Using Artificial Intelligence to Boost Creativity in Problem-Based Learning

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Abstract: *The increasing presence of generative artificial intelligence (AI), particularly Generative Pre-trained Transformer (GPT) tools, has prompted renewed attention to how such technologies may support creativity and problem-solving in secondary education. This action research investigates the impact of guided prompt engineering and structured AI-assisted learning activities on Secondary 2 students' creativity and problem-solving within a problem-based learning (PBL) framework. The study was conducted in a Hong Kong secondary school across four Secondary 2 classes, where students collaboratively designed AI-supported web applications to address authentic learning challenges. A mixed-methods research design was employed, incorporating pre- and post-surveys, product-based assessments, classroom observations, and group interviews to capture both quantitative trends and qualitative insights. Findings indicate that while students initially demonstrated varied levels of familiarity and confidence with GPT tools, structured instructional guidance in prompt engineering significantly enhanced their creative engagement, idea generation, and ability to translate abstract concepts into practical solutions. Students reported increased motivation, deeper engagement in design and coding tasks, and greater confidence in iterative problem-solving and collaboration. Although concerns regarding over-reliance on AI and technical limitations were identified, the results suggest that GPT can function effectively as a cognitive partner when its use is carefully scaffolded. This study contributes evidence-based insights into responsible AI integration and offers practical implications for educators and school leaders seeking to foster creativity and higher-order thinking in AI-enhanced learning environments.*

Keywords: Generative Artificial Intelligence, Creativity in Education, AI-Assisted Learning, Human–AI Collaboration

1. Introduction

The rapid advancement of generative artificial intelligence (AI), particularly Generative Pre-trained Transformer (GPT) technologies, has begun to reshape teaching and learning across educational contexts. In recent years, AI-powered tools such as ChatGPT have attracted growing attention for their potential to support idea generation, problem-solving, and personalized learning. However, despite increasing availability, the effective pedagogical integration of generative AI in lower secondary education remains uneven and underexplored, especially with regard to fostering students' creativity and higher-order thinking skills.

Creativity is increasingly seen as an important skill in 21st-century education, especially in areas that focus on problem-solving, innovation, and student involvement. In constructivist learning settings like problem-based learning (PBL), creativity goes beyond artistic expression. It shows in

students' ability to come up with ideas, look for different solutions, and create useful items to solve real problems. Previous studies indicate that creativity can grow through open-ended tasks, teamwork, and design processes that prompt students to think beyond just one right answer.

With the rise of generative artificial intelligence tools, new opportunities and challenges have emerged in supporting student creativity. While critics argue that AI-generated content may reduce originality or promote cognitive dependency, recent studies suggest that with appropriate scaffolding, generative AI can be a cognitive partner "for idea generation, for perspective-taking, and for iterative refinement". This highlights the importance of pedagogical design, specifically in fostering students to use AI reflectively rather than passively.

Preliminary observations and survey findings in this study indicate that fewer than half of Secondary 2 students actively use GPT tools to support their learning. This limited adoption may stem from factors such as insufficient awareness, restricted access, uncertainty about educational value, or concerns regarding over-reliance and academic integrity. As a result, many students fail to leverage AI technologies in ways that meaningfully enhance creativity and problem-solving—skills that are increasingly emphasized in 21st-century education. This gap highlights the need for research that moves beyond questions of access and examines how AI-assisted learning can be intentionally structured and guided to support cognitive development rather than replace student thinking.

Problem-based learning (PBL) provides a promising pedagogical context for such exploration. Rooted in constructivist learning theory, PBL emphasizes authentic problems, student agency, collaboration, and the active construction of knowledge. When paired with generative AI tools, PBL has the potential to create rich learning environments in which AI functions as a cognitive partner—supporting brainstorming, offering alternative perspectives, and scaffolding inquiry. However, without appropriate guidance, AI use may remain superficial, reinforcing passive consumption rather than creative engagement.

One emerging approach to addressing this challenge is prompt engineering, defined as the deliberate design of inputs that guide AI systems to produce pedagogically meaningful outputs. In educational settings, prompt engineering shifts students' interaction with AI from simple answer-seeking to reflective dialogue, exploration, and iteration. Teaching students how to formulate effective prompts may therefore play a critical role in enabling AI to support creativity and problem-solving within learning tasks.

This conference paper reports on an action research study that investigates the use of guided prompt engineering within AI-assisted problem-based learning for Secondary 2 students. The study aims to examine how structured AI integration influences students' creativity, problem-solving processes, and engagement in learning activities. By focusing on classroom-based implementation and student experiences, this research seeks to contribute practical insights for educators, curriculum designers, and school leaders navigating the evolving role of generative AI in secondary education. Ultimately, the study emphasizes that the educational value of AI lies not in the technology itself, but in the intentional pedagogical design that positions AI as a tool for thinking, creativity, and student-centred learning.

