WIP: Using mind mapping to enhance architecture students' abilities in managing both practical and lecture-based teaching methods

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Abstract

In architectural education worldwide, students typically engage with two main pedagogical approaches: hands-on studio work and traditional lecture-based learning. This dual approach can lead to a disconnection between the subjects, making it challenging for students to bridge the gap between both methods. To resolve this, educators are exploring different strategies to help students integrate the skills from both pedagogies. This article focuses on the role of Mind Mapping in lecture-based courses, aiming to connect theoretical knowledge with the practical skills learned in studio courses. The study was conducted during Fall 22, Spring 23, and Fall 23, incorporating 4 courses of Construction III (62 junior students), 1 course of Construction I (18 sophomore students), and 4 courses of Sustainability (49 senior students). The researchers assessed students' performance by analyzing the knowledge reflected in their mind maps and its application in exams. Additionally, a survey was conducted to gauge students' views on how Mind Mapping influenced their learning and performance. Finally, the authors reflect on the intervention design and suggest how academia could develop new pedagogical methods to better connect the skills from both pedagogies in architectural education, offering insights for research and practice.

Introduction

Mind maps are visual pedagogical tools that can significantly benefit students who are inclined towards visual learning. This method is especially useful for architecture students, as their field is inherently visual and artistic, requiring a strong connection between theoretical knowledge and visual representation. Architecture students, known for their creative abilities and visual orientation, often find that their learning preferences align more with visual study tools than with traditional reading and writing methods. In fact, "Architecture students are generally visually orientated and have rather creative minds, capacities that seem less compatible with the more-strict rules and systematic approach of doing research" [1]. This preference highlights the importance of incorporating visual tools like mind maps into their educational experience [2].

Moreover, the integration of various teaching methods is crucial for enhancing how students acquire knowledge [3], [4], [5], [6], [7]. In architecture, it is essential to establish clear connections between theoretical concepts and their practical applications [8], [9]. Mind maps facilitate this process by providing graphic representations that help link different topics within a course. These visual aids are particularly valuable because they help clarify the relationships between material objects and concepts, enabling students to better understand complex subject matter [10]. By using mind maps, students can gain a more holistic view of their course content and its interconnections, making it easier to grasp the full scope of a topic. Architecture education also faces the challenge of adequately preparing students for the multifaceted nature of professional practice [11], [12]. Architects must develop a range of personal attributes, such as social skills, decision-making, and problem-solving, which are critical for success in their careers. These challenges raise questions about the effectiveness of undergraduate architecture programs in preparing students for the demands of the profession. As the field evolves, it becomes increasingly important to ensure that students not only excel in design but also acquire the skills necessary for managing projects and navigating complex real-world situations [13], [14], [15], [16].

In addition to professional skills, architecture students must cultivate academic abilities, which are interdisciplinary by nature [17]. While design remains a core focus, students must also develop a broad set of academic skills that bridge the gap between artistic creativity and scientific precision. Architecture education requires diverse study techniques to address the varied academic challenges students face, as the field integrates both artistic and technical components. Traditional undergraduate education should focus on honing skills such as reading, writing, and discipline, all of which are critical for students to succeed in architectural research [18]. Despite the importance of these academic skills, many architecture students are reluctant to engage with traditional academic methods. A survey of second-year architecture students in the Netherlands revealed that while most students recognized the usefulness of research courses, they also expressed strong negative feelings about them, citing stress and dislike towards such academic activities [1], [19], [20]. This highlights the need for alternative teaching methods that can make academic skills development more engaging and less stressful for students, encouraging them to take a more active role in their learning [5], [21].

Given these challenges, exploring various teaching strategies in architecture education is essential to better prepare students for both academic and professional success [22], [23]. The use of mind maps in particular offers an opportunity to bridge the gap between theoretical knowledge and practical skills. Investigating how mind maps can benefit students in conventional lecture courses, as well as their potential to connect skills gained in studio settings, presents a promising avenue for enhancing the overall educational experience. By integrating these tools into architecture curricula, educators can better support students in developing the diverse set of skills required for success in the field.

