Artificial Intelligence Literacy: Collaborating to Support Image Research in Architecture Education

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This paper explores a collaborative approach to integrating artificial intelligence (AI) literacy into the architecture curriculum, with a particular focus on the role of architecture libraries and librarians in supporting this technology during the concept phase of design research. It outlines a student assignment that uses text-to-image AI generators to recreate architectural images and assess the role of bias in the image's automated creation. A comprehensive online guide supports the student's investigation of AI ethics, concept creation, prompt engineering, and evaluation. Feedback from the assignment indicates increased confidence in using AI image generators and enhanced critical thinking abilities. The paper advocates for AI's role as a co-creator in architecture, emphasizing the importance of incorporating critical thinking in architecture courses, and underscores the value of collaboration between faculty and librarians in AI integration.

INTRODUCTION

Generative artificial intelligence has already changed the field of architecture. Tools that create images based on text or image prompts aid in creating inspiration and visual representations of designs, and a clear use for this technology is to generate conceptual images in a studio setting. Whether using text, sketches, or a combination to manufacture an artificial intelligence (AI) output, designers now have the means to reference images that are highly personalized to specific projects. In architecture education, these tools can help students explore concepts more easily, but their use requires a critical approach to mitigate issues of bias or appropriation.

Left unchecked, the uncritical application of generative AI in a studio context can result in work that is derivative or unethical. While AI tools can help to extend authorship in ways that expand our creative potential, their use must be rigorously documented, credited, and supplemented by original work—much like library-based research itself. This paper argues that librarians are uniquely suited to provide both practical and critical skills relating to the use and implementation of generative AI.

Libraries typically support conceptual research by providing access to resources that reference precedents, or images that offer inspiration. With generative AI in the mix, this project explores how generated images can enhance concept research and reestablish the role of the architecture library in this new wave of information-seeking behavior. The boom of generative AI has been compared to the emergence of Wikipedia. At that time, libraries struggled with how, if at all, to leverage Wikipedia as a research tool. In the present day, Wikipedia serves as a launching point for research with built-in critical thinking mechanisms like hyperlinked citations and verified claims. Generative AI may be on a similar trajectory.

Funded by a University of Toronto Learning & Education Advancement Fund to inform the use of generative AI in pedagogical contexts, the role of the architecture library in using AI as a research synthesis tool is explored. It investigates the expansion of traditional image research methods—using images in books for inspiration, looking at plans, elevations, and sections in articles to inform case studies, or managing image databases for teaching and research—to complement using generative AI in the concept phase of research. In the same way that librarians offer instruction on how to think critically about web resources like Wikipedia, this project showcases a collaboration with the library on instruction to strengthen architecture students' ability to think critically about artificial intelligence and image generators.

CONTEXT

While interest and contributions to the literature on AI are growing, there is minimal research published on how libraries can support this technology as a research tool. At the time of writing, a search for library instruction and AI retrieved less than ten results, all of which focused on text-to-text generators like ChatGPT. The article *The CLEAR Path: A Framework for Enhancing Information Literacy through Prompt Engineering* outlines a framework for prompt engineering that can be incorporated into academic library instruction to teach how to navigate and develop AI content more effectively.[1] Other articles focus on the potential benefits and concerns of operating environments

in libraries.[2] However, no literature exists on the role of library instruction in using AI image generators for concept research.

Likewise, the use of AI in architectural literature is steadily increasing in the context of practice, but academic instruction lags behind. For example, an article published in *Architectural Record* in 2021 discusses how AI can help architects use data to drive designs by suggesting that decisions can be made much faster and earlier in the process, potentially leading to a greater advantage in addressing profound problems.[3] The same use is echoed in an issue of *Volume* from the same year, in which Dark Matter Labs discusses the potential for AI to help architects solve problems like the climate crisis by using algorithms to support our understanding of complex problems and enable data-driven decision-making.[4] The other notable role in design, AI as co-creator, is discussed in the article *Exploring the Nuances of Designing (with/for) Artificial Intelligence*.[5] It notes that discussion in the design discipline is limited, but in situations where physical prototypes are not possible, AI harnesses the power to explore possible directions during the design process.