The research questions in the study are listed:

- How do students design an AI prototype for a project through the use of generative chatbots?
- How do students perceive the use of generative chatbots when designing an AI prototype to address real-world or learning challenges?

2. Literature review

2.1. Generative AI in K-12 Education and Creativity

Deployments of generative AI in K-12 education have rapidly increased since late 2022, raising both excitement and concerns about student creativity. (Zhang & Tur, 2024) Zhang & Tur conducted a systematic review of ChatGPT's use in K-12, synthesizing 13 studies from the first wave of research (Zhang & Tur, 2024). They found broad optimism that ChatGPT can *"spark student engagement, foster initiative, and stimulate creativity"* in learning. For instance, AI chatbots can support inquiry-based learning by encouraging learners to think critically and generate creative solutions to complex problems. This aligns well with PBL pedagogy, where students tackle open-ended problems – ChatGPT's ability to suggest multiple approaches or reframe questions can broaden students' thinking. (Zhang & Tur, 2024)

Thomas K. F. Chiu complements this view from the perspective of teachers and school leaders. In a qualitative study with 88 educators, Chiu examined how generative AI (ChatGPT for text, and Midjourney for images) is transforming school practices (Chiu, 2024). A key finding is that teachers see GenAI necessitating a shift in educational priorities: with AI readily providing information or basic solutions, schools must place greater emphasis on "generic skills" like digital literacy, critical thinking, and creativity when designing learning outcomes. In fact, participants argued that what and how we assess must be revisited – moving away from rote homework exercises (which ChatGPT can easily handle) and toward more creative performances. As one subtheme in Chiu's study notes, "more effort is needed to foster students' development of ... creativity" in the AI-infused classroom.

2.2. Prompt Engineering: A Key to Unlocking Creativity

To realize AI's creative potential in the classroom, prompt engineering has emerged as a critical skill. Prompt engineering refers to the craft of writing effective inputs or questions that guide AI to produce useful, relevant outputs. In education, this means framing prompts in ways that *augment* learning – for example, asking ChatGPT to give hints or alternative perspectives, rather than just complete solutions.

Educators and researchers are increasingly pointing to prompt engineering as the linchpin for success with AI. In the systematic review, Zhang & Tur explicitly list "Designing Effective Prompts" as an important recommendation for teachers. They found studies suggesting that teachers need specific training on how to write and customize prompts to fit their curriculum and student needs. By carefully tailoring prompts, teachers can ensure ChatGPT's responses stay on-topic and pedagogically useful (e.g. prompting the AI to use age-appropriate language or to align with the lesson objectives).

A 2024 article by Park & Choo goes further, offering practical frameworks for prompt engineering in education. They introduce the PARTS model (Persona, Aim, Recipients, Theme, Structure) and CLEAR principles (Concise, Logical, Explicit, Adaptive, Restrictive) to help educators design prompts. The idea is that a good prompt should set context (persona/role of the AI),

define a clear task and audience, and even impose limitations so that the AI's output is on target. For example, a teacher might prompt: "You are a science coach. Our aim is to help Secondary 2 students brainstorm solutions for a water filtration problem. Using simple language, suggest three creative approaches, and ask a question to prompt further thinking." (Park & Choo, 2024). Such a prompt gives ChatGPT a specific role and instructs it to output multiple ideas plus a follow-up question – nudging the AI to act as a creativity catalyst rather than a one-off answer machine (Park & Choo, 2024).

3. Methods

3.1. Background

This AI curriculum for junior secondary students aims to teach effective use of AI to support creativity in student projects. It encourages students to develop their own solutions using AI, transforming imagination into practical outcomes. The program builds confidence by guiding students to present their solutions to others.

In the research, we have conducted this action research in 4 classes. The ICT panel head, along with one ICT subject teacher, was responsible for managing two classes. The students in these classes were approximately 12 to 13 years of age. Each class comprises approximately 18 to 20 students, organised into five distinct learning groups. Consequently, 20 groups were evaluated as part of this action research. Teachers have run the teaching, collecting students' surveys (pre-survey and post survey) and assessing students' project outcomes (web application). Afterwards, two groups had been invited to join a group interview to present their thoughts on this project.