Background

Educational institutions today are increasingly focused on innovating and improving the systems used to deliver knowledge to students. One such innovation is the growing use of graphical study tools to enhance both teaching and learning processes. These tools, particularly mind maps, have proven to be effective in stimulating students' cognitive abilities, allowing them to better grasp complex concepts [24]. Mind maps, which were originally introduced by psychologist Tony Buzan in the early 20th century, have gained widespread popularity due to their capacity to help students organize ideas and notes in a clear, visual format. This technique aims to optimize various brain functions, facilitating improved learning and comprehension, especially for young students [25]. Mind maps are more than just tools for organizing information; they are visual diagrams that illustrate relationships between ideas and foster deeper engagement with the learning process, enhancing intellectual, cognitive, emotional, and even motor development, particularly in contrast to the outdated memorization-heavy methods of the 19th century [26].

Several studies highlight the rapid adoption and benefits of mind maps, especially in their ability to visually represent complex ideas. In his research, Eder Aco (2019) defined mind maps as primarily tools for representing complex ideas, adaptable to various academic disciplines. Mind maps are particularly useful in fields such as architecture, where visual communication is essential. While originally designed for young learners, the application of mind maps in the learning processes of university students—especially those studying architecture—represents a potential shift in how academic concepts are organized and understood. This shift challenges traditional reliance on methods such as reviewing material only before exams, encouraging a more continuous, interactive approach to learning [26].

The holistic nature of mind maps makes them an invaluable tool for fostering a comprehensive learning experience [26]. Mind mapping stimulates cognitive, emotional, and physical aspects of learning, creating a multidimensional environment that engages students on multiple levels. The inclusion of graphic elements like images, symbols, and diagrams allows for a more intuitive understanding of concepts, making it easier for students to comprehend and apply theoretical knowledge [27]. This approach allows students to customize their learning experience according to their personal interests and needs, fostering a deeper connection to the material. Additionally, mind maps provide a concise, technical summary of a student's strengths and weaknesses, making them an excellent tool for instructors who wish to track the progress and development of their students. The ability to visually represent the relationships between ideas and course content in a personal and engaging way contributes to a richer learning experience, encouraging students to become more active participants in their academic growth [25].

Within the context of architecture, students typically engage with two distinct types of courses: hands-on studio classes and traditional lecture-based classes. These two categories demand different skill sets—studio courses focus on practical and manual abilities, while lectures emphasize cognitive skills and conceptual thinking. This division of skill sets can create a disconnect for students who struggle to link the knowledge from both types of courses. Mind mapping offers a solution by serving as a bridge between the practical skills learned in the studio and the theoretical concepts taught in lectures. By visually representing the knowledge gained from both types of courses, students can better integrate the skills they acquire in each setting, leading to a more holistic understanding of their field. This approach is particularly beneficial for architecture students, as the ability to organize and synthesize complex information is crucial for their professional development. Beyond the field of architecture, academic proficiency is an essential goal for all university students, regardless of their discipline. The foundational skills required for academic success—such as reading, writing, and the ability to synthesize and conceptualize ideas—are crucial for acquiring and developing knowledge. As suggested by Wollscheid, Lødding, and Aamodt (2020), academic work involves various phases, including questioning, summarizing, clarifying, and predicting, all of which contribute to mastering the learning process [18]. Students must also possess discipline and a strong commitment to their studies, as active involvement in the learning process is necessary for overcoming challenges and distractions. The development of these skills is vital for academic success and personal growth, and mind maps provide a tool for reinforcing these skills, allowing students to organize their thoughts and better engage with the learning material [26].