To build on the idea of AI as co-creator, articles published a year later, like *Creative Turn*, envision humans in the role of curator or art director when prompting AI generators in the creative ideation process. The author explains image generators as an additional tool in the toolbelt.[6] *MADE Artists vs. AI* describes a test of this notion, by the wall covering company Wolf-Gordon, which translated the original designs of artists into text descriptions. The AI-generated image results, though some slightly similar, reflected the haphazardness of AI and heavy training on stock images.[7]

METHODS

To incorporate library-based AI instruction—or AI literacy—into the architecture curriculum, the head librarian of the architecture library applied for funding from the university. The funding supported a graduate student who helped create instructional materials initially envisioned as a workshop tangential to course instruction. The purpose of the instructional materials was three-fold. First, we aimed to help students understand how to ethically use AI for image research. This includes a discussion of how the artificial intelligence algorithms work and the importance of documenting the design process to show what work is yours, what is borrowed, and what is AI-generated. Second, this initiative sought to demonstrate how AI and traditional research outcomes differ—or, more interestingly, support each other: how can research be used to inform prompts and fact-check AI-generated content? Last, we hoped to demonstrate how to think critically about AI-generated images through the development of an evaluation method like the CLEAR framework.[8]

After considering the exploratory nature of generative AI tools in architecture education, the project shifted away from being offered as a standalone workshop to course-embedded content. A first-year Computation and Design course, offering settings, exercises, and information to assist students in developing fundamental computational design skills, was the ideal partner. This is a required course for all first-year students across the umbrella of programs in the faculty. While the course has traditionally focused on computational tools like Processing and Grasshopper, the sudden prevalence of image-generation AI tools amongst our students led to a restructuring of the class. The course now foregrounds AI, with a three-week introductory module that aims to equip students with the conceptual and critical resources to understand, produce and critique AI-generated work. Students eagerly participated in class discussions that situated their lived experiences of AI within the critical context of work by scholars and artists like James Bridle and Aarati Akkapeddi, then applied these skills in a pair of AI-focused assignments.

The first assignment asked students to make a critical intervention when using AI image generators; participants were asked to select an image of architecture with some kind of critical relationship to the course's in-class discussions on bias, equity, and computation. Then, using a text-to-image AI generator of their choice, they were asked to recreate the image as closely as possible using a text-based prompt. Students were discouraged from using a building's proper name—instead, they were asked to develop a set of textual descriptions that resulted in a generated image with visual similarity to their initial selection. Finally, they were asked to run the same prompt through a second text-to-image generator. In many cases, dataset bias found in differing generators resulted in substantially different images. In their response, students submitted a narrative outlining how the two images differed, how they were similar, and what they could infer about image-generator bias from their results. The final class assignment asked students to combine their learned skills in computational design and AI image generation. The assignment navigates between AI-generated plans, parametrically designed structures, and the AI renderings of student designs. Following this process, students were prompted to contemplate questions surrounding authorship, reflecting on who contributed and to what extent.

To support the assignments and aid in the student's exploration of image generators, the library team created an online guide using a popular information sharing software for libraries, LibGuides, that addressed the three areas of the AI literacy project outlined earlier. The online guide not only supports the assignment but is available publicly as a library research guide to support other architecture courses as we continue to explore the use of AI technology in the curriculum.[9] It is divided into five main sections: How Generative AI Models Work, Concept Exploration and Visualization Workflows, Prompt Engineering, Critically Evaluating AI Tools, and Citing Generative AI. The library graduate student, a teaching assistant (TA) for the course, led instruction during the lecture about prompt engineering. Further, TAs discussed the content of the guide during tutorials. Students were encouraged to use the guide as they completed the assignments. Finally, following the first assignment, students provided

Figure 1. Screenshot of "How Generative AI Models Work" explaining the processes behind which diffusion models are trained to generate images

feedback on the usefulness of the library guide. The TAs distributed a five-question survey that asked questions about the guide's impact. Students could respond to the questions anonymously but sharing their email addresses entered them into a draw for a café voucher. Two hundred and eleven students completed the survey. Following the first assignment and completed survey, the guide was updated to respond to feedback.

HOW GENERATIVE AI MODELS WORK

The first section supports the project goal to help students understand how to ethically use AI for image research. By understanding how generative AI models work, students can make more informed decisions about their credibility. An explanation of diffusion models and generative adversarial networks weighs benefits like the ability to create a diverse range of personalized images and drawbacks like being trained mostly on images gathered without the consent of their authors. (Figure 1) While the systems being trained on algorithms are mentioned, the focus is on providing a high-level overview of how these algorithms work, instead of deep diving into technicalities. As the authors of the article *Exploring the Nuances* confirm, AI algorithms require expert knowledge to understand.[10] Even to the AI developers, the logic of the algorithms are a 'black box' detached from the model's inputs and outputs.

By de-mystifying the workings of AI models, students can better understand how an output image emerges from a set of training data, defeating misconceptions that AI models are an objective summary of data, but that the training techniques, AI developer intents, and human reinforcement training present biases in AI models.

