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# Student creativity in the age of AI: Are we raising prompt engineers or thinkers?

Student paper

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***Abstract*** **- As generative artificial intelligence (AI) tools become more common in education, new questions arise about their impact on student learning, particularly on creativity and independent thinking. This study examines how AI affects secondary school education through both surveys and experiments. We gathered data from anonymous surveys of students (n = 161) and teachers (n = 51), and from a controlled programming experiment with 20 senior students. In the experiment, students received instructions for three programming tasks that matched their curriculum. They completed these tasks using both AI-assisted and traditional methods. The tasks were judged for accuracy, organization, and creativity. The survey indicates that AI use is widespread, that students have improved in prompt engineering, and that apprehension regarding originality and honesty has arisen. AI helps improve accuracy and optimize solutions for students, yet their work showed less variability and was less creative. By comparing students' and teachers' views with what was observed, it suggests that teaching strategies should use AI to support, rather than replace, independent thinking.**

***Keywords - Artificial Intelligence in Education, Student Creativity, Programming Education, AI-Assisted Learning, Secondary Education, Generative AI (GenAI)***

## I. INTRODUCTION

Generative AI tools like ChatGPT are now widely available to students, especially in computer science and programming. In this paper, generative artificial intelligence is referred to as Generative AI (GenAI), meaning AI systems that generate new text, code, or images based on user prompts. Many describe these tools as transformative for education, helping with idea generation, task organization, and problem explanation [1]. There are also concerns that students may become too reliant on AI, which could weaken their independent thinking and higher-level reasoning skills [2].

Creativity is important in programming education because there are often many ways to solve a problem. AI tools can make ideas clearer and easier to express, but research shows they might also reduce originality and flexibility, resulting in more similar solutions [3]. Even though people talk a lot about AI in education, there are still few controlled studies on how AI affects creativity in real secondary-school settings.

This study aims to fill this gap by using both anonymous surveys and a controlled programming experiment. Both parts are given equal weight, allowing a direct comparison between what students and teachers think about using AI and what students actually do.

## II. RESEARCH QUESTION AND HYPOTHESES

This study looks at how generative AI affects student creativity and independent thinking in secondary school programming. Based on this, the research questions are:

***RQ1****: How does AI assistance affect functional correctness and structural quality in student programming tasks?*
***RQ2****: How does AI assistance influence student creativity in programming tasks?*
***RQ3****: How do perceptions of AI use compare with observed student behaviour?*

Based on the findings, the following hypothesis was proposed*:*

***H1:*** *AI-assisted students will demonstrate higher functional correctness, while non-AI students will exhibit higher creativity due to greater diversity in solution approaches.*

## III. LITERATURE REVIEW

Recent studies show that generative artificial intelligence, especially large language models like ChatGPT, is changing education in significant ways. Zhai et al. [4] describe ChatGPT as a "game changer" because it explains concepts, gives feedback, and creates content across many subjects. Kasneci et al. [2] add that these models can make learning easier and more accessible, especially when they help students understand material rather than just doing the work for them.

However, these benefits also bring up important teaching and ethical concerns. Reviews show that if AI use is not managed, students might rely on it too much, think less for themselves, and lose critical thinking skills [5]. These risks are higher in secondary schools, where students are still building basic thinking skills.

### *A. AI, Academic Performance and Creativity*

Experiments show more complicated effects. Doshi and Hauser [6] found that generative AI can boost individual creativity, but it may make group work less diverse and produce similar outcomes. Long-term studies show that creativity can drop after using AI for a while, even after students stop using it [7]. These results make us wonder if AI's creative benefits are only temporary.

### B. AI, Creativity as a Measurable Cognitive Construct

In educational research, creativity is often measured by looking at divergent thinking. Runco and Acar (2014) [8] list fluency, flexibility, and originality as key signs of creative potential. Studies of the Torrance Test of Creative Thinking show that these measures are reliable and valid [9]. Experts also often judge creativity. Amabile's Consensual Assessment Technique (CAT) shows that creative work can be rated reliably when experts agree on what counts as creative [10]. Later studies confirm that this method works well in academic settings [11]. These approaches give a strong basis for judging creativity in student programming tasks.

### C. Synthesis and Research Gap

Overall, research shows a main conflict. Generative AI can speed up work and help with idea generation, but it can also limit originality and variety. Most studies use surveys or focus on college students, and few combine surveys with experiments in secondary schools. This study addresses this gap by using a mixed-methods approach. It combines anonymous surveys with a controlled programming experiment.