Mind maps play a crucial role in helping architecture students develop these skills, as they encourage students to visualize their ideas and solutions in a clear, structured way. By incorporating mind maps into their learning process, students can better understand the relationships between different design elements and improve their ability to generate innovative solutions. The use of mind maps can also help students grasp the complex interactions between materials, techniques, and design principles, further enhancing their design capabilities [28]. In architecture, design is the core competency that defines the profession. Architects must develop skills that enable them to generate novel ideas, solve complex problems, and communicate effectively through visual tools. Architects as project managers play key roles in the construction industry, from design to implementation and demolition, with a strong understanding of materials and techniques [13]. The ability to apply imagination, create conceptual designs, and use graphics for problem-solving are all essential components of architectural practice.

Research into the academic and professional skills of architects reveals the importance of solution generation and problem recognition in the design process. As Lawson (1979) observed, architects tend to excel in generating multiple solutions to a problem, demonstrating their ability to think creatively and critically [29]. However, they may not

always be as skilled in recognizing the underlying structure of a problem, which is essential for effective problem-solving. This highlights the importance of design education in helping students refine their planning and problem-solving skills. By incorporating mind mapping into architectural education, students can improve their ability to recognize key elements of a problem, generate solutions, and communicate their ideas more effectively. The process of visualizing solutions through mind maps not only supports cognitive development but also enhances the overall design process. Mind maps are a valuable tool in architecture education, enhancing learning by helping students organize complex ideas, link theory to practice, and integrate creative and technical skills. They bridge the gap between studio and lecture-based courses, promoting a more holistic approach to learning. By engaging cognitive, emotional, and physical aspects, mind maps support the development of essential skills, preparing students for both their academic and professional futures in architecture.

Research Objective

The purpose of this study was to carry out a pilot test to investigate the effect of mind maps on the learning process of architecture students, who frequently balance conceptual and practical learning. The research objectives were (i) to improve the learning experience for architecture students and (ii) to help connect practical concepts with theoretical knowledge, which is a common challenge in architectural education. This article presents the results of the initial pilot test for assessment validation.

Methodology

This exploratory study utilized a qualitative approach [30], [31], [32] to evaluate the cognitive performance of architecture students, focusing on their use of mind maps. Data was collected over three semesters: Fall 2022, Spring 2023, and Fall 2023, involving 129 students from various courses, including 62 junior students from Construction III, 18 sophomores from Constructions I, and 49 seniors from Sustainability. The survey, administered using Qualtrics and analyzed through Excel, combined closed- and open-ended questions to gauge students' perceptions of how mind maps influenced their learning. The unit of analysis examined the period from when students created the mind map until the end of their examination. This survey aimed to determine the perceived benefits of mind mapping before exams and whether it had any impact on students' performance during these assessments.

The research focused on two main questions: the first explored how mind maps aid in architecture students' learning, and the second investigated how they connect studio-based, practical skills with theoretical lecture-based knowledge. The teacher responsible for the courses also designed the exams, ensuring consistency in terms of difficulty, pedagogy, and thematic content. All exams consisted of five descriptive questions and three application-

based questions, testing both theoretical understanding and practical problem-solving skills. The exams were individual, closed-book assessments, each with a 120-minute time limit.

To analyze the survey responses, the data was coded based on pre-established and emerging categories, following Saldana's [33] and Yin's [34] guidelines for content analysis. The coded answers were organized into broader themes, which provided insights into how mind mapping influenced the students' learning processes, outcomes, and development of practical skills. This analysis helped uncover the potential role of mind maps in bridging the gap between the theoretical and practical aspects of architectural education.

Results

The first research question in this study explored how mind maps contribute to the development of architecture students. Responses highlighted four key benefits: mind maps serve as effective study tools, foster creativity in applying knowledge, facilitate understanding through visual elements, and help students enhance their architectural skills. These premises emphasize the diverse roles mind maps play in the academic journey of architecture students.

