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An approach to AI-supported learning in architectural education: Case of speculative space design

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Abstract
The study discusses integrating text-to-image artificial intelligence (AI) tools into the architectural studio. If the integration of AI is realized through narrative production, which is a combination of written and visual media, the student's interaction with the tools can be strengthened. This approach was tested through a workshop called "AI-Supported Speculative Space Production Workshop" conducted by the authors of the article as a case study. The workshop included 12 participants and lasted for 10 days. The expected output at the end of the workshop was a storyboard consisting of sequences that narrate and visualize the designed space. The data of the case study was collected through observation, diaries written by the students and submission of all productions in the process. The case study process was evaluated and presented according to the reflectivity between the participants' productions in the design process by using the visual analysis method. In addition, the outputs of the case study were assessed by design experts according to three criteria that are related to the research, sketches, the narrative, and the integration of them. It was observed that especially the students who used the AI tool in relation to other representations in the design process achieved more successful results. In this way, inferences were made about how text-to-image AI tools can be integrated into the architectural design studio process while understanding their limitations and potential. These approaches are expected to contribute to the effective utilization of AI in the studio.

Keywords
Artificial intelligence, Design education, Reflectiveness, Speculative spaces, Visual analysis.

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1. Introduction

Over the centuries, architects have created impressive works of architectural imagination through the design of imaginary, unbuilt, conceptual, or radical spaces, using their creative abilities to explore new spatial or philosophical possibilities (Spiller, 2008). Speculative narratives provide a conceptual space for architecture students to develop new discourses and question reality, allowing them to reflect on possible futures, create technological visions and fictional worlds, and question existing assumptions and systems (Uyan Dur, 2021). Architects can create speculative productions in the form of polemical drawings, models (real or virtual), or texts about buildings and cities (Spiller, 2008). With recent technological developments, the use of generative artificial intelligence (AI) for this purpose has started to be explored by architects and designers (Blythe, 2023; Malakuczi et al., 2024; Sağlam & Çelik, 2023). This study discusses integrating text-to-image AI tools into the architectural education curriculum through the production of speculative spaces. Thus, alternative ways of thinking are proposed to explore new horizons in architecture using AI tools. The questions of how these tools can be used for this purpose and what benefits they can provide are attempted to be answered within the scope of the article.

Just as digital architecture and computational design theory require us to reconsider architectural theory and methodology (Kolarevic, 2000; Oxman, 2006; Terzidis, 2006), integrating AI into the architectural design process has made it necessary to work on new strategies in architectural research. Like computational design tools, which have changed traditional design approaches by enabling the designer to explore various possibilities (Terzidis, 2006), generative AI tools can support the design process in exploring possibilities. The meaning of creativity in architecture is also changing as computational design technologies such as digital tools, information and communication technologies (ICT), and AI in a broad sense develop (Akcay Kavakoglu et al., 2022) and it has become necessary to make this inquiry through empirical studies. This study aims to contribute to this questioning environment by focusing on the text-to-image generative AI model, which is a deep learning model.

It is observed that the studies on the use of text-to-image-based GAI (Generative Artificial Intelligence) or AI Image Generators in the architecture studio in the literature mostly focus on visual production (Çiçek et al., 2023; Paananen et al., 2023; Tong et al., 2023). However, the design process is influenced and strengthened by many different types of sources (i.e., written, verbal, and visual) (Goldschmidt & Sever, 2011). In the use of text-to-image AI models, the written text becomes more important as it constitutes the input. Therefore, it is important to handle written and visual data together in the integration of AI in the studio. In this direction, using different media together by establishing a narrative can be a good way to construct the interaction of AI and the design student. In the direction of this hypothesis, a workshop titled 'AI-supported speculative space production' is taken as a case study. The workshop explores possible alternatives through various utopia-dystopia narratives while considering daily life and the human scale. The workshop was organized with a total of 12 participants and two facilitators and lasted 10 days. The participants of the workshop were mostly first-year to second-year architecture students.

In architecture, whether professionally or in education, designers need to externalize their designs to develop their own thoughts and communicate with others. Schön (1983) conceptualizes the design process as a reflective and communicative interaction with the materials and artifacts of the design situation. At the point where the designer externalizes his/her thoughts, his/her production and interaction with visual media play an important role in the design process (Schön & Wiggins, 1992). According to Schön, design problems are actively set or 'framed' by designers, who make 'moves' by using external design representations. Similarly, Goldschmidt (2014) argues that designers continuously cycle through the phases, refining their ideas and solutions based on reflection and feedback (Goldschmidt, 2014). Recent advancements