## IV. METHODOLOGY

### A. Survey Design and Administration

This study used two anonymous questionnaires, one for students and one for teachers, at Druga gimnazija Sarajevo, a secondary school offering both the national curriculum and the International Baccalaureate (IB) programme. The surveys were made and shared through Google Forms, and all responses were exported to Excel for analysis. There were 161 student responses and 51 teacher responses.

#### 1) Ethical approval and collection timeline

Data collection started once all required permissions were in place. The Ministry of Education of Canton Sarajevo was asked for approval on 11 October 2025 and gave it on 5th of December 2025. After that, the student survey link was sent to homeroom teachers on the 7th of December 2025 and stayed open for a month, leading to 161 student responses.

All responses were anonymous. No names, student IDs, or other identifying details were collected. Participation was voluntary and based on informed consent, following standard educational research ethics.

#### 2) Survey instruments and constructs

The student survey was designed to capture (i) frequency and patterns of AI tool use, (ii) purposes of use (e.g., homework support, concept clarification, writing support), (iii) perceived influence of AI on creativity and autonomy, (iv) prompting practices and self-assessed prompt quality, and (v) perceptions of ethical issues such as disclosure and academic integrity

The teacher questionnaire was constructed to capture (i) perceptions of student AI use frequency, (ii) observed effects on originality, (iii) challenges for assessment validity and grading, and (iv) concerns related to academic honesty and detectability of AI-assisted work.

Both surveys used structured questions, such as a Likert scale and multiple-choice items. These questions were meant to collect quantitative data and also to learn more about motivations, concerns, and changes seen in student work.

#### 3) Sampling approach and respondent profile

The demographic characteristics of the student and teacher samples are summarised in Tables I and II. Presenting these data in tabular form provides a transparent overview of grade levels, programme affiliations, age distribution, and teaching experience.

TABLE I. STUDENT SAMPLE CHARACTERISTICS (N = 161)

| Variable | Category | Percentage (%) |
|---|---|---|
| Grade level | First year | 24.2 |
| | Second year | 25.5 |
| | Third year | 25.5 |
| | Fourth year | 24.8 |
| Programme | IB programme | 51.6 |
| | National programme | 48.4 |
| Age | 15 years | 16.8 |
| | 16 years | 24.2 |
| | 17 years | 28.6 |
| | 18 years | 24.2 |
| | 19+ years | 6.2 |

TABLE II. TEACHER SAMPLE CHARACTERISTICS (N = 51)

| Variable | Category | Percentage (%) |
|---|---|---|
| Programme taught | IB programme | 41.2 |
| | National programme | 23.5 |
| | Both programmes | 35.3 |
| Teaching experience | 0–5 years | 21.6 |
| | 6–10 years | 15.7 |
| | 11–20 years | 39.2 |
| | 20+ years | 23.5 |

#### 4) Distribution procedure and survey environment

Homeroom teachers sent the Google Forms survey link to their classes via the usual communication channels, and students completed the survey during their homeroom period. This method included students from different grades and programs, reducing the risk of selection bias from teacher access or informal networks. Students also completed the survey at school, which helps keep the results valid for perception-based questions.

The teacher survey link was sent to all teaching staff using the school's communication channels.

#### 5) Data analysis approach and reporting

Survey data were exported from Google Forms into Excel. Analysis was conducted using:

- descriptive statistics (frequencies, percentages, central tendency for Likert items where applicable),
- comparative summaries by programme type and demographic groups (where relevant to research questions)

### B. *Experimental Design and Procedure*

To add to the survey results based on students' perceptions, a controlled experiment was set up to see how students perform in practice with and without AI assistance.

*1) Participating and grouping*

The experiment included 20 senior students drawn from both programmes:

- 10 IB programme students
- 10 national programme students

Students were allocated into four experimental groups (n = 5 per group):

1. IB with AI
2. IB without AI
3. National programme with AI
4. National programme without AI

*2) Experimental setting and duration grouping*

The experiment took place in a classroom during regular class hours. Each group had 90 minutes, or two periods, to finish the tasks. All groups worked under the same conditions, with identical time limits, tasks based on the curriculum, and the same submission rules.

There was a clear difference in how long each group took. Students who used AI finished all tasks in 15 to 25 minutes, while those without AI used almost the full 90 minutes. This time gap is important because it reflects changes in workload and how students approached the problems, so it is part of the experimental record.

