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## The integration of Generative AI in the design search process

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### Abstract

**Context:** The integration of Generative AI in educational practices has been rapidly evolving, particularly within design programs. Institutions like Singapore Polytechnic have begun leveraging generative AI tools, such as MidJourney and DALL-E, reshaping how students approach ideation, research, and creativity in a technology-driven environment.

**Aims:** This study aims to explore the impact of a generative AI-assisted search workflow on design students' research and ideation processes. Specifically, it investigates how this integration affects students' design vocabulary, variation in visual references, ability to justify visual choices, and overall design quality, guided by Puentedura's SAMR model, particularly at the Modification level.

**Methods:** The case study involved 45 second-year Visual Communication and Motion Design students. Data were collected through content analysis of submitted work, student and lecturer interviews, and assessment rubrics spanning five design briefs. A comparative analysis was made between students' abilities before and after exposure to the generative AI search methodology, with a focus on four specific research questions.

**Findings:** Results indicated that higher readiness students experienced a slight expansion in their design vocabulary and variation in visual references. However, both high- and low-readiness groups struggled to adopt a broader range of visual references, revealing a tendency to rely on traditional search methods alongside AI. Students' abilities to justify their design choices and the overall quality of final designs showed minimal improvement, with many relying on AI-generated content without critical assessment or integration into their creative processes.

**Implications:** The findings suggest that while generative AI can enhance ideation speed, it often does not deepen critical design reasoning or vocabulary development. The study highlights the need for structured frameworks that promote deeper engagement with AI outputs and a more diverse approach to research, suggesting that exposure to technology should be accompanied by explicit instruction in design principles and critical evaluation techniques to ensure meaningful learning outcomes.

**Keywords:** Generative AI; design education; ideation; search strategies; SAMR Model

## Introduction

AI is rapidly reshaping education, with design programmes leading the way. Generative tools such as MidJourney and DALL·E now mirror industry workflows for ideation, reference gathering, and even final production, enabling students to hone creativity and adaptability for an AI-driven design landscape. AI is reshaping learning well beyond design. At the Romanian-American University, chatbots and virtual tutors give business students realistic conversation practice, instant feedback, and personalised lessons (Măduța, 2024). Arizona State University deploys ChatGPT and Transkribus so journalism students can auto-transcribe archives and build immersive historical simulations (Spike, 2024). A London private school is even piloting AI-run “teacherless” GCSE classrooms overseen by learning coaches (“The future of the AI-enhanced classroom,” 2024). Across these cases, AI automates tedious tasks, customises instruction, and opens space for greater creativity and critical thinking.

Puentedura’s SAMR framework (2024) tracks AI’s evolution in education from Substitution (automated marking) and Augmentation (chatbots for feedback) to Modification (AI-driven historical simulations) and Redefinition (VR or generative content). Our study operates at the Modification tier, piloting a generative-AI search workflow that reshapes design students’ research and ideation, broadens their visual vocabulary, and deepens innovation for an AI-centric future.

### The SAMR model

First developed by Dr Ruben Puentedura. The SAMR model serves as a framework for integrating technology into education. The model was initially developed to help educators understand and assess how technology could transform teaching and learning. SAMR stands for Substitution, Augmentation, Modification, and Redefinition, representing a progression of technology use in the classroom (Savignano, 2017).

In the Substitution phase, technology is used to replace traditional tools without changing the task or how a person might learn. It makes things easier or faster, but the basic activity stays the same. For example, using a calculator to do math problems is quicker and helps avoid mistakes, but essentially still solving the same problems (Kurt, 2023).

In the Augmentation phase, technology continues to replace traditional tools, but with functional improvements that enhance the learning experience. It allows for increased efficiency, additional features, or capabilities that weren’t possible before, but the overall task remains the same. For Example, instead of manually drawing a diagram, students might use graphic design software to create it or use an online tool to search for images. These tools replace traditional methods (drawing by hand or using a physical reference book), but they provide advantages like easy editing or instant image access.

In the Modification phase, technology allows for significant redesign of the task, enabling more complex or dynamic learning opportunities. The task is transformed, and students can engage with it in a more interactive, collaborative, or deeper way. The use of technology is no longer just about efficiency but about altering the learning process to make it more interactive and engaging. For example, Students work together in real-time on a digital design project using

Canva, where they can edit, share feedback, and improve the design as a team. This would be hard to do without technology, making the project more interactive and collaborative (Schmidt, 2024).

The Redefinition phase represents the most transformative level of technology integration. At this stage, technology enables new tasks that were previously impossible without it. The learning experience is revolutionized, offering students unique opportunities to engage with content in creative and innovative ways that go beyond traditional methods. For example, students can use augmented reality (AR) to explore ancient civilizations by virtually walking through reconstructed historical sites. This task would be impossible without AR, allowing students to experience history in a completely new and interactive way, far beyond what traditional textbooks or classroom activities could offer (2U Wordpress, 2023).