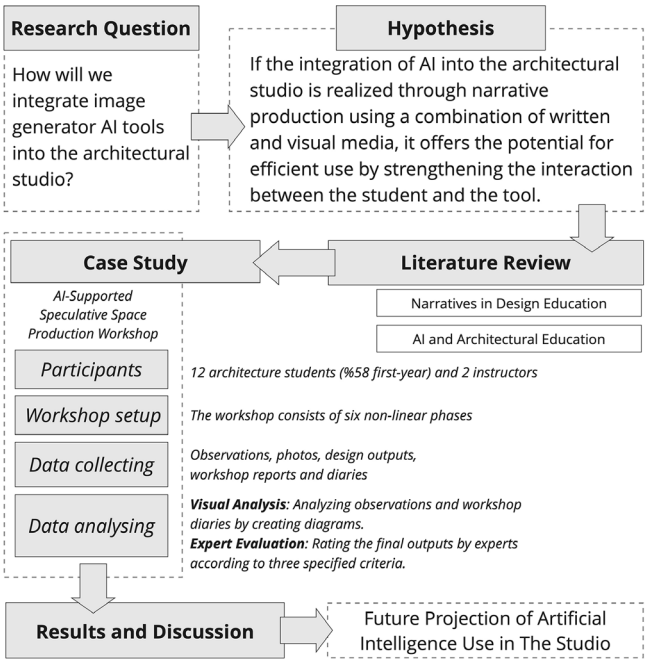

Figure 1. *The framework of the study.*

in AI tools that use natural language models as input have made it possible to create detailed and realistic representations alongside traditional methods such as sketching, model-making, and collages (Paananen et al., 2023). Establishing a reflective relationship with the production of text-to-image AI can feed the process of externalization in the design process. In this context, the case study process was evaluated and presented according to the reflectivity between the participants' productions in the design process by using the visual analysis method. In addition, the outputs of the case study were assessed by 8 design experts according to three criteria of a successful speculative narrative. The success cases defined by the experts and the design process they went through are discussed together with the scenarios of using AI tools. Figure 1 shows the framework of the study.

First, the study explores narratives in architectural design and the current uses of text-to-image AI tools in the field of architectural design through a literature review. Subsequently, the "artificial intelligence supported speculative space production workshop" is explained along with its method and is evaluated. The results of the case study are discussed, and conclusions are drawn. In this context, the study systematically presents the potentials and limitations of AI in the context of architectural design and provides recommendations to studio instructors.

2. Literature review

A literature review has been conducted under two main headings to explore the potential use of generative AI tools in speculative space production and education: a) narratives in architectural design education and b) integrating AI tools into architectural education.

2.1. The role of narratives in architectural design education

There are many types of external representations that can give the designer fresh ideas and inspire the designer in architectural design education (Goldschmidt & Sever, 2011). Visual, auditory, and written external representation types can be given as examples of various stimuli. Each of these stimuli types provides inputs that give the designer ideas and trigger some thoughts in his/her mind. Although the contribution of visual stimuli to the design process has been intensively studied within the subject of Design Cognition and in design education, there are also studies that examine the effects of written sources on the designer. For example, Goldschmidt and Sever's study (2011) shows that participants who were given written stimuli generated more creative ideas. Compared to visual stimuli, the use of written stimuli triggers more abstract thinking (Goldschmidt & Sever, 2011). However, of course, the contribution of written sources to the design process does not have to be only stimuli. The designer can also use the written text as a representational tool to externalize his/her own thoughts. Designers use a range of representation techniques, including sketches, physical and digital geometric models, diagrams, graphs, notations, and object properties (Gül & Maher, 2009). Each technique has different potentials in terms of constructing thought throughout the design process. The use of these different representation techniques in the process will positively affect the design process (Oxman, 1997) because the design process needs

the most appropriate representation technique to deal with the design problem encountered (Dorta et al., 2016). Writing in design develops alternative solutions and ideas (Gelmez & Tüfek, 2022) and can be a method for the designer to construct the space in education. Writing directly contributes to the design process of students (Gelmez & Tüfek, 2022) when allowing a student to reflect on his/her personal design project (Clemente et al., 2017).

There is also the use of writing in combination with various AI tools that produce visuals from text. For example, in Yıldırım's study (2022), it was observed that students who produced through AI with written inputs benefited from the tool while solving the design problem, and in Sadek and Gelil Mohamed's study (2023), it was observed that students who created prompts with narrative production and fed these prompts to AI achieved more creative results compared to the traditional method. In the paper, during the design process in the architectural design studio, students were both given written stimuli and expected to produce a narrative. This stimulus and the text expected to be produced by the students are on utopia and dystopia literature. The reasons for this are, first of all, it becomes evident that every utopia must necessarily design space. Therefore, we can say that every utopia generates a sense of spatiality and is inherently architectural. So, the subject of utopia and dystopia is suitable both for reading and writing about and for spatial production. The other reason is that it is important to recognize that architecture is also about hope and envisioning a better future through the possibilities of the different (Picon, 2013). Therefore, it is necessary to open opportunities for people to transform and shape the city they live in as they desire. And utopias are fertile fields for thinking about alternative possibilities. At the same time, being able to speculate on the future, whether through utopia or dystopia, encourages all kinds of critical thinking and includes comprehensive evaluations of the life of an individual, the city, and the world. The ability to produce and discuss this critical thinking is very important in architectural education. In this way, architectural education is a productive domain for questioning space and imagining alternatives. Therefore, in architectural education, utopias that are open to speculation have a unique importance.

2.2. Integration of artificial intelligence models into architectural education

When discussing the integration of AI into architecture, it is essential to first define and clarify the concept's scope. AI is an umbrella term encompassing the concepts of "machine learning" and "deep learning." There is a relationship between these three concepts, ranging from a broad sense to a narrower one. While all machine learning models fall under AI, not all AI models are within the scope of machine learning. Additionally, deep learning is a relatively recent advancement in machine learning that has significantly advanced the field of AI (Leach, 2022). AI has become a generative system with deep learning. Generative AI refers to various technologies that can synthesize text, images, or other content in response to written prompts (Oppenlaender et al., 2023). This study focuses on text-to-image generative AI tools that are in the scope of deep learning. The literature review focuses on the uses of these models in architectural design and architectural education.