*3) Task design and instruction sheets*

Students received instruction sheets with three programming tasks in Java, which is the language used in their curriculum. The tasks increased in difficulty, starting with array manipulation and ending with more open-ended logic, such as menu-based programs. Both the AI and non-AI groups worked on the same tasks to ensure a fair comparison.

- Students in the non-AI group got an instruction sheet and completed the tasks using only their own knowledge and approved non-AI resources, like notes or official documentation.
- Students in the AI group got an instruction sheet with extra tips for using AI. The tips explained how to write prompts and keep a prompt log. Students recorded the prompts they used and the AI tools they picked, so they could review them later. Students assigned to the AI-assisted group could make use of widely accessible generative AI tools, such as ChatGPT or other language model-based assistants

*4) Anonymization and coding scheme*

The experimental work was anonymized using a coding system to ensure no student identities appeared in the dataset. Each submission was labeled with one of the following codes:

- IB AI-assisted: IBAI01–IBAI05
- IB non-AI: IBNAI01–IBNAI05
- National AI-assisted: OSAI01–OSAI05
- National non-AI: OSNAI01–OSNAI05

This coding system allowed for blind evaluation and made it possible to compare results consistently across different groups.

### C. *Evaluation Framework*

Student performance was evaluated with a clear framework that considered both technical results and creative aspects in their programming projects.

Creativity was measured by looking at fluency, flexibility, and originality, based on research on divergent thinking. Fluency (F′) measured how many unique, valid solution elements or approaches a student included in their code for a given task (such as using different control-flow methods, input validation techniques, or decomposition strategies), with scores adjusted to match the rubric's scale. Flexibility (Fx′) assessed the range of categories or strategies applied (for example, varying algorithm types, structural designs, branching logic, error management, or modularization), also normalized. Originality (O′) indicated how uncommon the student's approach was compared to all solutions for the task, awarding higher scores to those that significantly deviated from typical methods.

The three measures were standardized and then averaged to make a composite creativity score (CSS), as shown below:

$$CSS = \frac{F' + Fx' + O'}{3} \quad (1)$$

$F'$ *= fluency*

$Fx'$ *= flexibility*

$O'$ *= originality*

To combine technical and creative performance, overall performance was calculated as a weighted sum of functional correctness (C), structural quality (S), and creativity (CSS):

$$TPS = \omega_1 * C + \omega_2 * S + \omega_3 * CSS \quad (2)$$

*C = Correctness (functional correctness)*

*S = Structure (structural quality of the solution)*

*TPS = Total Performance Score*

*w1,w2,w3 = weighting coefficients defined in the evaluation framework*

The coefficients used for weighting (ω1, ω2, ω3) were chosen to maintain a deliberate balance among technical accuracy, code organization, and creativity, all within the scope of programming assignments that match the curriculum. Results in this study are shown both as individual scores (C, S, CSS) and combined into a total TPS (see Eq. 2).

*1) Ethical procedures*

Ethical procedures were carefully followed throughout both the survey and experimental stages. Participation was voluntary; informed consent was obtained from the school and the Ministry of Education, and participants were kept anonymous throughout collection, coding, analysis, and reporting. The approval timeline for both the student and teacher surveys is shown above. These steps follow standard research ethics in education.

*2) Scoring and evaluation procedure*

Programming submissions were evaluated using a set rubric based on the proposed framework, which included functional correctness, structural quality, and creativity. To reduce bias, all student work was anonymised with alphanumeric codes such as IBAI01 to IBAI05, IBNAI01 to IBNAI05, OSAI01 to OSAI05, and OSNAI01 to OSNAI05 before evaluation. Each solution was judged using the same criteria. Creativity was measured by the composite score in Equation (1), and overall task performance was calculated using Equation (2).

Although the experimental sample was small (N = 20), using a single evaluator was a planned choice. Because there was limited time after getting approval from the Ministry of Education and coordinating with the school, having one trained evaluator helped keep scoring consistent and followed the rubric closely. This method reduced differences between evaluators and kept the experiment controlled. Given these constraints, this evaluation process was the most reliable and consistent way to compare AI-assisted and non-AI student performance in this setting.

### D. Statistical Analysis

Statistical analyses were used to summarise survey responses about AI use and to look at performance differences found in the experimental part of the study.

First, survey data were analysed from students (N = 161) and teachers (N = 51) using descriptive statistics such as frequencies, percentages, and averages for Likert-scale items. Responses were grouped by programme affiliation - either International Baccalaureate or national curriculum - when this was relevant to the research questions.

