these elements can help refine and optimize the model for broader application across different programming languages and subjects. Additionally, it is important to continuously gather feedback from students regarding their experiences with the FIL model and use this feedback to make iterative improvements. This approach ensures that the instructional model remains responsive to student needs and preferences.

Finally, educational institutions should evaluate the scalability of the FIL model in various educational settings. Allocating necessary resources, such as technology infrastructure and support staff, will facilitate the successful implementation of the FIL model.

V. Limitations

The interpretation of the results of the current study should consider some limitations. The sample size was quite small, with only 74 students, who were divided into two groups, from a single undergraduate programming course, which might limit the generalizability of the results to other contexts or larger populations. Furthermore, this study focused on the immediate impact of the FIL model on students' programming skills rather than considering the immediate and long-term impact of the FIL model on students' programming skills and the application of the acquired skills. In the context of employing generative AI technologies in educational environments, the current study was limited to the use of only one AI technology i.e., ChatGPT, which may not capture the potential benefits or drawbacks of other AI tools or broader AI applications in educational settings.

Additionally, the various forms of how instructors would implement the FIL model and utilize generative AI technologies e.g., ChatGPT could have influenced the outcomes. The study also did not account for external variables such as students' prior knowledge, learning styles, or access to additional resources, which could have affected their improvement in programming skills. By acknowledging these limitations, future research can address these aspects to provide a more comprehensive understanding of the impact of the FIL models and AI technologies e.g., ChatGPT integration in education.

Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

Gasaymeh supervised the development of the data collection instrument and the process of collecting and

analyzing the data. Gasaymeh and AlMohtadi have written, reviewed, and agreed to the published version of the manuscript. All authors had approved the final version.

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