The action research has been conducted in 2025 September to 2025 October. In this pilot study, the project was implemented across four Grade-8 classes during their information computer literacy lessons within a secondary school setting

3.2. Teaching Plan

The action research took place from September to October 2025. This pilot study was carried out in four Secondary 2 classes during their information computer literacy lessons at a secondary school. The teaching involved guiding students in using AI tools to create web applications with Vibe code. Students improved their web apps by interacting with AI, using feedback from their peers.

3.3. Research Method

We used a mixed-methods research design to study how AI-assisted learning affects students' creativity and problem-solving skills. Methods included quantitative pre- and post-assessments, qualitative observations, and product-based assessments.

The pre-survey questions are designed to evaluate students' motivations for using or not using technology, as well as their comfort level with it. The research seeks to identify trends in adoption, perceived usefulness, and potential obstacles. Together, these questions enable researchers to position learners along a continuum of AI literacy and readiness, thereby informing the development of more effective, equitable, and pedagogically robust AI-integrated learning strategies. Additionally, they reveal the balance between perceived advantages (such as increased creativity and accessibility) and concerns (such as dependency and academic integrity). The post-survey questions are organized into two primary thematic areas: creativity-related perceptions and experiences and technical and skill-based development.

After teaching students to use AI for web app creation, I selected two groups (5 students) for a qualitative survey. The survey focuses on their general experience, creativity and problem-solving, challenges and support, as well as reflection and suggestions.

Product-Based Assessments: Creativity is essential for evaluating how students use AI in learning. The 4 C's of 21st Century Skills—creativity, critical thinking, communication, and collaboration—are applied in product-based assessment. An assessment rubric also provides another way to measure students' creativity.

In this study, creativity was operationally defined as students' ability to generate original ideas, develop meaningful solutions, and iteratively refine digital products in response to authentic problems within a problem-based learning (PBL) context. Rather than treating creativity as a general personality trait, this research adopts a product-based view of creativity, emphasizing observable outcomes demonstrated through students' AI-supported web applications. To enhance clarity and consistency in assessment, the rubric was revised and refined with the support of a generative AI tool (Gemini), which assisted in translating abstract assessment criteria into clear performance descriptors. The revised rubric was subsequently transformed into a graphic format to improve readability and shared understanding among teachers and students. This visual representation of the rubric is presented in Figure 1, allowing students to better comprehend assessment expectations and supporting transparent evaluation of creative learning outcomes within the problem-based learning context.

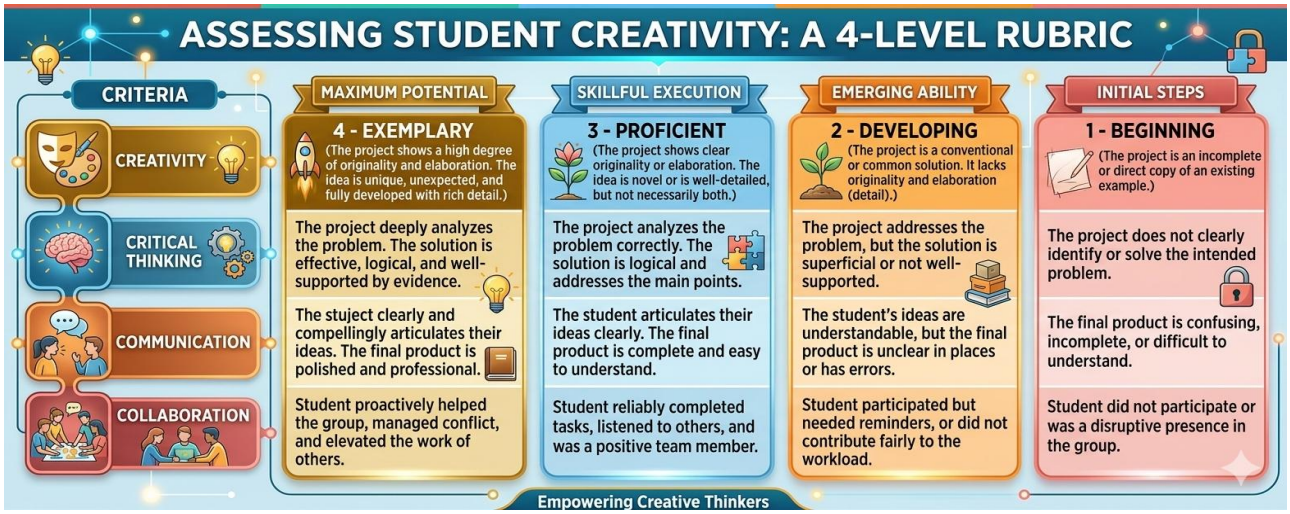

Figure 1*Product-Based Creativity Assessment Rubric for AI-Assisted Problem-Based Learning*

4. Results

The pre-survey results have shown that 60% of students have used GPT in their learning. Around 70% of students are very comfortable or somewhat comfortable of using technology to help with schoolwork. Most students (about 63%) are positive about using GPT or similar AI tools for learning, mainly for convenience, idea generation, and concept explanation. However, 36% avoid it due to accessibility issues in Hong Kong, cost, accuracy concerns, and fear of dependency.