In the experimental part (N = 20), student performance was measured using rubric-based scores for functional correctness (C), structural quality (S), and creativity. Creativity was measured with the composite creativity score (CSS) from Equation (1). Total performance scores (TPS) came from Equation (2). Since each group had only five participants and the rubric data were ordinal, the analysis relied on group-level descriptive comparisons instead of formal hypothesis testing.

The mean scores and trends are shown for four experimental groups: IB with AI, IB without AI, national programme with AI, and national programme without AI. This method follows best-practice guidelines for exploratory educational studies with small samples, using descriptive and comparative analysis to find patterns for future research.

## V. Results

### A. Analysis of Demographic Data and the Dynamics of AI Tool Integration

By including both groups, the research compared how generative artificial intelligence (GenAI) is integrated into different teaching and ethical settings.

Most students use these tools often, with many reporting daily or every-other-day use. This suggests that students rely on AI regularly, not just for occasional tasks.

Most students use tools such as ChatGPT, Google Gemini, and Canva AI. This shows they prefer platforms that handle both text and images. Earlier research also found that students like AI systems that offer idea generation, organization, and writing support all in one place. [1].

Educators see AI use as even more widespread. Most teachers rate it as very common, especially for homework, explaining complex ideas, and writing essays. These results show that AI is becoming a 'cognitive assistant,' changing how students learn on their own outside the classroom [2].

### B. Evaluation of the Impact of AI on Creative Processes and Autonomy of Thought

This research mainly examines the balance between using technology efficiently and keeping originality and independent thinking. Survey data, including Likert-scale and open-ended responses, show that students and teachers see this issue very differently.

*1) Student Perspective: AI as a Catalyst vs. AI as Substitution*

Students perceive AI most often through the lens of ease in thinking. The survey reveals that students employ AI for organizational purposes and to facilitate their creativity, using it as a starting point or a barrier to breakthroughs, suggesting that "the idea remains mine" and "is only a helper, not a creator."

However, some students admit to using AI to create nearly all of their assignments. This shows a move from using AI as a helper to letting it do most of the thinking, which affects important skills like problem-solving and evaluation, as described in Bloom’s taxonomy. Even though students still feel like the work is theirs, the high level of AI use may slowly reduce their ability to think and solve problems on their own [5].

These results match earlier studies, which found that while AI helps people come up with more ideas, it can also lower originality and flexibility in creative work [3].

*2) Educator Perspective: Authenticity Crisis and Evaluation Challenges*

Most students feel positive about using AI to help with their work, but many teachers are more doubtful. Teachers often worry about losing originality, having similar writing styles, and missing a real student voice. Many agree ($\mu > 4.2$) that AI makes it harder to judge students’ actual knowledge and creativity.

Teachers see that AI-generated assignments are often well-organized and meet the guidelines, but they miss the personal effort, unique ideas, and critical thinking students usually show. Although AI can make writing look better, it might cover up the real learning that happens.

This disagreement shows a basic difference in how students and teachers see things. It also suggests that what counts as creativity is changing. Students often value creativity in the final product and how fast it is done, while teachers connect creativity to thinking, problem-solving, and questioning ideas. If AI use is not controlled, student work might all look similar, and originality could be lost to efficiency [6].

### C. Prompt Engineering as a New Paradigm of Digital Literacy

Survey data strongly support the idea that prompt literacy, or the ability to create clear and purposeful queries, is now a key factor in academic success when using AI in learning. The results show that managing AI is not just a technical skill, but also a cognitive ability that affects the quality of work.

Students who are better at creating prompts also say they are more satisfied with the quality, coherence, and depth of their work. Instead of using AI to do their thinking for them, these students use it to help refine their arguments and improve their writing style. This supports the idea that students are becoming content curators, making creative choices as they guide and shape what the AI produces [12].

Educator responses reinforce these findings. A majority of teachers (μ = 4.04) agree that students with advanced prompting skills produce assignments of higher conceptual coherence. Educators also stress that teaching prompt engineering should include clear guidelines, so that AI does not take the place of real thinking and effort.

These findings suggest that in the future, the digital divide will be less about who has access to technology and more about who can clearly express complex ideas when working with AI [13].

### *D. Ethical Challenges and the Redefinition of Academic Integrity*

Another important part of the research looks at the ethical issues that come with the widespread use of Generative AI. Survey results show a big gap between how often people use AI and how often they are open about it.