The use of AI tools in the architectural studio has become a tool used by students in various stages of design, such as research, analysis, representation, and facade design, and its integration into the studio has diversified alongside developments in AI (Paananen et al., 2023). Moreover, natural language-supported text-to-image AI tools that emerged in 2022 hold significant potential for use in the early stages of design (Jaruga-Rozdolska, 2022). An AI image generator employs deep learning algorithms and text-to-image techniques to produce novel images aligned with user-provided text descriptions, trained on diverse image data and parameters (Enjellina et al., 2023).

The current literature presents how AI image generator tools have been integrated into architectural design ed-

Table 1. *Information of participants.*

Participant	Years Studied	Tool(s)	Experience
S1	2	MJ + PsBeta	No
S2	1	MJ	No
S3	1	MJ	No
S4	3	MJ + PsBeta	No
S5	1	MJ + PsBeta	No
S6	2	MJ	No
S7	1	MJ	No
S8	1	MJ + Adobe Firefly + PS Beta	No
S9	1	MJ + PsBeta	No
S10	3	MJ	No
S11	2	MJ	No
S12	1	MJ + PsBeta	No

1 = **58%**
2 = **25%**
3 = **17%**

ucation. The initial search focused on terms such as "artificial intelligence," "generative text-to-image models," "Midjourney," along with keywords like "architectural education," "architectural design," and "design studio." Articles in the literature can be categorized into three main themes based on their focus: 1) the impact of these tools on creativity, 2) prompt engineering, and 3) the role of these tools in the design process.

Paananen et al. (2023) and Sadek & Gelil Mohamed (2023) examine the impact of these tools on students' creativity. For instance, Sadek and Gelil Mohamed (2023) found that students who used AI tools during the early stages achieved more success than students using traditional methods. Paananen et al. (2023) argue that these tools support creative idea generation when used in the early stages of design.

Some studies in the literature focus on the generation of textual data, i.e., prompts (Jaruga-Rozdolska, 2022; Paananen et al., 2023). For example, Paananen et al. (2023) extensively present the prompts used by students during the concept generation stage of the design process. Additionally, there are studies that use textual sources to convert them into spatial representations using text-to-image generation tools (Sadek & Gelil Mohamed, 2023; Yıldırım, 2022). For instance, Yıldırım (2022) suggests that students benefit from their favorite books, while Sadek and Gelil Mohamed (2023) recommends starting the design process with a narrative.

The design process is multifaceted and complex. Therefore, it is important to consider AI tools as participants in this process and to structure their interaction with designers (Akcay Kavakoglu et al., 2022; Figoli et al., 2022). For example, integrating AI tools into architectural education in collaboration with sketching is highlighted as an important aspect (Tong et al., 2023; Yıldırım, 2022).

In conclusion, it is possible to draw the following conclusions from the studies conducted at different focal points in the literature:

- Integrating AI tools into the architectural design process made educators reconsider their curriculum.
- In the early stages of the design process, text-to-image AI tools can act as a catalyst to support creativity.
- It is important to design AI and student interaction in the studio.
- The data selection to be used in the integration of these tools into the design process is crucial.

While the literature reveals the various potential uses of these tools, the question of how to integrate them into architectural education remains somewhat ambiguous. The answer to this question needs to be explored through empirical studies.

3. Case study: artificial intelligence supported speculative space production workshop

The workshop covers a total of ten working days. The participants of the workshop are mostly first-year to second-year students. Table 1 reveals the years studied by the participants in their architecture undergraduate education, the AI tools they used for their final submissions, and whether they had prior experience with these tools before the workshop.

The workshop aimed to educate students about using AI tools in architectural design and provide them with practical experience in integrating text-to-image-based AI tools into the architectural design and representation phases. Within the workshop's scope, the architectural and urban imaginings of the selected utopia or dystopia are supported by generative

AI tools across transitional and continuous written, verbal, and visual representations. Students were encouraged to draw sketches and write texts, and they attempted speculative space production based on utopia or dystopia. In the following section, the setup and phases of the workshop and the methodology were explained.

3.1. Workshop setup

In this section, the preparation of the workshop will be examined in four parts:

a) literature review to define the scope and subject of the workshop,

b) identifying various utopia and dystopia works,

c) determining the text-to-image AI tool to be worked with,

d) studies on the workshop program.

3.1.1. Reviewing the literature to define the subject and scope of the workshop

The first stage of preparing the workshop structure is the review of the literature. When various studies related to the AI tools planned to be used in the workshop are examined, it is observed that text-to-image AI tools can support designers in terms of generating ideas in the early stages of design (Paananen et al., 2023; Sadek & Gelil Mohamed, 2023). The study by Sağlam and Çelik (2023) attempted to use AI tools on utopias as a means of possible alternatives and, therefore, constructing speculative spaces. However, this study differs from our study by using literary utopias in the conceptualization phase of architectural design. As a result, the subject of the workshop is to experiment with spatial production based on utopia and dystopia.

3.1.2. Selecting utopia and dystopia literature

Each utopia-dystopia literature is undoubtedly significant; however, for the works given to the participants in the workshop to be suitable for the purpose of the study, they need to cover various criteria. These criteria can be listed as follows:

- The selected books should have been written in various historical periods.
- They should encompass or potentially encompass the six criteria expected in the final production in the workshop ((1) City Plan, (2) Transportation system, (3) Daily movement, (4) The functions and forms of the structures, (5) Management - Politics, (6) Culture of production and consumption).
- They should be suitable for research, having articles, and/or theses, and/or critical essays written about it.

