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AI-ZPD Connection: Scaffolding Learner Experience with Generative Tools

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Abstract: The use of generative AI in education is not just a trend—it's an inevitability. These tools are rapidly becoming an integral and growing part of the learning landscape. The applicability is both in teaching and learning methodology. Freshmen computer programming students utilize AI tools in their laboratory product tasks. This is to either supplement them, help jumpstart it, or view sample codes to make them understand better. This study is directed to assess learner performance in a computer programming course using the Java language taking the BSIT degree. It undermines the theory of ZPD, zone of proximal development. In the ZPD level of potential development, they solve Java machine problems under guidance of a more knowledgeable individual and in the level of actual development, they solve them on their own without any learning scaffolds. The paper also aims to mount learner experience from the level of potential development based on a questionnaire inquiring the utilization of generative AI tools while solving machine problems through coding and executing their coursework. The study shows that 87% of the 117 students claimed they are using ChatGPT, or other AI-powered integrated development environments while answering their machine problems in the Computer Programming course. It has also been revealed that students received higher grading average of 90.2% when utilizing generative AI tools and only 77.9% otherwise. When 79% of the students asserted that they tapped the use of generative AI tools to understand Java concepts and 72% professed they were seeking code explanations, utilization was indeed inevitable. The dependence of the students on the tools may play in the zone of proximal development, which is identified as the distance between the two levels.

Keywords: generative AI tools, zone of proximal development, computer programming, learner experience, learning scaffolds

1. Introduction

It’s inevitable, the utilization of generative AI tools in education is an inevitability, and it's already rapidly transforming the learning landscape. The applicability is both for teaching and learning methodology. Freshmen computer programming students are often given immense application of Java Programming Language as core programming language for the degree leading to software and information technology. Students are utilizing AI tools in their laboratory product tasks or machine exercises. This is to either supplement them, help jumpstart it, and/or view sample codes to help them understand better. Lee et al. (2025) identified the growing interest in applying generative AI to education, particularly in programming instruction. Traditional instruction often challenges students to grasp abstract programming concepts. Popovici (2023) from the Politehnica University of Bucharest, have found that their students have been expending generative AI tools, ChatGPT and its precursors for answering their homework for at least 6 months. They have explored the ChatGPT capabilities and assessed their value for educational purposes. At present, while it’s inescapable for students to utilize generative AI tools while they were given programming problem tasks in a laboratory session, their logic formulation skills narrow down. They can only assume and think that every solution they search, and encounter comes handy.

The zone of proximal development was originally developed to account for the learning potential of children and investigates zone of proximal development applications to the concept of teacher professional development (Vgotsky, 1978). The Zone of Proximal

Development (ZPD) is the range of tasks a learner can do with help but not on their own. It refers to the tasks a learner can accomplish with guidance from others, but not independently. It's the set of skills a person can learn with a little help, which they can't master by themselves. Within the zone of proximal development there are two levels, the actual development level, which is the upper limit of tasks that a learner can perform independently. And the second level is the level of potential development, where the upper limit of tasks that a learner can perform with the assistance of a more competent individual.

This is the case under study of this experiential paper particularly freshmen students taking Computer Programming 2. Valderama (2018) highlights in a study about the two levels in the zone of proximal development (ZPD), the Potential Development Level, where students undertook activities for course learning in the form of activity items for laboratory through learning scaffolds passing through teaching/learning activities (TLA) listed in the course syllabus, i.e., concept and flow discussions, actual program demonstration in the presence of a faculty. The other is the Level of Actual Development, where students went through the activities intended and aligned for course learning throughout activity items for machine laboratory exercises using their own aptitude and capability, utilizing through paced learning scaffolds, thus termed as an experiential learning activity. In this study, students work on laboratory machine problems on their own, identifying them in the ZPD level of actual development. On the ZPD level of potential development, students may either work with peer collaboration, aid from the professor, and other external sources as their learning scaffold. This study poses that their scaffold is the immense use of generative AI programming tools. However, authenticity depends on striking a balance between AI technologies and human judgment. ChatGPT calls into question the legitimacy of academic labor, emphasizing the necessity of moral standards and encouraging critical thinking (Werdiningsih, 2024). The Zone of Proximal Development (ZPD) developed by Russian psychologist Vygotsky (1978) defined in his work, as "the distance between the level of actual development as determined by independent problem solving and the potential development level as determined through problem solving under guidance or in collaboration with more knowledgeable peer." In the generative AI era, as this paper exhibits, the more capable peer is ChatGPT and other similar tools. Ebardo & Suarez (2023) revealed that while attitude can lead to the behavioral intention to adopt contemporary learning, specifically mobile learning, social norms do not exhibit a positive influence at a significant level.