Here are the main reasons why students choose to use GPT or not use GPT for learning:

Table 1. *Main reasons why students choose to use GPT or not use GPT for learning*

Top Reasons for Using GPT	Top Reasons for NOT Using GPT
It provides examples and effective ways to	Blocked in Hong Kong or requires VPN.

study.	
Helps answer questions and explain concepts.	May generate wrong answers or inaccurate details.
Convenience and speed in completing tasks.	Requires payment (not free).
Convenience and speed in completing tasks.	Preference for other AI tools or traditional methods.
Generates new ideas and assists with brainstorming.	Concerns about cheating or over-reliance on AI.
Helps find accurate data faster.	Fear of losing creativity and brainstorming skills.
Summarizes content and creates study notes.	Answers may come from unreliable sources.
Acts like a teacher or tutor for difficult topics.	Lack of accessibility or technical issues.
Useful for writing inspiration and structuring homework.	Belief that they can learn without AI or with tutors.
Supports personalized learning and adapts to learning styles.	Some dislike the interface or settings.
Helps break down complicated materials.	

To gain insight into students' views on how AI might enhance creativity, a pre-survey question was given to gather their opinions. The following figure presents the results in this area.

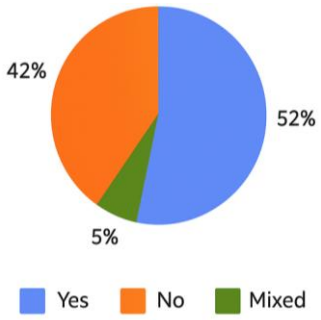

Figure 2*Students' perspectives on the potential of AI to boost creativity*

Table 2. *Students' perspectives on using AI for learning prior to conducting action research*

AI can help people be more creative	AI cannot help people be more
Main reasons given:	Main reasons given:
AI provides many ideas and suggestions that people can build on.	AI lacks originality and imagination; it only uses existing data.
It can inspire creativity by showing new perspectives.	People may over-rely on AI, leading to loss of creativity.
AI helps people visualize concepts (e.g., generating art or images).	AI often gives repetitive or similar answers, reducing novelty.
It allows users to express ideas in multiple ways.	Creativity requires human thinking, which AI cannot replicate.
AI can expand thinking skills and encourage brainstorming.	Using AI makes people lazy and discourages independent idea generation.

People can use AI outputs as references to create something new.	AI is just programmed logic, not true creative thought.
AI-generated content can motivate humans to surpass AI (e.g., in art).	AI lacks originality and imagination; it only uses existing data.

4.1. Using AI to boost creativity

Most students indicated that utilizing AI technologies such as GPT will not pose significant challenges for this project. Fewer than 10% of respondents reported that using GPT may present difficulties. After finishing the project, students shared how it contributed to boosting their creativity. Based on their feedback, we can summarise their positive perspectives into six categories.

4.1.1. Idea Generation & Inspiration

Many students said the project gave them lots of ideas, choices, and new perspectives. The following feedback has been provided by our students: “It offered additional inspiration,” and “AI broadened my perspective on creativity and generated new ideas.”.

4.1.2. Thinking Outside the Box

Students mentioned the project challenged them to think creatively, explore different solutions, and view problems from multiple angles. The following feedback has been provided by our students: “It helped me view different aspects of the problem and solution” and “Significantly enhanced my creativity by challenging me to think outside the box”.

4.1.3. Using AI as a Creative Tool

Many responses highlighted learning how to use AI prompts, refining outputs, and leveraging AI for coding and design. The following feedback has been provided by our students: “Learning how to use AI to write certain codes using different prompts” and “It helped me learn how to give good prompts to AI chats for better results”.

4.1.4. Design & Development Creativity

Students felt creative when designing web apps, interfaces, and prototypes. The following feedback has been provided by our students: “Designing the app interface enables me to explore different ways and be creative” and “It helps me to make the designs in my head become a real website”.

4.1.5. Problem-Solving & Brainstorming

The project encouraged finding solutions for learning challenges, researching methods, and creating unique approaches. The following feedback has been provided by our students: “We can use our creativity to come up with different solutions for just one problem” and “It helped me think of ways to help the needy”.