When the criteria are evaluated comprehensively and considering the number of participants (12), the created literature pool is as follows:

- Utopia (1516) - Thomas More
- The City of the Sun (1602) - Tommaso Campanella
- New Atlantis (1626) - Francis Bacon
- Herland (1915) - Charlotte Perkins Gilman
- We (1921) - Yevgeny Zamyatin
- Brave New World (1932) - Aldous Huxley
- 1984 (1949) - George Orwell
- Island (1962) - Aldous Huxley
- A Clockwork Orange (1962) - Anthony Burgess
- The Dispossessed (1974) - Ursula K. Le Guin (This novel is divided between two participants due to its portrayal of two different cities: Urras and Anarres.)
- The Spaces of Hope (2000) - David Harvey (Work focused on the Edilia, or 'Make of it what you will' section.)

3.1.3. Determining the text-to-image AI tool to work with

In the process of developing the workshop curriculum, it was decided to use Midjourney as the text-to-image AI tool based on the instructors' experiences and research. Midjourney is selected for its features, such as allowing the user to be more participatory in the process compared to other popular tools like Adobe Firefly and Dall-E (Jaruga-Rozdolska, 2022), offering options to create alternatives for the generated image, expand its context, and having a user-friendly interface (Sadek & Gelil Mohamed, 2023). Various attributes such as desired and undesired elements, the style of the image, aspect ratios, and abstraction scale can be defined by writing prompts. Additionally, the ability to view the work of other users

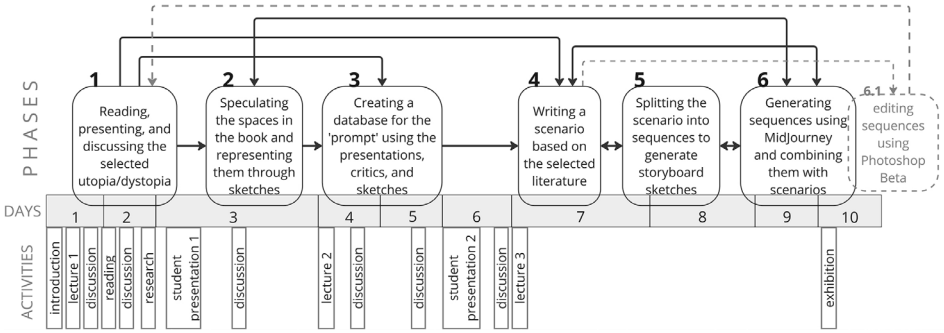

Figure 2. *Phases of the workshop.*

and examples for creating prompts in a Discord interface can be considered as positive aspects of this tool.

3.1.4. Studies regarding the workshop program

The workshop program has been equipped with various activities such as presentations, readings, and discussions in line with the skills aimed to be acquired by the students. In this regard, the instructors have made the following preparations: (d1) Three different presentations have been prepared, covering the history of utopia-dystopia, the use of AI in architecture, and sequences in architecture. (d2) As part of the goal to enhance participants' skills in narrative and visual production, Bayrak's (2019) article "Istanbul 2100" and Tschumi's (1981) book "The Manhattan Transcripts" have been selected as sources. Moreover, discussions have been organized based on the selected texts to increase active participation. (d3) To increase peer-to-peer interaction and make studio productions more collective, a Google Drive folder accessible to all participants has been created, allowing them to track each other's work.

3.2. Phases of the workshop

During the workshop, the students followed six non-linear stages in the analogue-digital production cycle, including their synthesis: (1) Reading, presenting, and discussing the selected utopian/dystopian work, (2) speculating the spaces in the book and representing them through sketches, (3) creating a database for prompts using presentations, critics and sketches, (4) writing a scenario based on the selected literature, (5) splitting the scenario into sequences and generating storyboard sketches, (6) generating sequences using Midjourney and combining them with the scenarios. These stages have been involved in a reflective relationship throughout the process; for example, participants have made returns to their work in the second and fourth stages while producing in the sixth stage. This process is presented in Figure 2. The subsequent section delves into each stage of the process in more detail, accompanied by the students' productions.

The first stage of the process spans a three-day period. On the first day, students received a lecture on utopia-dystopia. On the second day, students continued their research in the studio environment, and on the third day, the first stage was completed with presentations and discussions. Students utilized both the original source and literature to prepare their presentations. Following the presentations, the instructors evaluated them based on the six categories mentioned above (see section 3.1.2).

The second stage of the process began on the third day of the workshop, following the book presentations. Students sketched to create their initial visualizations of the spaces in the utopia/dystopia they were responsible for (Figure 3). Students were encouraged to produce sketches from different scales and perspectives to comprehensively depict the space/city during this stage.

In the third stage, students acquire various AI tools and gain initial experiences. This stage began with a lecture that covered the history of AI, its applications in the field of architecture,

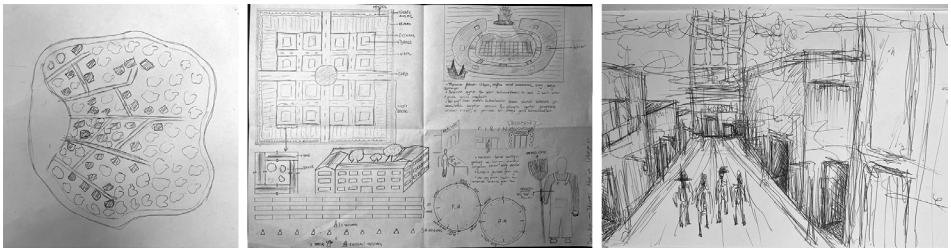

Figure 3. *Phase 2: initial sketches (left: Island sketch by S8, middle: Utopia sketches by S1, right: A Clockwork Orange sketch by S9).*