The SAMR model is used to guide teachers in transitioning from using technology for simple tasks (Substitution) to more advanced and transformative practices (Redefinition). The framework emphasizes that technology should not only replace traditional methods but also enable new, innovative ways of engaging students and enhancing learning experiences.

### **Analysing AI tools in education using the SAMR model**

Most educational AI initiatives remain at SAMR's Augmentation level: they speed up work without changing underlying practices. Inha University's fashion design students, for instance, employ ChatGPT and MidJourney to draft concepts faster, yet still rely on traditional creative skills (Lee & Suh, 2024). Likewise, Tamkang University uses AI for grammar and content tweaks, but students engage with writing in the usual way (Yu-Ching & Lin, 2024). Using AI tools at the Augmentation level can enhance effectiveness and engagement in humanities subjects like history, linguistics, and fashion design, which often involve creative, interpretative, and subjective tasks. For example, AI-driven tools enable students to engage with historical texts or simulate events, fostering a deeper connection to the material (Spike, 2024). Notwithstanding, there remains an untapped opportunity to transform learning through Modification and Redefinition levels to enrich the learning experience even further.

AI tools have been explored in STEM subjects like computer programming in the Modification and Redefinition levels. In the case of Sultan Qaboos University in Oman, ChatGPT is used to help students with coding tasks and debugging (Abdulla, Ismail, Fawzy, & Elhag, 2024). In this context, AI tools don't just support learning; they facilitate more interactive, adaptive, and personalized learning experiences. Programming education, by its nature, benefits from real-time problem-solving and personalized feedback, which AI provides. This allows students to explore coding strategies in ways that would have been more time-consuming and challenging without AI support.

In summary, AI in education is predominantly being used at the Augmentation level to enhance creativity, productivity, and engagement without redefining or modifying existing processes. Design education, being more subjective and creative, has fewer constraints in adopting AI, making them ideal for experimentation with these tools. In this paper, we pilot a search methodology using Generative AI at the Modification level of the SAMR model, fundamentally redesigning how design students research and ideate. By leveraging AI tools, this approach seeks to enhance students' creative processes by diversifying their search results and

expanding their design vocabulary, ultimately fostering deeper innovation and equipping them to thrive in an AI-driven world.

### **The importance of research for designers**

Every industry has its own specialized vocabulary, including technical terms and jargon. For example, the medical field uses terms like "myocardial infarction" (heart attack) and "tachycardia" (fast heart rate) to communicate complex ideas clearly, helping avoid errors and ensuring consistent care (Sandoval et al., 2020). The design field is no different—strong design vocabulary enhances communication, collaboration, and problem-solving. In design education, early years focus on building this vocabulary, ensuring students can understand and use industry-specific language effectively. For designers, mastering these terms allows for deeper discussions, critical analysis, and more precise execution of ideas (Zhou et al., 2024).

A robust design vocabulary lets designers pinpoint, retrieve, and critique visual references with precision. By naming specific styles, techniques, and compositional devices, they draw richer insights and justify choices more persuasively (Fu, Yang & Wood, 2015). For example, when a client requests something “bold and fun,” a designer who recognises Pop- or Psychedelic-art cues can target those terms, explore wider precedents, and deliver a more refined solution.

Additionally, a robust vocabulary enables designers to clearly explain their creative decisions, linking design elements like colour, typography, and layout to project goals. It builds credibility, fosters trust, and ensures that their vision is effectively communicated and understood. During critique or feedback sessions, it empowers designers to defend their work with confidence, transforming their designs into impactful and purposeful communication (Wynn et al., 2022). For example, a designer with a strong vocabulary can clearly link design elements like colour, typography, and layout to project goals. This in-depth understanding, gained through thorough research and analysis, makes it easier to communicate ideas during a pitch, enhancing the client’s experience and building trust in the process.

### **Typical Search Process**

Design research has always been a vital part of the creative process, evolving with advancements in technology and knowledge dissemination. In the pre-internet era, designers conducted research through printed materials found in bookstores or libraries, meticulously taking notes, bookmarking pages, and photocopying relevant content. On-site research was equally significant, with ideas and materials documented through sketching or photography (Garcia-Lopez et al., 2019). Today, the context for design research remains multifaceted, extending beyond basic tasks like selecting art styles, colors, or fonts. It delves deeper into understanding a client’s brand persona, values, and unspoken intentions. Designers strive to uncover metaphors and visual rationales that align with the client’s vision, often addressing psychological aspects of the brief. Ultimately, research equips designers to act as detectives, piecing together spoken and unspoken clues to create work that resonates visually, emotionally, and intellectually.