CONCEPT EXPLORATION AND VIZUALIZATION WORKFLOWS

The next section includes four videos demonstrating image generation tools for initial design conception, final visualization, and image editing. A variety of AI tools and platforms are demonstrated. The AI platform and model Midjourney is used for concept image generation, a process using AI generations as a quick "sketching" tool to develop initial forays into a design concept. The associated video introduces prompting syntax and techniques for Midjourney and demonstrates how to iteratively prompt to achieve the desired results. (Figure 2)

Meanwhile, the Stable Diffusion XL platform is used to demonstrate image inpainting, a function offered with certain AI models that allows the user to specify areas of the image that they would like to keep, and areas to spot-treat with a new prompt. Similarly, the generative fill function in Photoshop is demonstrated for image editing, allowing users to specify regions for new prompts, and blending two separate regions together. (Figure 3) While some AI functions are currently model specific, many feature similar functionality, and the principles and techniques taught could be applied across platforms. As supported in the literature, the guide emphasizes using image generators in the concept phase of design research as a co-creator—not the sole creator of designs. In the same way that libraries play a significant role in democratizing information, the library-based

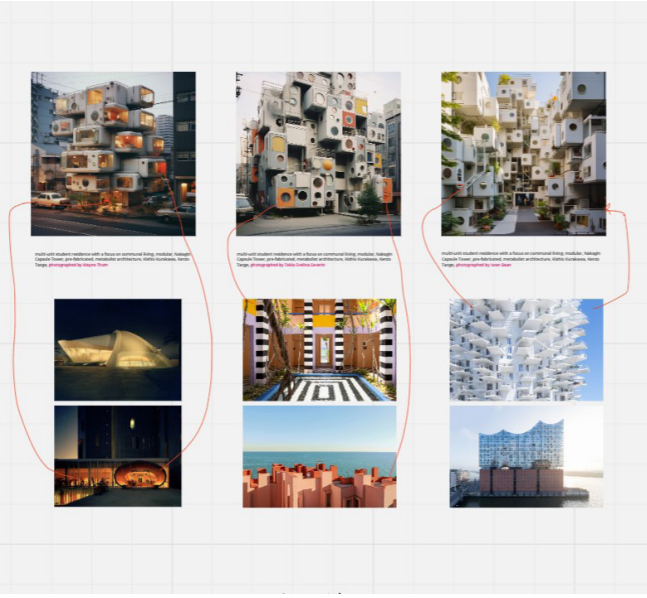

Figure 2. Screenshot of "Concept Exploration Workflows" video showing how AI image generations frame outputs differently by prompting with different photographers

Figure 3. Screenshot of "Image Based Generative AI Inpainting" video showing how to spot-edit AI image outputs by highlighting regions to keep and regions to change

guide to using AI for concept creation explores the role of the library in democratizing design. In this sense, the artificial intelligence tool gives every designer a kind of 'intern' to support their research process.

CRITICALLY EVALUATING AI TOOLS

The remaining sections of the guide focus on prompting, evaluating, and crediting generative AI tools. The benefits of using AI to support research is clear, but it must be undertaken with care. Library instruction typically discusses how to create search strings to find relevant articles in databases that support research; the similarity between *prompting* and *searching* therefore positions librarians to weigh in on how best to create AI prompts. As discussed in the CLEAR framework article, the effective use of AI tools requires a clear understanding of the language and concepts used.[11] For example, the prompt "A building emerging from the landscape in a desert designed by Antoni Gaudi on a bright sunny day photographed by Iwan Baan" assumes that the user has at least a basic understanding of the styles of Gaudi and Baan. During this phase, using more traditional research mediums like books and articles to learn about different styles makes sense.

The project's ultimate goal lies in developing and disseminating methods for the critical evaluation of AI tools, an area where librarians can make the most potential impact. To help make critical thinking more digestible for students, the project team developed a framework with the acronym VALID-AI.[12] It outlines questions to consider when evaluating an AI tool or output such as validating the data, analyzing algorithms, making legal and ethical considerations, interpreting how the AI tool works, evaluating bias, checking the accuracy of outputs, and a self-assessment on the ethical use of the tool.

Further, this section of the guide discusses the accuracy and reliability of AI outputs, bias in the datasets that AI tools are trained on, how to identify truth and deepfakes, and implications for artists and copyright. Using example cases of malicious AI use, it shows how AI tools can be used to purposefully deceive and mislead, to teach students how to evaluate images critically. This section presents different viewpoints regarding AI ethics from artists who use, profit, and have suffered from the rapid proliferation of this technology. Many of the principles applied in this section are core concepts in information literacy instruction. In the same way that librarians teach students to evaluate information sources, they can also play an important role in teaching students to evaluate generative AI outputs. Like all images, AI-generated images must be credited. The last section of the guide identifies best practices in citing AI-generated images.