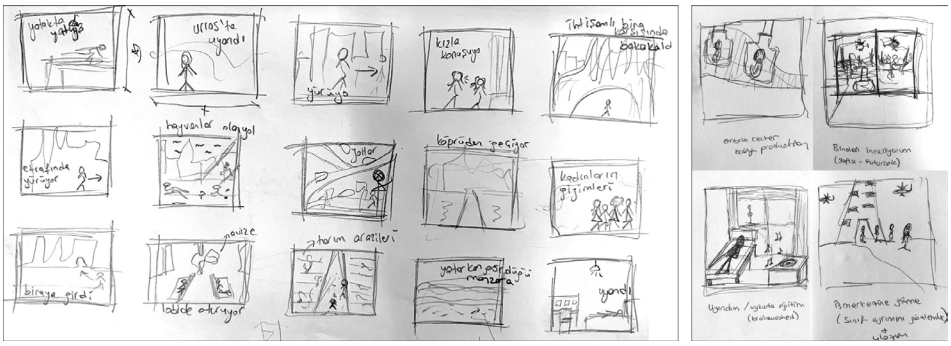

Figure 4. *Phase 5: Storyboard Sketches (Left: Urras from The Dispossessed, right: Brave New World).*

and the introduction of popular image generator tools. Students received fundamental guidance on writing prompts. They conducted their initial experiments in prompt writing using tools like Adobe Firefly, Scrabble Diffusion, and mnml.ai. Following this, a systematic process was undertaken to gather the data they would use in prompt writing to visualize their utopias. In this process, students transformed the visual, verbal, and written data they had gathered about utopias up to this point into suitable text data for prompts. Visual data was transformed through sketches produced in the second stage using Midjourney, verbal data through the feedback given on presentations and sketches, and written data through transforming the information collected during presentations.

The fourth stage began on the seventh day of the workshop with a lesson on Tschumi's architectural theory, understanding sequence in architecture, and the storyboard technique. In this stage, students were asked to write a scenario based on their imagined utopia/dystopia. The scenario was expected to be narrated from the perspective of a character who does not follow the book's storyline but reflects the spaces of the city comprehensively. Thus, a dialogue between text and visuals was established again through narrative. Each student's scenarios were edited based on the feedback from the instructors. For example, a portion of the S11's scenario related to the book "Dispossessed", the city of Anarres, by Ursula K. Le Guin is as follows:

> *"As soon as I descended, they took me on a quick tour. Everything and everyone are intertwined. No one has their own space. I had not thought of it this way before. The factories are clustered somewhat separately from the city. Workers are toiling. But for what? There is no such thing as money. Why are they working?... I get the answer: To progress. No one tells them to work. Everyone works in the field they want, and they are free to contribute to the advancement of the lineage. But isn't that the goal? To advance the lineage. Is that really it?"*

The fifth stage is breaking down the scenarios into sequences and preparing storyboard sketches. At this point, students have created the sequences with hand-drawn sketches (Figure 4).

The sixth and final stage involves producing the sequences conceptual-

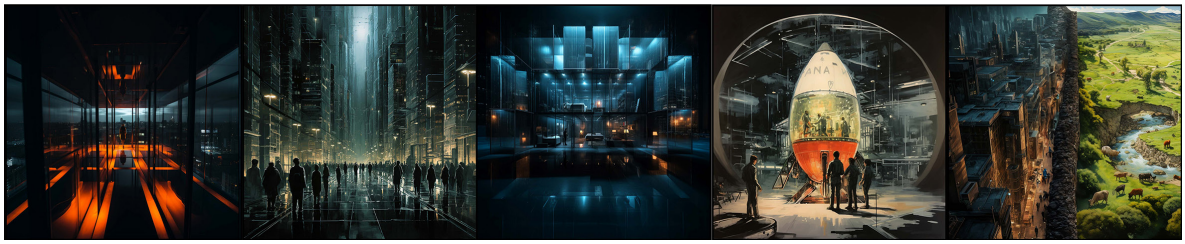

Figure 5. *Phase 6: Sequences generated via Midjourney ("We" sequences by S5).*

ized in the fifth stage, using Midjourney (Figure 5). The last three days of the workshop are dedicated to the refinement, finalization, and presentation of the productions. Scenes were repeatedly generated through Midjourney, in line with the students' spatial speculations and the feedbacks from the instructors, until they approached the desired vision. In cases where Midjourney was insufficient, adjustments were made to the visuals using Adobe Photoshop's beta version with AI support. As a result, storyboards were combined with scenarios and presented. Students produced an average of 13 frames, with a maximum of 20 and a minimum of 9. There were no restrictions on the length of their scripts. The shortest scenario was approximately 250 words, while the longest scenario was approximately 850 words.

3.3. Analyzing the study

The case study was analyzed in two aspects: process and outcome. In the analysis of the participants' design process, the visual analysis method was used to determine reflective behaviors. The expert evaluation method was applied to analyze the final products of the workshop.