Mind maps are particularly useful as study aids, enabling students to synthesize and summarize course content efficiently, thus optimizing their study time. One student noted that they could study while creating mind maps, stating, "At the time I developed the mind maps, I was studying at the same time." Another student described mind mapping as an "efficient" study method, showcasing its ability to streamline the review process. The tool's format also makes it highly accessible and manageable, particularly in the lead-up to exams, as it provides a clear, concise way to review material. One student remarked, "I think it is a very positive methodology because it is a great way to review the subject before the exam."

Additionally, mind maps function as valuable learning tools, helping students identify core ideas and better understand complex topics. One student mentioned that mind maps helped them "identify the main ideas about a topic," simplifying their study process. The ability to categorize and connect various topics further supports deeper learning, as it allows students to link related concepts in a more structured way. Students also found that mind maps encouraged further exploration of topics, leading to a better overall understanding. One student appreciated mind maps as "an additional opportunity to reinforce learning with topics or subtopics that may have been left a little unclear," demonstrating how this tool can enhance comprehension and foster academic growth.

Mind maps have proven to be a valuable tool for architecture students, as they allow for the creative representation of both technical and practical knowledge. They facilitate personal reflection, providing students the ability to incorporate what they learn in their own words.

One student expressed that creating mind maps was a "creative way to put knowledge into practice," highlighting how the activity encourages personal engagement with the material. By summarizing the knowledge in a creative manner, students can connect the reading material with a broader understanding of the course content. For instance, a student noted that creating a mind map helped them better understand the material because it required them to interpret the content in their own words. This process fosters deeper comprehension and strengthens the student's grasp of the subject matter.

In addition to promoting creativity, mind maps also serve as powerful visual tools that aid in the learning process. Visual representations, such as diagrams, help students to organize information in a more structured and accessible way. One student noted that mind maps "help to memorize the subject better" and allowed them to retain new information more effectively. Another student emphasized that mind maps encouraged them to "analyze the contents with more attention to detail," underscoring the benefit of visualizing information in a manner that reveals connections and hierarchies within the material. This ability to create visual diagrams aids students in organizing ideas based on proximity and hierarchy, which is especially valuable in understanding complex architectural concepts. As one student shared, by placing related ideas next to each other in the mind map, they could "understand [the material] better" and gain a clearer perspective on the topics covered.

How do mind maps help in the formation of architecture students?	
Study tool	Summarize and synthesize the contents seen throughout the year
	Optimize time by studying while doing the activity
	Easy access to review for the exam or any other activity
Learning tool	Extract useful information and main ideas
	Categorize and connect each one of the contents
	Encourages further investigation of the contents
Creative way to put knowledge into practice	Encourage the practice of personal reflection by internalizing the contents
	Organize the information to your preference in your own words
	Create an effective relationship between reading and understanding the course
Visual elements that facilitate the understanding of the course	Allows information to be captured and memorized
	Allows to analyze contents in greater detail without much difficulty
	Creates relationships between content through visual proximity
	Achieve a clearer information hierarchy
Method to develop architecture skills	Improves graphic expression
	Allows the practice of sketch drawing
	Encourages more precision when drawing

Mind maps also support the development of practical skills essential for architecture students. The act of drawing and sketching, integral to architecture, is improved through mind mapping. One student explained that mind mapping "helped [him] to learn to draw better and to show a better graphic expression," demonstrating how the technique can enhance graphic communication skills. Furthermore, the process of summarizing and diagramming complex information through mind maps provides students with the precision needed to effectively communicate architectural concepts. As another student pointed out, mind maps help to "explain a concept clearly and briefly," which is a critical skill in architecture, where clear communication of ideas is essential for success. The technique not only sharpens students' ability to express themselves graphically but also allows them to practice and refine their drawing skills, which are indispensable for completing architectural assignments.