Seasoned designers mix online sources with print references—books, periodicals, Pantone guides—to sharpen keywords and tap diverse databases (Bako et al., 2022). Digital-native students, however, seldom look beyond Google or Pinterest (Creighton, 2018). When their brief-

to-keywords-to-image routine lacks precise terms, they waste time, lose inspiration, and deliver shallow work. Reliance on repetitive web content shrinks their design vocabulary and critical insight, leaving outcomes thin on depth, innovation, and originality.

## AI Search Methodology

We propose an AI-enhanced search workflow—combining ChatGPT for text and MidJourney for visual prompts—that operates at SAMR’s Modification level, reshaping how students gather references. Instead of relying on limited self-generated keywords, learners co-create richer terms with AI, probe unfamiliar styles, and iterate visuals interactively. This refines their vocabulary, broadens search scope beyond conventional engines, and reduces trial-and-error delays, fostering more precise and inventive outcomes.

The AI search methodology deploys two generative AI applications that are used together in an interconnected manner. ChatGPT, a generative text-based AI-powered language model, functions as a search engine interface designed to generate human-like text responses based on user-provided text input. MidJourney, a generative text-to-visual AI-powered image generation model, acts as a creative tool designed to produce images based on text prompts provided by the user. In the search methodology, these two AI applications are used interactively, either starting with ChatGPT and transitioning to MidJourney or beginning with MidJourney and moving to ChatGPT.

In our ChatGPT-to-MidJourney workflow, students first query ChatGPT to generate keywords tied to the brief, then refine those terms into MidJourney prompts. ChatGPT can also supply movement summaries or brand-defining adjectives and combine all findings into polished prompt strings. The same keywords feed broader searches on Google, Pinterest, and other design platforms, enriching visual and textual references for ideation and mock-ups (see Appendix A).

Using MidJourney's "Describe" function, the AI application generates four descriptive paragraphs based on the visual input provided. These paragraphs offer a detailed analysis of the visuals, highlighting key elements such as style, composition, and thematic elements (see Appendix B for examples). Alternatively, students can use the textual context provided by MidJourney, combining the information to create a new word prompt based on their desired visual ideation (see Appendix C for an example). The typical step-by-step process students follow in their design research in a usual workflow vis-à-vis the suggested AI search methodology is described in Appendix D.

## Method

In this case study, we examined how students’ ideation process, the quality of their designs, and their perceptions changed with the implementation of the AI-search methodology framework. In particular, we addressed the following research questions:

- RQ1: Do students have an expanded **design vocabulary** after exposure to the AI-search methodology framework?
- RQ2: Do students have more **variation in their visual references** after exposure to the AI-search methodology framework?

- RQ3: Are students better able to **explain and justify their choice of visual references** after exposure to the AI-search methodology framework?
- RQ4: Are students' final designs of **higher quality**, after exposure to the AI-search methodology framework?

## **Participants**

The AI-search methodology framework was piloted in two classes in a Design History module for year 2 Visual Communication and Motion Design students in a Polytechnic Institution. 45 students, aged between 17 and 19 years old, participated in the study. The students completed the lesson activities in pairs (21 pairs in total).

## **Setting**

The 18-week Design History module traces design's evolution across Western and Asian movements, linking core elements—line, colour, function—to today's practice. Classes run three hours each and alternate between Week A, which covers historical concepts and movements, and Week B, where students present solutions developed from AI-assisted research and ideation briefs issued at the end of each Week A session.

The module includes three continuous assessments (CA), with the AI search methodology being extensively applied in CA03. CA03 consists of five design briefs that students must research and resolve on a bi-weekly basis. They integrate the AI search process into their research and ideation workflow for each of the five briefs. Appendix E details the topics covered and the design briefs.

In the integration of the design history module, the first brief—Colour Expression—did not incorporate AI search methodology. The research and teaching team opted to establish a baseline of student capabilities based on one year of design education and prior knowledge. Students were instructed not to use AI tools in their research and were provided with a presentation template to complete. No specific guidance was given on how to approach research and ideation, allowing students the freedom to work in ways they were familiar with.

After the baseline exercise, students received an AI-search workshop. We first covered ethics—hallucinations, verification, and responsible use—framing AI as a tool akin to books or search engines. Two slide decks followed: one listed descriptive adjectives for Western and Asian art movements to seed richer prompts; the other detailed effective MidJourney prompting. Instructors then stepped back, letting students adopt the AI workflow autonomously. This hands-off approach prevented homogenised outcomes and enabled clearer measurement of progress across four briefs.

## Data collection and analysis

Table 1 shows the data sources for each RQ.

**Table 1: Data sources used for each RQ.**

RQ1 - Expanded design vocabulary	Content analysis Student interviews
RQ2 - Greater variation in design references	Content analysis Student interviews
RQ3 - Better explanations and justifications for design references	Content analysis Lecturer interviews Student interviews
RQ4 - Quality of designs	Content analysis Lecturer interviews
RQ5 - Greater perceived competence	Student interviews

### Content analysis

Data for RQ1-4 were collected from student-pairs' work that were submitted in completion of each of the five design briefs. To get a baseline of students' ideation process and quality, students submitted works to Brief 1 **before** the introduction of the AI-search methodology. Thereafter, they were taught how to use the AI-search methodology and were expected to apply it in Briefs 2 to 5.