OUTCOMES

Between the date that the first assignment was distributed and its due date, the guide had 1150 views. Student feedback on the guide and assignment indicate that together they had a substantial impact in increasing student confidence using AI image generators. Over 50% of students who gave feedback said the guide provided practical steps for integrating AI into image research and that it provided clear examples of how to use AI for developing a design concept. Further, over 60% of respondents said the guide either "very" or "extremely" strengthened their ability to critically assess generative AI tools. Nearly 30% of students said they were extremely likely to recommend the guide to their peers. When responding to specific sections of

the guide, students ranked the sections from most useful to least useful as Prompt Engineering, Critically Evaluating AI Tools, How Generative AI Models Work, Concept Creation, and Citing Generative AI. Almost all of the sections were rated at least 55% either “very” or “extremely” useful. The least used section was concept creation, the only section with a video component. This result could indicate a preference for text and image examples instead of lengthier videos.

The last two questions offered an opportunity to provide written responses. When asked what information students felt was missing from the guide, most responded that the guide was informative and that nothing was missing. However, roughly 10% of the responses offered suggestions for improvements. A handful of students requested more discussion around the limitations of AI and links to more free AI tools. Seven students suggested expanding the examples in the guide beyond Midjourney, which is the focus of the guide, to include other generative tools like DALL-E and Replicate AI. There were seven further suggestions to develop the prompt engineering section in more detail, and two students suggested a deeper analysis of AI bias and how to combat it. Two additional students requested real examples of AI being used in built architecture. 88 students provided comments for the final question, all of which indicated a positive experience and praise for the guide.

ASSIGNMENTS

In the first assignment, student submissions in the 90-100 percentile showed a developing understanding of AI biases, by comparing image generations from different models, students hypothesized on the biases and datasets within their AI tools. Generally, student analysis shared the following themes:

1. AI images are inaccurate/unreliable, generating buildings that are of the wrong scale, or structurally unsound/impossible;

2. AI biases certain architectural styles over others, especially when prompted with two or more different architectural styles;

3. AI models are biased on culturally specific imagery, unable to accurately reproduce images of certain cultures, which could be due to a lack in image data, or due to a difference in language;

4. AI can represent the most typical condition of a certain building typology (e.g. university buildings share many similarities in style to impart a feeling of prestige);

5. Certain AI biases are relational: if most images of a certain building are taken in the nighttime, prompting for that building will cause the image to become a night view;

6. AI models have a ‘model style’ preferring a particular form of representation when unprompted for a specific style.

These results showed student understanding about the various nuances and issues regarding AI image generation, and the ability to critically approach AI images in the future. (Figure 4)

In the final assignment, most student reflections on authorship in their design process identified the AI model as a co-author, or design tool, with themselves as the main author. Very rarely

Figure 4. Excerpts from the first assignment examining AI’s biases towards indigenous architecture by attempting to recreate the Aanischaaukamikq Cree Cultural Institute (left) with AI through the model DALL-E (right). Japnam Dhaliwal, Stefano Proietti, and Maui Millen.