3.3.1. Analyzing the process

In order to analyze the design processes, the processes of each student were decoded separately. This analyzing method was handled under 3 main headings: a) data collection, b) determination of categories, c) visual analysis. These sub-headings will be detailed in the rest of the chapter.

a) Data collection: During the workshop, observations were made. Diaries written by the students and interim submissions were collected. With these data, the students' productions in the process, the relationships they established between the productions and the representational media they used were revealed.

b) Determination of categories: The productions made during the workshop were systematically handled and categorized. Thus, it was aimed to create a common language for the process of all participants. The categories are basically divided into three according to the mode of representation: written, verbal, and visual. Representations are also categorized under 2 sub-headings: stimuli and productions. Stimuli is a source of inspiration, and it may be an internal representation like mental imagery or an external representation like a real-world object, an image for example (Goldschmidt, 2010). Stimuli types are novels (utopia & dystopia literature), sources (articles and books), lectures and critiques provided by the studio instructors. Productions are the different types of external representations that students produce and submit during the workshop. Depending on the medium, these are divided into eight categories: prompt, scenario, presentation, narrative, storyboard sketches, AI-generated sequences, and sequence sketches.

c) Visual analysis: As a result of the data collected and the categorization of these data, diagrams were produced to visualize the design process of each student. The diagrams were aimed at revealing the students' use of AI in the process and the relationship of this use with other productions. In this way, it is possible to observe the reflectivity in students' design processes.

The diagram is based on an equilateral triangle to reveal three modes of representation. Each of the modes; written, verbal, and visual, is placed at the corners of the triangle. Production types are also placed in the diagram according to the mode they belong to.

Accordingly, Prompt and Scenario are given in written; sequence sketches, storyboard sketches, and AI-generated sequences are given in visual. The presentation is placed between the two since it is both written and verbal; narrative (final digital storyboard) is placed in the middle of the diagram since it contains all three representation modes in common. Source and book, which are stimuli types, are placed in written, while lectures and critiques are placed in verbal representation type. All these components are represented by circles, and dashed lines are used to show the relationships. When two representations relate, it means that the information created in one representation is transferred to another. The presence of two lines between two representations indicates that the production that the student has realized in a certain representation is revised when he/she moves to the other representation and returns to the first representation. Figure 6 shows the visual analysis diagram created for S7. For example, while there was only one interaction line between the presentation and sequence sketches, the AI-generated sequences produced by developing the Prompt were changed by returning to the prompt stage. Therefore, a relationship in which it reflects from one representation to another was revealed. Since the study aims to integrate AI into the design process, in the diagram design, the AI-generated sequences and Prompt representations belonging to the AI generation are colored differently from the other representations. Each circle in the diagram expands in proportion to the number of interactions that the representation has.

The visual analysis method was applied to the design process of 12 participants of the workshop (Figure 7). When the diagrams are analyzed comparatively, it can be seen that the cases with the highest number of relationships established with different representations are S5, S6, S11, and S7; the cases with the lowest number are S12, S2, and S4.

Based on the diagrams, the participants who use AI more effectively in their processes can be analyzed. Accordingly, it is seen that S11, S5, S9 and S4 stand out in the use of AI. In addition, the participants who support the narrative, which is the final product and located in the middle of the diagram, with other materials the most, are S5, S10, S6, and S3.

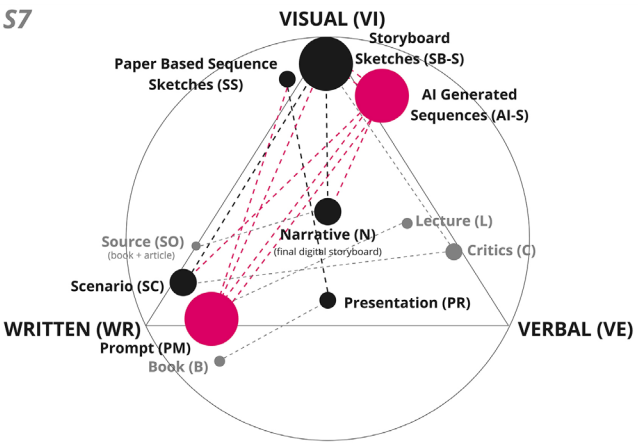

Figure 6. *Diagrams setup.*

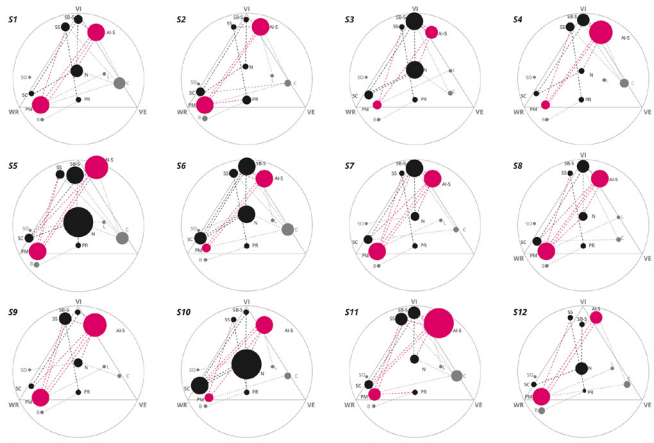

Figure 7. *Diagrams show the relationships that the participants established between the design media throughout the process.*

3.3.2. Analyzing the outputs

The final outputs were evaluated by eight judges. Two of the judges were also the instructors of the workshops. The remaining six judges were PhD students from various programs related to architecture. The judges participated in the evaluation without being aware of the research objectives, the hypothesis of the study, and the workshop process. The jury members carried out the evaluations independently of each other. The evaluation grades were given on a scale of 1-5, with 1 being the lowest score and