### Student Interviews

Students were labelled high or low AI-readiness according to whether they had already used AI in the baseline task; these early adopters also earned stronger prior grades. Work was coded for (RQ1) the proportion of design-specific terms and (RQ2) the breadth of visual sources. A lecturer then rated each pair on (RQ3) justification quality and (RQ4) brief fulfilment. The coding scheme is in Appendix F. Owing to the small case-study sample, no statistical tests were applied.

### Lecturer interviews

Upon completion of the module, two lecturers who were not involved in the implementation of the AI-search methodology but who taught the students in the new semester were interviewed. Lecturers were asked questions about the students' use of the AI-search methodology in the other modules to check for transfer of learning. They were also asked about students' ability to explain and justify their choice of visual references (RQ3) and their design quality (RQ4), as compared to previous cohorts who were not taught the AI-search methodology. The interview guide is in Appendix F. The interviews, which took about 30 minutes each, were recorded and transcribed. To answer RQ3 and RQ4, thematic analysis was used to identify recurring themes in the interviews.

Upon completion of the module, five students were interviewed. Students were selected based on their readiness to apply the AI-search methodology and the quality of their ideation in

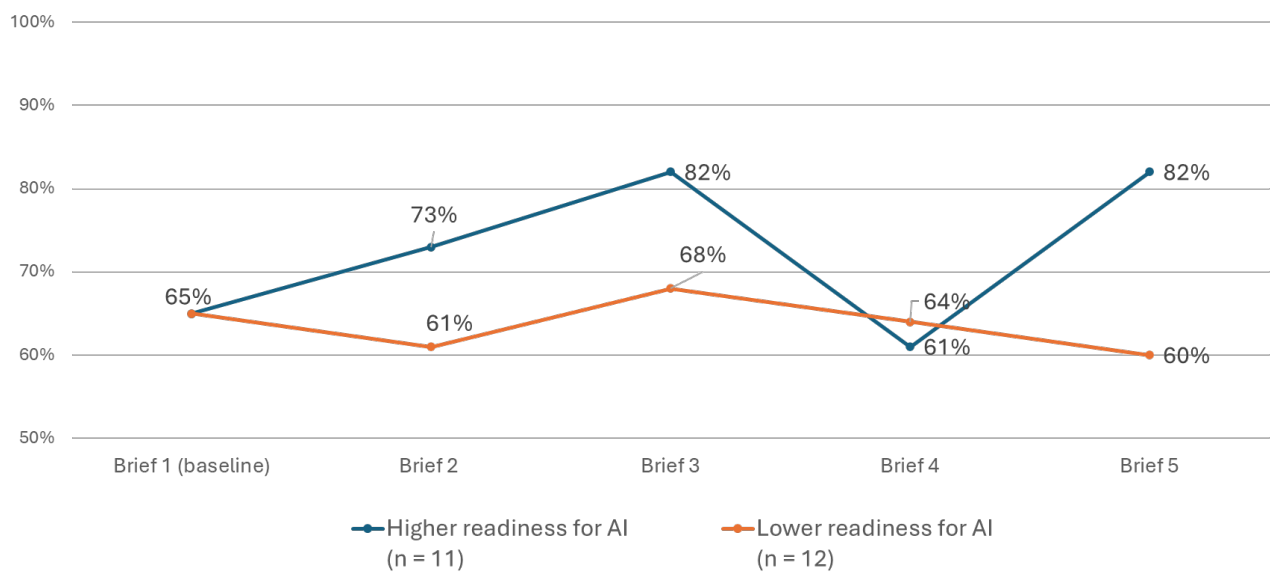
the module. They were asked questions about how the AI-search methodology had impacted their ideation process in terms of design vocabulary (RQ1) and visual references (RQ2), their perceived ability to explain and justify their choice of visual references (RQ3), and their perceived confidence in using the new AI-search methodology (RQ5). The interview guide is in Appendix G.

The interviews, which took about 30 minutes each, were recorded and transcribed. Thematic analysis was used to identify recurring themes in the interviews.

## Results

### RQ1: Do students have an expanded design vocabulary after exposure to the AI-search methodology framework?

Figure 1 shows the results of the content analysis to track student-pairs' work in the development of their design vocabulary through Briefs 1 to 5. The percentage of design words used in the ideation process in each brief was used as a measure of their design vocabulary. Using a higher percentage of design words for a given design brief, indicated an expanded design vocabulary.