The second research question explored how mind maps help bridge the gap between studio-based practical skills and traditional lecture-based learning. Responses from students suggested that mind maps contribute to an analytic approach to course material, improve communication of ideas, encourage better study habits, and help synthesize complex information. One student explained that mind maps led to "a complete analysis in

retrospective," demonstrating how the tool encourages students to reflect on the material critically. Additionally, mind maps foster the ability to distill the most important ideas from a larger body of information, with students highlighting how the tool helped them "organize our own" ideas effectively. This analytic process extends to architecture skills as well, with students noting that mind mapping improved the precision and clarity of their drawings. One student mentioned that the mind mapping process helped them create "more detailed" drawings, underscoring how these tools develop skills that directly relate to the precision required in architecture, such as constructing clear and accurate technical drawings.

Another significant advantage of mind maps is their ability to enhance the communication of ideas. One student remarked that mind maps "help us be precise, straightforward and clear," which is especially valuable in both academic and professional settings. Mind maps provide a platform for students to express complex concepts in a concise and understandable manner, as evidenced by a student who noted that mind maps helped "explain a concept short and plain." Since mind maps incorporate images and diagrams, they also foster diagramming skills that are essential for communicating architectural ideas effectively. The process of creating intelligible and communicative diagrams teaches students how to convey their thoughts clearly, an essential skill in architecture. As one student reflected, the most challenging aspect of mind mapping was "diagramming the paper in order for the information to be understood," highlighting the importance of clarity and communication in architectural work. Through mind mapping, students improve their ability to synthesize and present information in ways that are both effective and visually engaging.

Mind maps provide architecture students with a multi-faceted tool that not only aids in organizing and synthesizing knowledge but also promotes the development of essential skills, such as creativity, precision, and communication. The integration of mind maps into both practical and theoretical aspects of architectural education facilitates a more holistic approach to learning, connecting studio-based skills with those acquired in traditional lecture settings. Through their use of mind maps, students are able to engage with course material on a deeper level, enhance their learning outcomes, and better prepare themselves for the demands of their future professional practice.

Mind mapping before exams helps develop positive study habits. Students frequently mentioned that having similar classes on the same topics "helped them create mind maps for final exams." Additionally, using mind maps requires students to be organized. While some students noted that "it takes a long time to do," overall, one student found them "very useful for organizing ideas" and beneficial "for any professional field." The technique, being visual, accelerated knowledge acquisition, particularly for visual learners. As one student said, "if you're more visual, this study method is the best," and they found it "much easier to understand concepts with an explanation and a graph to represent it."

How do mind maps connect studio practical skills with traditional classes skills?	
Aim for an analytic approach of topics	Obtention of main ideas and synthesis skills
	More interest towards details about the topics learnt
	Practice of abstraction skills
Improvement communication of ideas	Devolpment of clear ideas with simple explanations
	Creation of diagrams, texts and diverse formats to explain different ideas
	Development of a number of synthesis strategies
Development of study habits	Repetition of topics thanks to relations between topics
	Improvement at organizing ideas and time
	Visual studying technique to fasten comprehension
Fostering summarizing skills	Encourages strong relationships between contents throughout the course
	Motivates to be deeply concious about contents taught in class
	Allows to recall previous ideas lost during the course
	Takes up the challenge to take notes throughout the course
Sketchbook used as a traditional tool	Encourages the skill of drawing in traditional classes
	Recollection of personal notes and diagrams
	Application of digital tools and skills

Moreover, mind mapping enhances summarizing skills. Some students felt that the course content was well-suited for this methodology. One student mentioned they could identify connections between topics, noting that "they were connected and related," and they could "see the relationship between concepts throughout the course," though they didn't attribute it directly to mind maps. Nevertheless, students believed mind maps made them more aware of the subject matter by requiring them to express their knowledge in their own words. One student explained, "while rewriting the topics learned in class, I was able to explain myself more easily." Additionally, the conciseness of mind maps helped students review previous lessons. They felt that "reviewing each topic helped identify the most relevant ideas" and that "mind maps help with memory," especially since multiple topics were covered.