This study aims to assess the competence of BSIT students in Java programming within the zone of proximal development. In the level of potential development where they are assigned machine problems to solve under guidance and the level of actual development where they are assigned machine problems to solve on their own without any learning scaffolds. More explicitly, the succeeding objectives were concentrated in this study, 1) present learners' performance in the actual development level (where students were entailed to solve and code Java machine problems distinctly) and in the level of potential development, (where they were under the aid of peers, professor and other external sources), and 2) mount learner experience from the level of potential development based on a questionnaire inquiring the utilization of generative AI tools while coding and executing their coursework.

2. Research Design

2.1 Profile and Instrumentation

The study employed quantitative and design to discover learners' performance on Java machine problems where they were asked to solve on the topics of variable declarations, use of input classes, arithmetic operations, decision control structures, repetition structures, and arrays. These topics have already been introduced in a pre-requisite Computer Programming 1 course. Throughout the trial phases the researcher had determined, the empirical method of research was used in this study. This comprises of assigning Java machine problems in the midterm and final term period. Student participants were composed of freshmen taking up the bachelor's degree in the Information Technology program. 117 students under four different

sections participated in the study through convenience sampling. They are composed of 44 female and 73 male students aged 18-27 years.

The participants were assigned to machine laboratory problems represented as course learning activities (CLA). The students' performance was evaluated using a 10-point laboratory rubric. This rubric was developed by faculty committees who teach programming courses and was supervised by the IT department chairperson. A questionnaire was floated after the semester on the inquiry of the utilization of generative AI tools and it is composed of 16 questions. The questions were evaluated to a validation process for content validity. McBurney (1995) defined that face validity is the superficial judgment of whether a test appears to measure what it's supposed to. Content validity, on the other hand, is a more rigorous, expert-based evaluation of whether the test comprehensively covers all aspects of the concept it's intended to measure. The questionnaire was formulated by (5) experts who are handling computer programming courses, including the chairperson. Four (4) of the experts tapped the questions as essential. Following the formula of Taylor (2017) in determining the ratio of content validity (CVR), the worth of the questionnaire is based on the experts' ratings. The equation is for Ratio for Validity of Content is CVR = [E - (N / 2)) / (N / 2)], wherein E is the total number of experts who rated the questionnaire as essential, and N is overall number of experts. The CVR is 0.6 which is an acceptable outcome.

3. Results and Discussion

3.1 Student Performance in the ZPD Levels

The zone of proximal development provides the structure of a typical learner in phases one is not aware of. Lev Vygotsky claimed that static measures assess mental functioning which has already matured, fossilized (Shabani, et. al, 2010). In the zone of proximal development, it is highly essential that the development of mental capacities of students, especially in the early years of tertiary, must be assessed through collaboration with a more competent individual and not solely based on one's independent pace. In the course of this paper, students under the Information Technology program in a Philippine-based higher education institution were tapped by the researcher to allow discovery beneficiaries that the utilization of AI generative tools as scaffolding strategies were operative amidst the learning phases from zero or little knowledge to the widening of the competency of a learner as results reflect as follows.

Gaging in the level of potential development, all 117 learners were given 8 to 9 sets of laboratory exercises in Java during the midterm period of the semester. Each set may contain 2-4 Java files to fully compile and execute. In the actual development level, they were given 5 machine problems each on the areas of variable declarations, use of input classes, arithmetic operations, decision and repetition structures, and arrays. This was administered in the final term period. The manner this coursework is given was fully monitored coding exercise, where students cannot switch tabs while coding, cannot collaborate with anyone and print lecture notes or sample codes are prohibited from access. Students in the senior year were invited to proctor. Grading each Java program is based on a 10-point rubric, below is Table 1 showing the grade percentage of the student performance.