Table 2. *Expert evaluations.*

	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12
	Utopia (1516) Thomas More	The City of the Sun (1602) Tommaso Campanella	New Atlantis (1626) Francis Bacon	He'land (1915) Charlotte Perkins Gilman	We (1921) Yevgeni Zamyatin	Brave New World (1932) Aldous Huxley	1984 (1949) George Orwell	Island (1962) Aldous Huxley	A Clockwork Orange (1962) Anthony Burgess	The Dispossessed - Anarres (1974) Ursula K. Le Guin	The Dispossessed - Urras (1974) Ursula K. Le Guin	Spaces of Hope (2000) David Harvey
Consistency with the literature	3.40	3.50	2.75	2.50	5.00	3.40	3.33	4.00	2.67	4.50	4.00	3.00
Comprehensive description of utopia or dystopia	4.13	2.88	4.25	3.63	4.25	3.38	3.63	3.50	2.88	3.88	3.63	3.13
Continuity of Sequences	3.50	2.13	4.38	4.00	4.63	3.38	4.25	3.63	3.50	4.50	3.63	2.13
Arithmetic Mean	**3.68**	**2.83**	**3.79**	**3.38**	**4.63**	**3.38**	**3.74**	**3.71**	**3.01**	**4.29**	**3.75**	**2.75**

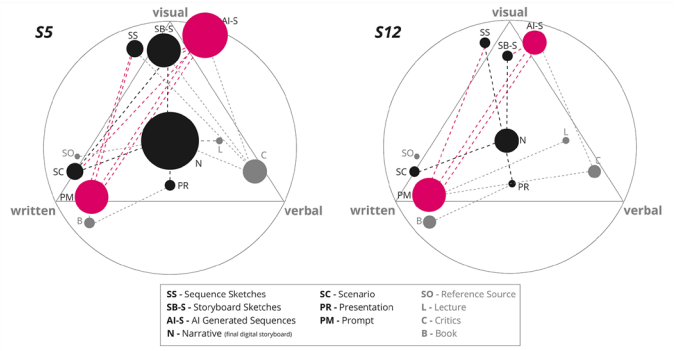

Figure 8. *Comparing the processes of the most successful and the least successful student.*

5 being the highest score. The grades given by the workshop facilitators and design experts have equal weights.

The expected output at the end of the workshop was defined as a storyboard consisting of sequences that would consistently narrate the spaces and experiences in the book each student was responsible for. The resulting products were evaluated based on the following criteria in line with these expectations: 1) consistency with the literature, 2) comprehensive description of utopia or dystopia, and 3) the continuity of sequences. The jury members evaluated the students' works according to these criteria. Among these evaluation headings, consistency with the given book is related to how detailed the student has researched the given book. The holistic description item is related to the construction of the space in line with the six sub-headings previously mentioned. In order to provide this construction of the space, it is important to use sketch drawings and text-to-image AI tool effectively. The last evaluation criterion aims to evaluate the continuity of the sequences and the relationship between the scenario writing, sketches, and images produced by artificial intelligence. In this way, instead of evaluating only the final product, the final production and the process are evaluated together. The grades obtained as a result of this evaluation are shown in Table 2. In the table, the grades given in three different evaluation criteria for each book are averaged.

According to the evaluation results, the student with the highest average grade is S5, and the students with high grades are S10, S3, and S11, respectively. The student with the lowest average grade was S12, and the students with the lowest grades were S2, S9, S4, and S6, respectively. However, when evaluated based on categories, the average grades of the students vary, which shows that students are successful at different levels in different areas.

3.4. Process and outcome crossover

In a general assessment, it was observed that successful students had more interactions and more shifts between design media. For example, when we compare S5, who received the highest grade according to the expert evaluations, and S12, who received the lowest grade, it is clear from the graph that S5 created a much richer network of relationships (Figure 8). It can be said that S5 expanded both the products she produced with AI and her narrative, which is the final product of the workshop, by establishing relationships with other mediums. Therefore, she followed a reflective process. S12, on the other hand, followed a more linear process by establishing fewer relationships between design mediums.

Moreover, when the processes of the students were analyzed together with the evaluation criteria, it was found that the students with high scores in the evaluation of consistency with the literature established more relationships between the presentations they made about the utopia/dystopia given to them and the narrative, which is the final product. In the other criterion, the comprehensive description of the utopia/dystopia, it was observed that students with high evaluation scores produced more sketches and AI-supported visuals. According to the last

evaluation method, which constitutes the continuity of sequences, it was observed that more successful students established relationships between the written scenario and the visuals they produced and that they thought of two types of production together. In order to achieve this, they considered scenario writing, sketch drawings, and AI-supported visuals together and provided a transition between different media.

4. Discussion

The utilization of AI image generator models in design education should commence by establishing the rationale behind their adoption, followed by instructing students on their proficient application with the correct terminology tailored to specific design assignments (Paananen et al., 2023). This section discusses how AI tools can be integrated into the architectural design process and education based on the experiences and insights gained from the case study. Firstly, under the focus of Midjourney, the potentials and limitations of image generator AI tools in the design process are systematically presented through literature research and case study. Subsequently, the discussion shifts to the integration of AI tools in the studio, along with recommendations for studio instructors.

4.1. Potentials and limitations

AI image generator tools offer several advantages in the design process. These include assisting designers with ideation, saving time by quickly visualizing thoughts, and democratizing the design process by aiding users with limited architectural knowledge. During the workshop, AI-generated images helped bring out ideas that might not have emerged during the sketching phase. Just as computational design tools can enhance traditional design approaches by enabling designers to explore various possibilities (Terzidis, 2006), AI tools can assist in generating new ideas, especially in the early stages when the problem is still ill-defined (Dortheimer et al., 2023; Enjellina et al., 2023; Jaruga-Rozdolska, 2022). Moreover, they allowed participants to quickly create high-resolution graphics, facilitating discussions about consistency with source material and the relationships between spaces not explicitly described in the work. Instead of spending hours sketching or using complex design software, a designer can quickly obtain a visual representation with AI tools (Yıldırım, 2022).