**Figure 1. Line graph showing the average percentage of design words used in each design brief, for students with higher and lower readiness for using AI tools.**

Before the AI-search workflow, both high- and low-readiness groups had similar vocabularies (65%). With the new method, high-readiness students rose to 73 % in Brief 2 and 82 % in Briefs 3 and 5, dipping to 61 % in Brief 4, where motion design—not vocabulary—was the focus. However, students with lower readiness to use AI tools (orange line, i.e., those who did not initiate the use of AI on their own accord) did not improve in their design vocabulary after the introduction of the AI-search methodology. For this group of student-pairs, their design vocabulary remained stable at about 60%. While the AI-search methodology facilitated visual ideation, it did not significantly expand students' design vocabulary. Higher readiness students showed slight improvement, likely due to their prior design knowledge and design reasoning

which helped them more efficiently identify and understand terminology, ultimately aiding in internalizing the use of these design terms. One of the participants - PO1 said:

*"I feel more comfortable using design technology now, but it doesn't really have much to do with AI... What I learned from class or from doing my own research on the projects helped me to understand it better. I still don't use AI as much... but if there's something pretty specific and I don't know where to find inspiration—for example, when we were doing that thing in design history with the Mexican tiles—I used AI and asked for the specific kind of design I wanted. That helped me to make the final product."*

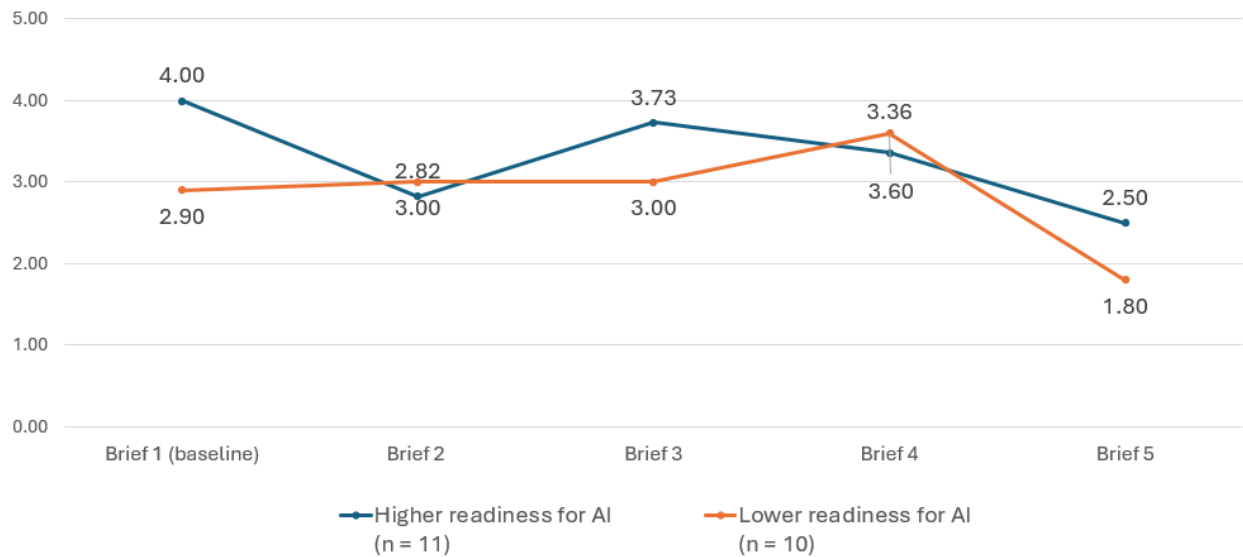
In contrast, lower-readiness students struggled to expand their design vocabulary, as they lacked the design reasoning needed to identify and internalize new design terminology. For example, PO2, a lower-performing student, said:

*"At first, we weren't sure what to do, and coming up with ideas on our own was difficult. Using AI helped speed up the process. Students who had already used Midjourney before were much quicker and more effective in ideation. Before this, I relied heavily on Pinterest and my mood boards often looked like existing references. But with Midjourney, I can generate something that feels more original, even if I'm not sure how to get there myself."*

Lower-readiness students, like PO2, relied on AI tools like Midjourney to compensate for difficulties in independent ideation and design reasoning. While AI enabled them to produce more original-looking visuals, they still struggled to understand and internalize the underlying design concepts.

### **RQ2: Do students have more variation in their visual references after exposure to the AI-search methodology framework?**

Figure 2 shows the results of the content analysis to track student-pairs' work in the development of their variation in visual references used in Briefs 1 to 5. The number of visual references used in the ideation process in each brief was counted and a higher number indicated a greater variation in visual references.



**Figure 2. Line graph showing the average number of visual references used in each design brief, for students with higher and lower readiness for using AI tools.**

Students with higher readiness for using AI tools (blue line) used a greater variation of visual references in Brief 1, 2, 3, and 5 as compared to students with lower readiness for using AI tools. The only exception was for Brief 4, where students with lower readiness used a greater variation of visual references (3.60) compared to the higher readiness group (3.36). Surprisingly, there was no clear improvement in variation of visual references among both groups of students after the introduction of the AI-search methodology.