Many students say they have turned in assignments that were partly or fully created by AI, without clearly stating how much AI was used.

Teachers consider this a new form of plagiarism that regular plagiarism checkers often miss.

These findings point to several key issues:

1. Ethical ambiguity: Many students do not view AI as an outside source that needs to be cited. Instead, they think of it like a search engine.

2. Need for regulation: Both students and teachers strongly agree that the use of AI needs rules. Both students and teachers strongly agree that schools should have clear policies about how AI can be used. Results suggest a shift toward a model of responsible AI use that requires disclosure of AI involvement.

These findings show that the problem with academic honesty is not caused by AI itself, but by the lack of ethical guidelines that can keep up with new technology [14].

### *E. Experimental Results: AI Use and Creative Performance in Practice*

To add to the survey results, a controlled programming experiment was run with 20 senior students from the International Baccalaureate and national programmes. The students were split evenly into AI-assisted and non-AI groups and completed three programming tasks that matched the curriculum and increased in difficulty.

Student performance was measured using rubric-based scores for functional correctness (C), structural quality (S), and creativity, which was measured by the composite creativity score (CSS). Table III shows the average scores for correctness, structure, creativity, and total performance for the four groups [8].

TABLE III. MEAN PERFORMANCE SCORES BY EXPERIMENTAL GROUP

| Experimental Group | Correctness (C) | Structure (S) | Creativity (CSS) | Total Performance (TPS) |
|---|---|---|---|---|
| IB with AI | 3.6 | 3.6 | 1.33 | 2.84 |
| IB without AI | 2.6 | 2.4 | 3.11 | 2.70 |
| National with AI | 2.8 | 2.4 | 1.33 | 2.18 |
| National without AI | 1.6 | 1.6 | 2.89 | 2.03 |

Students who used AI scored higher on functional correctness and structural quality in both programmes. This means they made fewer syntax and logic errors and wrote more standard program structures. On the other hand, students without AI had higher creativity scores, showing more variety in their solutions, control flow, and program organisation, especially in the open-ended menu-based task.

IB students did better than national programme students in overall technical performance, but the effects of using AI were similar in both groups. Using AI led to better correctness and structure, while students who did not use AI showed more creativity. These results show a gap between what students think about AI improving creativity and what their programming work actually shows.

## VI. DISCUSSION

Looking at both the survey and experimental results, there is a clear gap between what people think and what actually happens. Students often see AI as a tool that boosts creativity, but experiments show that using AI without limits can lower originality. The concerns teachers shared in the survey match the behaviors seen in the experiments.

The large time gap between the groups, AI-assisted groups finished in 15 to 25 minutes, while non-AI groups took the full 90 minutes, could affect the results. More time on a task lets participants explore and improve their ideas, which could raise creativity scores. On the other hand, working for a longer period can also cause fatigue and lower performance quality. Future studies should control for time-on-task, such as by giving all groups the same amount of time or matching their working times, to better isolate the effect of AI assistance.

The results emphasize the importance of having guidelines for teaching to inform the use of AI.

## VII. CONCLUSION

This study looked at how generative AI influences creativity and independent thinking in secondary-school programming. We used two main methods: anonymous surveys (students N = 161; teachers N = 51) and a controlled programming experiment (N = 20). The surveys show that AI is widely used. Most students use AI to help organize their work and generate ideas. Nevertheless, teachers worry about issues like originality, fair grading, and academic honesty.

The experiment gave more practical evidence. Students who used AI often wrote code that was more accurate and had fewer syntax and logic errors. However, students who did not use AI showed more variety in their approaches and higher creativity, especially in open-ended tasks. In general, the results show a gap between how creative students feel about AI and what is actually observed. Students often feel more creative when using AI, but their work tends to follow more standard patterns if they use AI without clear guidance.

In practice, generative AI should support learning instead of completely replacing student thinking. Schools, even the Ministry, should set clear rules for artificial intelligence, establish guidelines for responsible use, and teach students to use prompts while preserving their independent reasoning skills.

There are some limitations to this study. The experiment had a small sample size (n = 5 per group) from just one school and only one evaluator, so the results should be seen as suggestive, not final. Also, the big difference in time spent on tasks between the AI and non-AI groups might have affected creativity, separate from the use of AI. Future research should use larger samples from more schools, include several evaluators who check each other's work, and control for time spent on tasks to better understand the effects of AI.

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