Table 1. *Grade Performance of Students*

Section	Actual Development Level	Potential Development Level
101i	79%	92%
102i	76%	87%
103i	80%	91%
104i	76%	90%
Average	77.9%	90.2%

The difference in the grading presents that when students conveniently create Java codes and answer the machine problems in the laboratory with learning scaffolds identified to be the generative AI tools, they have much more correctly written and executed Java program codes showing higher grading. Lower grades have reflected otherwise when they code on their own. Jo & Soderberg (2025) suggests that platforms can sustain relevance by investing in brand-building strategies, fostering engaged learning communities, and integrating AI-powered tools in a complementary manner. In this context, the application of using ChatGPT and additional generative AI tools in programming can be utilized in manners that are monitored by the faculty and only employed on logic formulation and not on actual coding.

Table 2. *Statistical Data*

Variables	Mean	SD	Diff. between the means	t	Sig.
Average Grade of Students in the Actual Development Level	77.87	2.043	12.354	-8.345	0.0002
Average Grade of Students of Potential Development Level	90.22	2.143			

Table 2 shows that the statistical performance of the students in the actual development level has a remarkable variance versus those in the level of potential development. It entails a significant difference in the efficacy of the controlled and experimental laboratory activity learner performance. The standard deviation in the actual development was 2.043 while in the level of potential development was 2.143. The difference between the two is 12.354 which has a t-value -8.345 and significant difference in the score with 0.0020 at α=0.05.

3.2 Learner Experience in Generative AI utilization

The students responded to a 16-item questionnaire. In the interest of ethical and authenticity considerations, the respondents were ensured of anonymity and having a disclaimer of their replies would not in any way affect their grading performance in the course. They were also given the preference to opt out in case participation is unsolicited. Questions (Q) 1-3 were placed on their section, age, and gender. From these responses, Q4 revealed that 87% of the 117 are claimed that they are using ChatGPT, or other AI-powered integrated development environments (IDEs) while answering their machine problems in Java. Figure 1 presents the utilization of the tools (Q5).

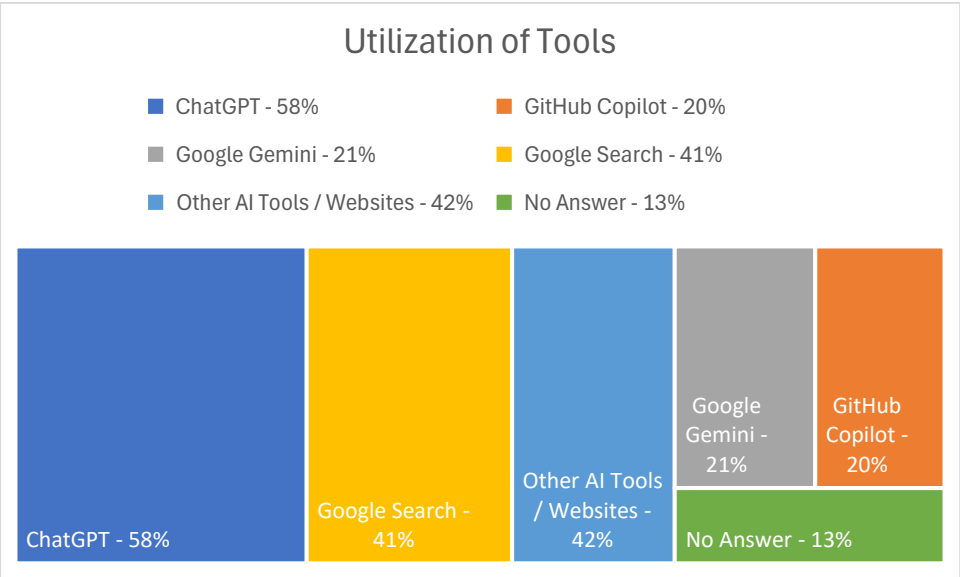

Figure 1. Utilization of Tools

From these results, it is inevitable. Students tend to utilize these tools when they are solving and coding Java programming problems. And the advert implication shows that when they are monitored to work on their own, they have lower performance in creating executable codes. Students were also queried (Q6) about the frequency of their use of the tools, and the results are as follows: 45% used them occasionally, 30% rarely, 21% used them several times a week, 5% daily, and only 5% have not used them. When asked about the purpose of the utilization in their Java coursework in (Q7), Table 3 presents a detailed percentage.