The research findings indicate that students' selection behaviours remained largely unchanged. The ease and immediacy of AI-generated results often led them to settle quickly rather than explore diverse sources. While the research tracked the variety of visual references used in each design brief and found no clear improvement in variation after the introduction of the AI-search methodology, students perceived AI as a tool that expanded their creative process in other ways.

A participating student with a higher readiness for using AI, PO3 said:

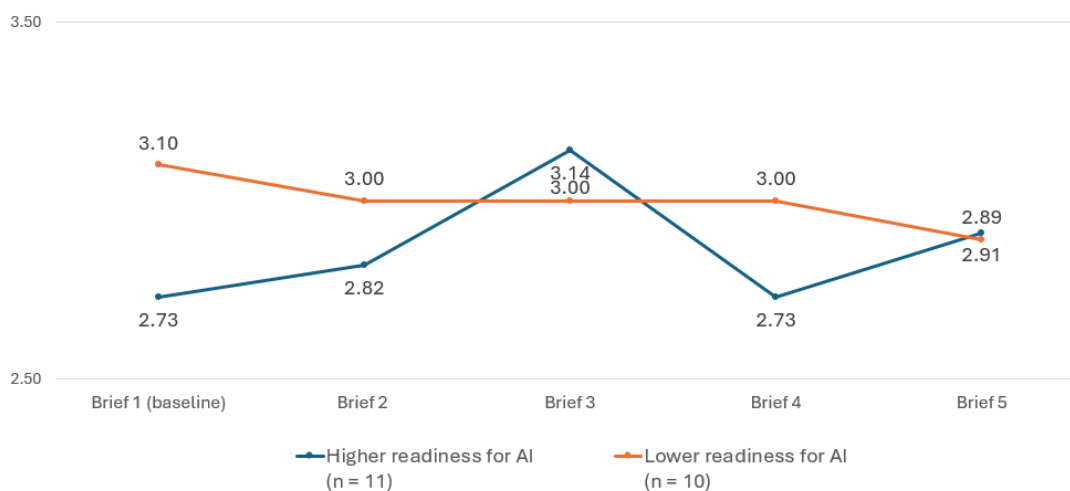
*“After going through all the modules and using Midjourney, I’ve become faster at picking out the specific words I need to get the results I want. That’s been really helpful. So, if I face the same problem again, I now know exactly what to type into the AI to get the outcome I envision. I wouldn’t say I’ve improved drastically, but it’s definitely a slight improvement. When you use AI, you need to be very specific. So, I’ve learned to use certain terms or go find very descriptive words to narrow down the result to match what I want. But sometimes, if I don’t know the right way to describe something, I end up relying on AI to figure out the right generative terms. Then, I use those terms in Midjourney to describe the image again. In a way, this process has helped me become more descriptive with my language. However, there are still times*

*when I personally can't describe the image with my own words after the AI generates it."*

Interviews show that AI accelerates ideation but rarely widens students' reference pools on its own. Most keep old search habits and use MidJourney or ChatGPT chiefly to polish ideas; as one student noted, AI let her create visuals that "don't exist yet," but it did not push her to seek unfamiliar sources. Perceived breadth therefore stems from novel image generation, not from deliberately broader research. Future instruction should pair AI with structured exercises that force students to expand keywords, challenge default choices, and diversify visual inputs. Lecturer interviews confirmed the pattern: students may add ChatGPT or MidJourney to their toolkit, but most still default to Google or Pinterest for references. As one lecturer observed, "Some students embrace AI; others stick to traditional methods." AI therefore boosts ideation yet—without explicit prompts to broaden search terms—does little to diversify reference selection.

### **RQ3: Are students better able to explain and justify their choice of visual references after exposure to the AI-search methodology framework?**

Figure 3 shows the results of the content analysis to track student-pairs' work in the explanation and justification of the choice of visual references used in Briefs 1 to 5. Student-pairs' explanation and justification were assessed using a detailed rubric and were given a score from 1 to 5 where higher scores indicated a better explanation and justification for the choice of visual references.



