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WIP: Utilizing Mind-Mapping to Connect the Skillsets of Architecture Students for Both Hands-On and Lecture-Oriented Teaching Approaches

Ignacio Guerra P., Universidad San Francisco de Quito

Ignacio is a professor of Construction and Sustainability in the College of Architecture and Interior Design CADI at Universidad San Francisco de Quito USFQ. Ignacio is an architect from UCE and gained his MBA with emphasis in sustainability from the UCV. Ignacio's interests are in the areas of sustainable architecture and construction, new pedagogies for architecture studies and development. Ignacio is passionate to bring his experience in the construction industry into the classroom.

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WIP: Mind mapping to improve architecture students' skills in navigating hand-on and lecture-based pedagogies.

Ignacio Guerra P. [1*], Juan Sebastián Andrade[2]

[1] Professor, Universidad San Francisco de Quito USFQ, Colegio de Arquitectura y Diseño de Interiores CADI, Departamento de Arquitectura, Casilla Postal 17-1200-841, Quito 170901, Ecuador.
[2] Undergraduate student, Universidad San Francisco de Quito USFQ, Colegio de Arquitectura y Diseño de Interiores CADI, Departamento de Arquitectura, Casilla Postal 17-1200-841, Quito 170901, Ecuador.

* Correspondence: Ignacio Guerra P., iguerrap@asig.com.ec, iguerrap7@gmail.com

Abstract

Worldwide architecture students learn under two main pedagogies such as studio hands-on practice and traditional lecture classes. Navigating under two unsynced pedagogies is difficult and can create disconnection between subjects under different pedagogies. To address this issue, educators are trying different approaches to bridge the skills required for both. This article explores the role of using Mind Mapping in lecture-based courses to connect with the knowledge of hands-on courses. During Fall 22, Spring 23, and Fall 23, researchers used mind mapping in 4 courses of construction III (62 junior students), 1 course of Constructions I (18 sophomore students), and 4 courses of Sustainability (49 senior students). This study analyses the outcome of students' performance in terms of the knowledge highlighted in their mind maps and the application in their exams. Finally, instructors conducted a survey to inquire students about their perception about the role mind mapping plays in their learning and course performance. The authors reflect on the design of the intervention and explore the avenues academia could take to form new pedagogical approaches to connect skills from both pedagogies in architecture education. Implications for research and practice are provided.

Introduction

Mind maps serve as a visual pedagogical tool, particularly suitable for students inclined towards this learning method. It is essential to underscore that visual learning methods are particularly pertinent for architecture students, given the artistic nature of their career, where visuals play a crucial role. "... 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]. Considering this characteristic of architecture students, there is a preference towards the use of create visual study tools rather than traditional reading-writing methods.

It is crucial to recognize that employing diverse teaching methods enhances the approach to knowledge acquisition. In the field of architecture, establishing connections between theoretical concepts and their practical and technical applications is essential. Therefore, a comprehensive understanding of topics and their interrelations becomes fundamental. Mind

maps serve as a valuable tool, facilitating graphic representations that link various topics covered within a course. Visual tools can help “clarify the relationship between material objects and concepts to understand” [2].

The critical challenges faced by an ArPM (Architect Project Manager) are listed as “social skills, decision-making skills, problem-handling skills, ability to recognize opportunities, and management of changes as key personal attributes affecting project success [3]. Consequently, it is possible to question undergraduate architecture courses and whether they are properly preparing students for their professional performance.

Similarly, there is a necessity for architecture students to cultivate academic skills. These skills possess an interdisciplinary nature. Despite the central focus on design in their curriculum, architecture students require academic skills because their field cannot be neatly categorized as purely artistic or scientific. Given the integration of plastic and technical elements in architecture, diverse study techniques become essential for students to address their varied academic requirements. Traditional undergraduate education is anticipated to foster the development of key abilities such as reading, writing, discipline, and a study-oriented disposition [4]. All these skills are crucial and should be honed to ready students for engaging in architectural research. Second-year architecture students in the Netherlands were surveyed to gather their insights on research and their inclination to pursue academic courses in this domain. The findings indicated that while the majority held a somewhat positive opinion, primarily regarding its perceived usefulness, there was a strong dislike and stress associated with them [1]. Thus, academic skills should be developed, and traditional methods are not favorably taken by students.

Consequently, investigating various teaching methods within the field of architecture can contribute to the enhanced preparation of students in both academic and professional domains. Consequently, there is an inquiry into the direct application of mind maps and their advantages to architecture students within the context of their discipline. Additionally, there is a central focus on understanding the benefits of mind maps in skill development for conventional courses and exploring their potential correlation with skills acquired in other courses, particularly in studio settings.