4.1.6. Collaboration & Diverse Perspectives

Some students mentioned teamwork and sharing ideas sparked creativity. The following feedback has been provided by our students: “During brainstorming, diverse perspectives sparked unexpected ideas”. Aside from positive comments, we also received a small number of less favorable responses: Several students replied with “Not really” or “N/A”, suggesting they didn't notice any impact. Two playful remarks mentioned issues with AI tools but nevertheless highlighted manual problem-solving.

4.2. Structured AI-assisted learning activities will lead to more meaningful engagement

4.2.1. Key Insights from the Post-Survey

The survey shows that 65% of students rated their overall satisfaction with the creativity they demonstrated in this project as positive, indicating that the majority felt the experience allowed them to express and develop creative skills effectively. This suggests that the project provided meaningful opportunities for students to engage in creative thinking, whether through designing, problem-solving, or using AI tools to enhance their ideas. The high satisfaction rate reflects the project's success in fostering an environment where creativity was valued and actively encouraged.

The survey results indicate that the most significant factor in stimulating students' creativity was designing the app interface, with 34% of students identifying this as the key contributor. This suggests that hands-on design work, which allows students to visualize and implement their ideas, plays a major role in fostering creative thinking. Meanwhile, 26% of students reported that using GPT to generate code enhanced their creativity, highlighting the value of AI tools in providing inspiration and enabling students to experiment with different coding approaches. Overall, the findings show that both practical design tasks and AI-assisted coding are effective strategies for promoting creativity in learning environments.

4.2.2. Insights gathered from the group interview session

From the group Interview result, we have gained a deeper understanding of students' perspectives after using GPT tools for project work, teachers are interested in exploring alternative approaches for gathering feedback. While quantitative survey results provide valuable insights into overall satisfaction and the impact of specific activities, teachers recognize the importance of capturing the nuances of students' experiences and opinions. By considering methods such as group interviews or open-ended discussions, educators can uncover more detailed reflections—both positive and constructive—about how AI-assisted learning influenced creativity, collaboration, and problem-solving. This broader viewpoint can help teachers refine future projects and better support diverse learning needs.

Throughout the project period, we have observed various ways in which students utilized GPT tools. These applications include programming and game development, such as writing code and creating games; homework assistance, particularly with mathematical problems and explanations of formulas; language support, including translation and clarification of complex texts; and idea generation, contributing new concepts and enhancing initial project versions.

After completing our web application project aimed at addressing learning difficulties, we noticed several key benefits. Students received immediate answers, allowing quick solutions to urgent questions. The application helped transform abstract ideas into practical actions, boosting creativity by enabling students to explore new methods and implement previously unfeasible concepts. Overall, it made problem-solving and project development more efficient.

In interviews, students suggested strategies for effective use: give specific prompts and images, verify GPT's responses, use it as a support tool rather than a substitute for critical thinking, understand the reasoning behind answers in math and writing, and practice independently after receiving assistance.

Students reported that this project positively affected their learning by enhancing hands-on engagement and encouraging experimentation. It also fostered creative thinking, allowing students

to implement ideas efficiently. Proposed classroom applications include recording and transcribing lessons for flipped learning and automatically summarizing teacher lectures.

5. Discussion

The integration of artificial intelligence (AI) tools, particularly generative models such as GPT, is reshaping our teaching and learning. These tools have enabled educators to leverage AI for enhancing student creativity, engagement, and problem-solving skills. This research investigates the impact of guided instruction and structured AI-assisted learning activities on students' creative thinking and problem-solving abilities. In this study, we have found that use of GPT within classroom can foster deeper understanding and meaningful interaction with students and learning goal.

The implications for teaching practice are substantial. Effective AI integration requires professional development for educators to design and implement guided, structured activities that maximize student benefits while minimizing risks such as overreliance or superficial engagement. Challenges include ensuring equitable access to technology, maintaining academic integrity, and fostering digital literacy. Opportunities lie in harnessing AI to personalize learning, support differentiated instruction, and cultivate higher-order thinking skills.

6. Conclusion and Future work

In summary, the research affirms the value of guided GPT instruction and structured AI-assisted activities in enhancing student creativity and problem-solving. For educators and school leaders, intentional integration of AI tools presents opportunities to improve engagement and learning outcomes. This highlights the necessity of educator involvement in designing and facilitating AI-based learning experiences.

School leaders can strengthen AI-assisted learning by investing in teacher training, providing adequate resources and reliable AI tools, fostering a culture of innovation, and establishing clear guidelines for responsible AI use. By engaging both teachers and students in ethical, critical, and reflective use of AI, schools can better leverage human and financial resources to overcome challenges and enhance teaching and learning outcomes

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