**Figure 3. Line graph showing the average score given for the explanation and justification for the choice of visual references, for students with higher and lower readiness for using AI tools.**

Students' justification scores stayed largely flat, clustering between 2.73 and 3.10 on a five-point scale. High-AI-readiness participants showed only a modest post-intervention bump—from a 2.73 baseline to 3.14 at best (Brief 3) before settling at 2.91—while low-readiness peers hovered around 3.0 and slipped to 2.89 in Brief 5. Overall, the AI-search method delivered, at most, marginal improvement. The lack of significant progress among students with high AI readiness could be attributed to the fact that these students may have already possessed strong research and visual analysis skills, which made the AI methodology redundant in

enhancing their ability to justify their choices. With limited room for noticeable improvement, their justifications remained relatively stable despite exposure to the AI-search framework. One of the participants - PO1 said:

*“When I was working on my last project, I learned about the history of UX design and why certain designs looked the way they did. For those kinds of things, AI didn’t help me at all. It was more about what I learned through my own research. But the difference with design history at the time was that we didn’t have to go that deep into it. We could do it if we wanted to, but the focus was more on finding visual references from sources like Pinterest or Majority. I think it’s important for students to figure things out themselves by doing their own research.”*

This suggested that for students who already had a strong grasp on visual research, AI tools acted as an enhancement tool rather than a transformative one. As a result, their ability to justify their choices didn’t drastically improve, as they were already adept at conducting visual analysis and justifying their design decisions without the AI framework.

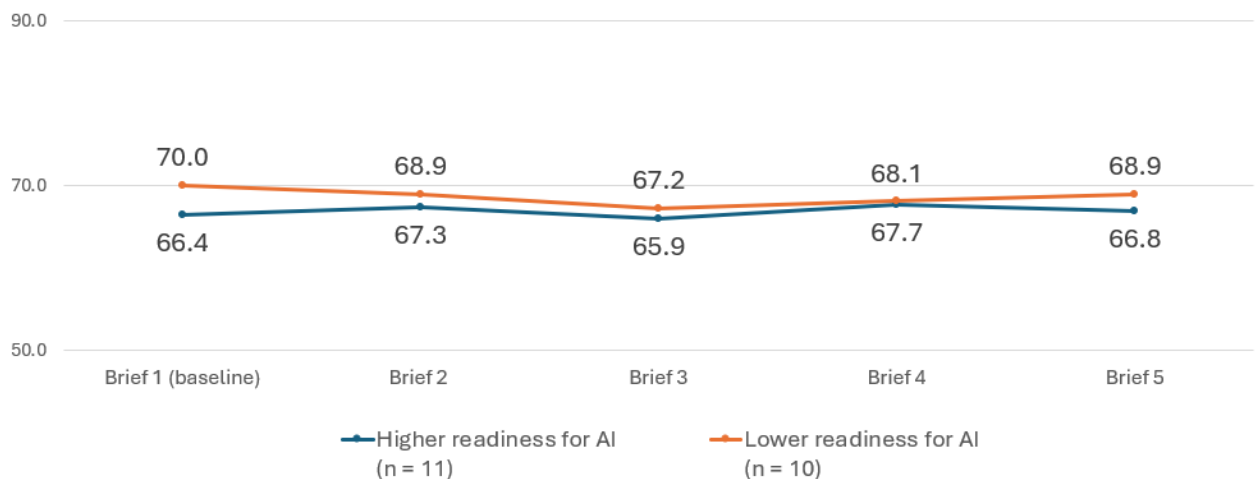
The lack of significant progress among students with low AI readiness could be attributed to several factors. Many students may have relied too heavily on AI-generated results, using them primarily as a shortcut to find images rather than critically analysing or contextualizing their choices. This is supported by student interviews, where one student, PO4 mentioned:

*“Yeah, I use ChatGPT to help expand my ideas. For example, I’ll start by searching for something specific, and then I’ll go to ChatGPT and ask it to expand on the concept or describe things in more detail. Once I have that, I can then use the information to feed into MidJourney to generate the actual image.”*

Although AI tools sped up reference gathering, they often encouraged superficial acceptance of results: pressed to deliver initial design solutions within a week while juggling four other modules, students—regardless of AI readiness—rarely refined or justified their visual choices. Lecturers noted that most moved from hesitant, note-bound presentations to confident final pitches, yet justification quality split along readiness lines. Those with strong prior research skills showed minimal change, whereas less-experienced peers leaned on AI images as shortcuts, offering only surface-level rationales and struggling to connect research to project goals. This pattern underscores how time pressure and limited critical engagement can blunt the deeper design reasoning AI is meant to enhance.

#### **RQ4: Are students’ final designs of higher quality, after exposure to the AI-search methodology framework?**

Figure 4 shows the results of the content analysis to track student pairs’ work in the quality of their final designs submitted for Briefs 1 to 5. Student-pairs’ final designs were marked using a detailed rubric and given a 1 to 100 score where higher scores indicated better design quality.



**Figure 4. Line graph showing the average score given for the quality of final designs, for students with higher and lower readiness for using AI tools.**

The findings suggest that while the AI-search methodology accelerates students' ability to generate visuals and expand their ideation vocabulary, it does not inherently improve the quality of their final designs. The scores, ranging from 65.9 to 70 out of 100, indicate that students struggle with bridging the gap between AI-assisted ideation and strong foundational design execution. This suggests that AI tools function more as enhancers of speed and content generation rather than replacements for critical design thinking skills. Without proper foundational skills, students may rely too heavily on AI-generated outputs without fully integrating them into a thoughtful, structured design process.