Finally, a crucial skill in studio classes is becoming familiar with sketchbooks. The practice of creating diagrams and sketches in practical classes made mind mapping an accessible tool. One student noted how the two skills were linked, saying, "I read the sketchbook notes, and when I finally understood them, I wrote them down in the mind map." In studio classes, the use of digital sketching tools is common, and mind mapping helped students develop these skills in traditional classes. One student shared how this was effective: "[When using digital tools for mind mapping,] you begin to understand the ideal layout to generate better understanding."

Discussion

The results obtained from the study demonstrate that students overwhelmingly recognize the value of mind maps as effective tools for facilitating their learning process. These visual aids are particularly appreciated for their ability to simplify the synthesis and comprehension of complex concepts. By creating their own mind maps, students can establish a more personal connection with the course material, which, in turn, enhances their performance. The use of mind maps as an innovative tool, as highlighted in the study, effectively engages students in a unique and personalized learning experience [25]. Students not only find these diagrams helpful for exam preparation but also appreciate their broader educational value. As one student shared, the mind maps contributed to their understanding by summarizing the entire range of topics covered in class. This reflects a clear pattern in the feedback, with students expressing a strong preference for mind maps as study aids that help improve comprehension through visual representation.

Further analysis revealed that students also recognized the impact of mind maps in bridging the practical skills learned in architecture classes with the theoretical knowledge from more traditional courses. The use of mind maps was seen to enhance students' analytical skills, enabling them to approach subjects with a more structured and insightful perspective. As one student noted, "mind maps are a strategy that enhances studying, learning, and thinking, adapting to individual and collaborative knowledge construction" [26]. This ability to organize and synthesize complex information through diagrams fosters a deeper understanding of architectural concepts and promotes the development of critical thinking skills. Additionally, mind maps help students develop a consistent study habit, which is vital for academic success. Through the process of summarizing and synthesizing information, students build confidence in their ability to analyze and communicate complex ideas, essential skills for their future careers [27].

Mind maps also proved to be instrumental in connecting various skills across different subjects. Students felt that by organizing topics visually, they were able to better understand and integrate knowledge, which is crucial for architecture students who must constantly synthesize various components of design and theory. One student emphasized that mind maps were particularly helpful in organizing content for architecture projects, as it "helps us to see things and take into account the organization and development for a project." This reflects how mind mapping not only aids in studying but also improves students' ability to communicate and apply their knowledge effectively. Ultimately, mind maps were seen as a tool that not only strengthens students' academic skills but also boosts their confidence by enabling them to link their learning to real-world applications.

Conclusions and Future Work

The research has shown that incorporating mind maps into architecture courses is a valuable tool for developing essential skills for students' careers. These benefits include using mind maps as an effective study and learning method, a way to apply knowledge practically, a tool for enhancing visual understanding, and a means of improving drawing abilities. Positive outcomes were also observed in integrating practical studio skills with traditional academic skills. Key characteristics of mind maps that connect both areas include a focus on analytical thinking, improved communication, the development of study skills, and the ability to synthesize information. Overall, mind maps offer significant advantages for the academic and professional growth of architecture students. As a pedagogical tool, they provide a visually engaging approach that most students in the study found ideal for understanding and studying course material. In this research, where construction classes were used to apply the method, the importance of linking theoretical knowledge with practical elements was highlighted. For future studies, improving the student perception survey could further explore the content of mind maps. Incorporating quantitative data would allow a deeper analysis of how mind mapping influences students' academic performance. Additionally, repeating the study with construction students could reveal how this tool impacts learning in the building industry. Investigating its application in art classes could provide insights into its effectiveness for students with different skill sets. Given that students reported improvements in areas such as retention, confidence, and discipline, it would be valuable to include faculty perspectives. A comparative analysis of classes that use mind maps and those that do not could offer useful insights from the instructors' point of view.

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