Table 3. *Purpose of Utilizing Tools in the Coursework*

Purpose	# of Students	Percentage
Getting code snippets or examples	54	46%
Debugging code	45	38%
Understanding concepts	93	79%
Generating explanations for code	84	72%
Finding alternative solutions	54	46%
Other purposes	10	9%
No Answer	4	3%

Respondents were instructed to select all purposes that may apply to them. Gaging from these results, Bugin (2024) stated that using generative AI effectively, much like other digital technologies, depends on having the right technical skills and resources. Since 93 of 117 students have asserted that they used the tools to understand the concepts and 84 have said that they are generating explanations for code, there is an identifiable success that supplements student understanding. However, there are still 54 who ticked the option of getting code snippets or examples and finding alternative solutions, thus 46% need to see actual solutions for them to function as well. Questions Q8-Q11 were composed of qualitative inquiry on the biggest benefits of using ChatGPT or other AI tools in your Java programming coursework, the biggest drawbacks, how has using AI tools impacted their understanding of Java programming concepts and how has using AI tools impacted their ability to solve Java programming problems. Most of the answers to these questions summarize the tools that supplement their learning, some feel unfair while others are figuring out on their own, some are categorically searching the actual codes, dishonesty, and being tool dependent. These results may lead to qualitative analysis for further analysis.

When Mulyani (2024) highlights the promising potential of Generative AI in enhancing teaching performance, it also revealed various challenges and obstacles during its implementation. On the learning experience of the students (Q12), 42% felt that they were affected somewhat positively. 32% were neutral, 19% were very positive, 6% were somewhat negatively affected, no one was very negatively affected, and 1% did not answer. While this research claims that it is inevitable that students are utilizing generative AI tools during their coursework, Q13 result reveals that 63% of the respondents believe that using AI tools has positively influenced their academic performance (e.g., grades, scores) in Java programming. 26% are unsure, only 9% say they do not believe so, and 1% did not answer. When asked about how using AI tools has affected their confidence ability to program in Java (Q14), the majority or 64% replied it has increased, 30% has no significant change, 15% claimed it has decreased and 1% did not answer. On the inquiry of feeling that relying too heavily on AI tools has negatively impacted their learning (Q15), 68% said yes, 30% no and 2% did not answer. Lastly, Q16 asked for other comments or observations they would like to share about the experience using ChatGPT or other AI tools in your Java programming coursework. This qualitative question may be used for further analysis in another future study.

4. Conclusion

In the era of artificial intelligence (AI), there is growing interest in applying generative AI to education, particularly in programming instruction. Traditional instruction often challenges

students to grasp abstract programming concepts (Lee et al., 2025). It is essential to discuss the implications enhanced academic policies on formal and informal disaster education within an institution while highlighting limitations on the use of AI tools (Ebardo, et. al, 2020). When 93 of 117 students in this study asserted that they used generative AI tools to understand the Java concepts and 84 have said that they are generating explanations for code, utilization was indeed inevitable.

The challenge remains in the teaching strategies and approaches. In the ZPD level of actual development, the professor on this study has implemented a strict and proctored based of monitoring the students so they cannot use any tool and coding on their own is instigated. On the other hand, on the ZPD level of potential development, they are free to seek any help from all sorts of resources. It has been clear from the results that the employment of generative AI tools reveals that their performance has a suggestive indicator exhibiting in Table 1 on their grade performance. Further studies may be confabulated on the supplementary effectiveness of allowing students to complement their learning styles and competencies through the usage of generative AI tools in computer programming. As Vygotsky (1978) the zone of proximal development (ZPD) is the variance between what a learner can do on their own and what they can accomplish with the help of a more experienced peer," the dependence of the students on the tools may unerringly play in that distance.

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