## Discussion

The research reveals that while the integration of the AI-search methodology framework marginally improved certain aspects of students' design processes, especially for higher-readiness students, it also highlighted several gaps in their ability to effectively utilize AI tools for meaningful design development. The first gap we found was that students exhibited minimal improvements in expanding their design vocabulary, with many relying too heavily on AI-generated content without engaging in deeper research or design reasoning. The over-reliance on AI tools led to superficial justifications for their visual choices, with many students failing to contextualize AI-generated visuals within their broader research. Without structured ideation, lower-readiness students struggled to integrate new vocabulary into their practice, even when exposed to diverse references. In contrast, students with stronger design reasoning skills could integrate AI results more effectively.

While AI-based search tools accelerate research, they rarely deepen design reasoning on their own: students still default to familiar references and use AI mainly to polish existing ideas rather than broaden their visual sources. Future iterations should therefore embed a structured "search-ideation" framework that teaches learners to map project goals to increasingly expansive keyword sets, interrogate AI outputs against design principles and cultural context,

and deliberately seek references beyond their comfort zones. Targeted exercises and rubrics can then measure how effectively students diversify their searches, justify their selections, and integrate unfamiliar influences—ensuring that AI exploration yields richer, more innovative design thinking. Third, AI accelerated research but often encouraged uncritical use: students, pressed by other deadlines, gave only surface-level rationales for visual choices. Future iterations should add scaffolded tasks and rubrics that train students to interrogate and contextualise AI outputs, while interventions for lower-AI-readiness learners must blend traditional and digital research methods to strengthen justification and presentation skills.

## Conclusion

To exploit AI fully in design education, students need clear frameworks for critiquing and refining AI outputs before final production. Instruction should prioritise core ideation, design principles, and problem-solving, positioning AI as an extension—not a substitute—of these foundations. Future iterations of our AI-search framework will add structured exercises and rubrics that force critical engagement with AI imagery, broaden reference sources, and balance digital tools with traditional research. We will also include explicit guidance on cultural context and design justification to strengthen students' rationales.

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## About the DI-IDEA Hub

DI-IDEA 数字智能教育中心旨在促进数字智能教育和研究成果的协作创造和共享。该中心为教师报告和教育资源提供了一个永久的、全球可访问的存储库。它还托管由特定兴趣小组、社区和教育组织生成和策划的集合。您可以在 <https://diidea.pku.edu.cn/> 上了解有关 DI-IDEA 的更多信息。

The DI-IDEA Hub for digital intelligence education is designed to foster collaborative creation and sharing of digital intelligence education and research outcomes. The hub provides a permanent, globally accessible repository for teachers' reports and educational resources. It also hosts collections generated and curated by specific interest groups, communities, and educational organizations. You can find out more about DI-IDEA at <https://diidea.pku.edu.cn/>.

## About the AI4E Competition

教育人工智能（AI4E）大赛是一项全球性倡议，旨在鼓励教育工作者探索并将人工智能融入教学与评估实践之中。该赛事由\*\*数字智能国际发展教育联盟（DI-IDEA）\*\*主办，并与 Camtree 合作举办，诚邀高等教育领域的专业人士走在前沿，善用人工智能提升学生学习成效、激发创造力，并优化教学方法。AI4E 大赛致力于激发创新与探索精神，最终目标是丰富教育体验并提升学习成果。

The AI for Education (AI4E) Competition is a global initiative aimed at encouraging educators to explore and integrate artificial intelligence into their teaching and assessment practices. Organized by the Digital Intelligence International Development Education Alliance (DI-IDEA), in collaboration with Camtree, this competition invites higher education professionals to lead the way in harnessing AI to enhance student learning, foster creativity, and refine pedagogical methods. The AI4E Competition seeks to spark innovation and inquiry, with the ultimate goal of enriching the educational experience and improving learning outcomes.

## About Camtree

Camtree: 剑桥教师研究交流中心一个贴近实践的教育研究的全球平台。该组织总部位于剑桥大学休斯厅，借鉴世界各地的高质量研究成果，支持教育工作者反思自己的实践并开展调查，以改善自己的课堂和组织的学习。这些调查的结果经过审查后，将根据知识共享许可（CC-BY 4.0）在数字图书馆内发布。您可以在 [www.camtree.org](http://www.camtree.org) 上找到有关 Camtree 及其数字图书馆的更多信息。

Camtree: the Cambridge Teacher Research Exchange is a global platform for close-to-practice research in education. Based at Hughes Hall, University of Cambridge, it draws on high-quality research from around the world to support educators to reflect on their practice and carry out inquiries to improve learning in their own classrooms and organisations. The outcomes of these inquiries, once reviewed, are published within the digital library under a Creative Commons Licence (CC-BY 4.0). You can find out more about Camtree and its digital library at <https://www.camtree.org/>