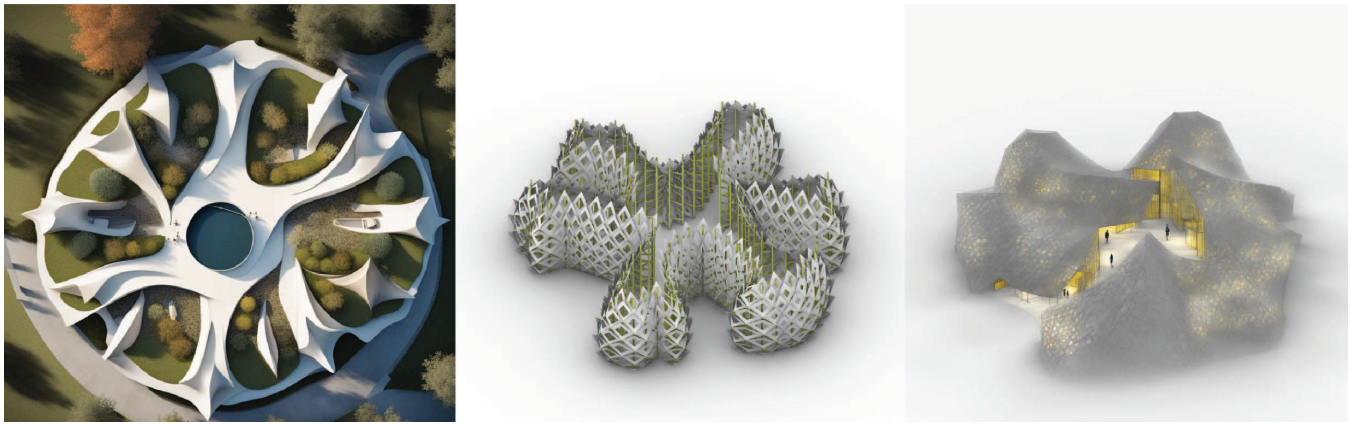

Figure 5. Excerpts from the final assignment showing the design progression from an AI-generated plan, to a parametrically designed form, and finally an AI-rendered image (left to right). Kinga Bitner.

were students able to identify other sources of authorship present in the process, such as the contribution of artists present in the dataset, specific persons being mentioned in their prompting processes, or the bias of the AI developers. Through this assignment, students were able to integrate AI into their own creative processes, allowing it prompt innovative ideas, influence the design and affect project outcomes, much like real-world applications of AI in architectural offices. (Figure 5)

DISCUSSION

Overall, this project shows that architecture courses that collaborate with librarians can have a positive impact and increase student's ability to think critically about generative AI tools and outputs. Students identified the sections of the guide that are most useful as prompt engineering and how to think critically about AI, indicating potential focus areas for architecture libraries going forward. The similarities between database searching and prompt engineering make library-based instruction a natural fit. Both systems operate heavily on keywords and structured commands to reach desired results. Moreover, librarians are well-equipped to provide literacy instruction on evaluating the accuracy, relevance, and completeness of the results, and combining traditional research to refine prompts so that they generate content that addresses specific challenges or contexts.[13] The VALID-AI framework is a tool to help students think critically about generative AI, generally, as well as the images or content created. Lastly, library-led discussions about bias, deepfakes, and copyright implications reiterate important concepts to students from a perspective outside of architecture.

As mentioned in the literature, the 'AI as co-creator' model stands out as an effective way to incorporate the technology into the design process,[14] but this view may be somewhat limiting: it is a co-researcher, co-author, or—more broadly—a co-pilot at any point of the design process. From the library perspective, generative AI is a welcome complement to traditional research methods and a powerful tool for research synthesis. The expectation for students to acquire expertise in the discipline remains critical, as they can benefit from utilizing traditional library resources, including during the prompting and evaluation processes.

Generative AI does offer potential as a research synthesis tool to help students distill key findings or trends across the literature. However, the current slate of research synthesis tools is strong in scientific literature but lacking in arts and humanities literature; for now, it is not a robust option. As the AI environment evolves, tools for synthesis, searching, and personalized resource recommendations are all within the realm of possibility. Architects will be able to leverage the technology most prominently during the concept and editing phases of design, the former a strong contender for collaborating with libraries on instruction. Its greatest potential is as a tool for efficiency, freeing up student's or architect's time to make important design decisions and solve real-world problems.

Additionally, recommendations based on the findings of this project include emphasizing critical knowledge and critical thinking in architecture courses and implementing guidelines for when and how generative AI tools can be used to support conceptual research. An expert-level knowledge of the discipline continues to be necessary. During design research, students still need a solid understanding of the ideas and theories in architecture to inform their projects. Likewise, the ability to think critically—whether about an existing project, a generative AI image, or *any* information output—is crucial to developing architects. As a result, it will become pivotal for students to break their design process into increments and credit work that is not their own, whether human- or AI-generated.

CONCLUSION

By incorporating generative AI tools into the conceptual phase of the design research process, students and practitioners can visualize and experiment with different stylistic and design

options, ultimately widening their creativity. This project shows that faculty/librarian co-instruction adds value to assignments in which students explore AI tools, particularly the prompting and evaluating components of the assignment. The core purpose of libraries has always been to provide access to information and instruction on how to find and evaluate information, and generative AI offers a new environment for librarians to add the same value. Further, collaborative instruction, as demonstrated in this project, helps reiterate critical concepts to students from different perspectives.

Going forward, sharing pedagogical methods and setbacks to inform others is increasingly crucial as the technology evolves and becomes further embedded in architecture curriculums. Exploring the role of generative AI in the design research process will require more substantial collaborations in the future. We aim for faculty and librarians to understand the technology—and help others to understand—to measurably alter conceptual research for the better.

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