In the workshop, where 58% of participants were first-year architecture students, AI support proved crucial in helping them think about space and convey their thoughts. Participants stated that AI tools allowed them to express ideas more effectively than sketches alone. It can be said that being able to make creative productions without the need for prior skills or experience democratizes the process (Oppenlaender, 2023).

On the other hand, there are also potential limitations to using AI in the design process. These can be classified as follows: the design tool taking over the designer's role, spatial inadequacy of the generated visuals, the potential for bias in artificial intelligence, restrictions against producing objectionable content, and access limitations.

One limitation is the risk of AI tools taking over the design process if the designer is unfamiliar with how the tool operates. If the designer does not understand the principles behind AI tools, their potential may remain untapped, and the tool may end up being a final product rather than an added element in the design process. However, design tools should be used to explore various possibilities (Terzidis, 2006). Using AI tools in relationships with different design media, as in the workshop process, can be a way to avoid this limitation. There is also a spatial inadequacy limitation in the outputs produced with current AI tools. For example, the final productions of the students in the workshop did not extend beyond the second dimension, leading to inconsistencies in some sequences. Some spaces in the sequences were not exactly the same as each other, hindering the presentation of a consistent representation of the envisioned space. To overcome this issue, additional tools can enhance the spatial

qualities of Midjourney productions. There are studies in the literature that aim to develop such a method (Doumpioti & Huang, 2023; Eke, 2023). For example, Eke (2023) has generated 3D models from Midjourney-generated visuals using depth map analysis and point cloud.

AI tools like Midjourney, influenced by their datasets, may not generate features absent from the training images. For instance, Student 4 tried to create visuals related to "Herland" and specified that women should have short hair. However, the resulting visuals showed women with long hair. Designers should be aware of such bias and may need to intervene in the outputs using different methods. Moreover, Midjourney restricts certain words in prompts to prevent the creation of objectionable content. Students working on dystopian scenarios encountered these restrictions during the workshop. For example, when generating scenes involving the 'epsilon' caste from "Brave New World," Midjourney imposed restrictions.

Another restriction is related to access. Midjourney is can only be accesible through various subscription packages. The Basic Plan, Standard Plan, Pro Plan, and Mega Plan offer different features at monthly prices of $10, $30, $60, and $120, respectively. The Basic Plan was used in the workshop, allowing up to 200 image generations per month. However, this limitation prevented students from experimenting as much as they would have liked during the image generation phase.

4.2. Recommendations to studio instructors

According to Schön's theory (1983), design is a 'reflective conversation with the situation'. Accordingly, it is important to provide an environment in the design studio that will allow the student to move between different design representations and situations. Considering that the design process should be constructed in a way that includes different media (Goldschmidt and Sever, 2011 & Dorta et al., 2016), it is important to construct the relationship between AI-generated representations with other media. In the research context, natural language is the communication medium for text-to-image models focused on. However, effective communication with AI requires meeting the requirements of a writing technique called "prompt." Exercises in narrative creation can be given at the beginning of the studio's prompt writing exercises. Adding activities to enhance students' writing skills to the curriculum has become even more important to strengthen communication through AI-driven text. Furthermore, students should practice using written sources more extensively to create narratives and practice converting visual and verbal elements into literary elements.

During the studio process, it is important not to rely on a single tool but to use various text-to-image AI tools. This way, students can understand how the AI tools they use work and decide which tool to use based on the problem at hand, avoiding reducing the process to a single design tool. In this sense, before working with Midjourney in the workshop, experiments were conducted with various AI tools, allowing students to learn important aspects of prompt writing and providing opportunities to get to know the tools better.

5. Conclusion

In terms of architectural theory and education, utopias have great importance in terms of criticizing the existing system and constructing alternatives. Including utopias and similar speculative narratives in the curriculum encourages architecture students to alternative ways of thinking and stimulates their creative thinking. In this context, the integration of text-to-image AI tools into architectural studios through narrative creation is proposed as a novel approach to provide students with a new perspective on the design process. This approach was tested through a workshop conducted by the authors of the study as a case study. The workshop, which lasted 10 days, included 12 participants and 2 facilitators. Most of the participants were first-year to second-year architecture students. Participants were able to use AI to create detailed

representations of utopian and dystopian spaces. The reflective and iterative use of AI throughout the workshop showed that these tools provide new perspectives and improve design outcomes. It was observed that especially the students who used the AI tool in relation to other representations in the design process achieved more successful results. In this way, inferences were made about how image generator AI tools can be integrated into the architectural design studio process. Thus, the study confirms that AI can be a valuable asset in architectural education.

Furthermore, the potential and limitations of AI tools are presented in line with the findings of the literature review and case study. The advantages of AI tools in the design process include assisting designers in generating ideas, visualizing ideas quickly, and democratizing the process for users with limited architectural knowledge. However, the limitations of AI tools in the design process and suggestions on how these limitations can be overcome are also presented.

The integration of AI tools into architectural education requires a thoughtful approach to curriculum design. It is essential to provide students with the necessary skills to use these tools effectively and to understand their potential and limitations. By incorporating exercises in narrative creation and prompt writing, students can improve their ability to communicate with AI and utilize it as a powerful design tool. In conclusion, the study confirms that AI can be a valuable asset in architectural education, providing students with new opportunities to explore and visualize speculative spaces.

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