Background

Nowadays, educational institutions and learning departments consistently prioritize the innovation and enhancement of learning systems employed to impart knowledge to students. The usage of graphical study tools has grown in popularity to enhance teaching and learning by strengthening students' cognitive abilities [5]. A crucial aspect of its consistent use and success lies in the capacity to transform theoretical concepts into clear and straightforward language, employing a didactic organization that engages and entertains students. Originally introduced by psychologist Tony Buzan in the early 20th century, mind maps serve as a method for notetaking and organizing ideas. They are structured to optimize various brain functions, enhancing learning abilities [6]. In simpler terms, when it comes to young students, mind mapping is a technique for elaborating ideas originating from a central theme. Additionally, mind maps are visual diagrams illustrating concepts associated with a particular topic, fostering visual learning capabilities. Similarly,

it is noteworthy to underscore that this tool facilitates comprehensive intellectual, cognitive, emotional, and even motor development. This stands in stark contrast to the antiquated rational school method prevalent in the nineteenth century, which heavily emphasized reading and memorization [7].

There are several investigations about the importance of mind maps and their rapid integration as a tool that enhances mental activity. It is important to mention that, as defined by Eder Aco in his study, that mind maps are mainly used as representations of complex idea (2019), because of their adaptability in visually representing information, mind maps find utility across various academic disciplines, where graphic elements like images, symbols, and diagrams enhance the understanding of the explained concepts [8]. The ability to summarize, diagram, explain, and conceptualize theoretical ideas in a tangible and simple manner facilitates their seamless application to fields of study like architecture. Specifically, while mind maps are primarily designed for children's development, incorporating them into the learning process of young university students introduces the potential for a shift in organizational approaches. This approach challenges the conventional reliance on reviews before exams [7]. Even with university students having attained a certain level of mental maturity, they can adapt to a new teaching tool that enhances their professional development.

Despite yielding numerous benefits, the significance of mind mapping lies in its ability to foster a comprehensive "holistic" learning process, stimulating factors such as thinking, feeling, and acting [7]. This activity holds value for students as a personal tool, adapting to individual needs and interests. Moreover, mind maps offer a creative avenue for students to engage with a unique teaching approach, contributing to the establishment of a novel information processing environment [6]. This, in turn, strengthens the connection between the learner and the content. Lastly, mind maps, being concise, provide a technical summary of a student's strengths and weaknesses, serving as a valuable tool for teachers interested in monitoring the progress and development of their students.

Within the field of architecture, courses typically fall into two categories: hands-on studios and traditional lecture-based classes. Navigating through these classes demands distinct skill sets, with the former emphasizing practical and manual abilities to express ideas, while the latter focuses on cognitive skills requiring a different mindset. Mind mapping serves as a bridge, connecting hands-on skills with lecture-based classes by encouraging students to visually represent their knowledge and course content in a personalized and didactic manner. The advantages of mind maps align with the specific skills and learning needs of students, particularly those in the field of architecture, which is the primary focus of this study. It is crucial to discern the academic skills essential for all college students and those specifically crucial for architecture students. As a starting point, irrespective of their major, college students attending more traditional classes generally aim for academic proficiency.

The academic performance of college students is closely tied to essential skills. Academic preparedness, encompassing reading and writing skills, basic disciplinary proficiency, and academic working skills, serves as a foundation for further academic development [4]. These skills, integral to knowledge acquisition and idea development, constitute a primary form of learning across disciplines. Mastery and familiarity with studied content require the

creation of texts and skills like synthesis and conceptualization. As Wollscheid, Lødding, and Aamodt (2020) assert, "Questioning, summarizing, clarifying, and predicting are all phases of the learning process that students need to pursue despite challenges, exemplifying what it means to master academic work" [4]. Moreover, college students must possess discipline and a strong commitment to academics. The overall idea of learning requires a student that “is involved in the learning process; it intervenes with all capabilities, emotions, skills, abilities, feelings and motivations” [7]. Success in academic work requires active engagement, unwavering focus, and persistent effort. These skills are indispensable for overcoming obstacles and distractions, contributing to successful academic pursuits.

The fundamental skill in the field of architecture is design, serving as the core focus in the learning process. “While [architects as project managers] play important roles in the construction industry from the design stage to implementation and demolition”, as well as overall understanding of materials and techniques [3]. Design, however, remains the core competence of the architect. Specific classes aim to develop the necessary abilities for design, encompassing cognitive, problem-solving strategies, and tools pertinent to architecture. Cross identified several core features of design abilities, including the production of novel concepts, application of imagination, use of graphs for problem-solving, adoption of solution-focused strategies, and proficiency in creating graphics and spatial models [9]. These skills are integral to the multifaceted responsibilities architects undertake in their professional practice.

Within the realm of design-related skills, several are notably relevant, with the adept utilization of graphics as visual tools being crucial for effective communication and problem-solving. In the field of architecture, the application of graphs extends beyond mere technical guidance. Proficiency in working with visual aids encompasses tasks such as creating diagrams, composing sheets, and addressing other essential aspects, all crucial for the successful execution of a project.

The evidence suggests that architecture students, upon analyzing a specific situation, tend to generate various solutions. As Lawson (1979) observed, "Architects already showed greater ability in the production of solutions and less ability in the recognition of the problem structure" [10]. Lawson attributes this phenomenon to their academic learning process, reflecting the cultivation of more refined planning skills than the comparison group. The diverse solutions architects create showcase their proficiency in solution generation.

Research Objective

The aim of this study was to conduct a pilot test to explore the impact of mind maps on the learning process of architecture students, who regularly navigate the integration of conceptual and practical learning. The objectives of the research were (i) to enhance the learning experience of architecture students and (ii) to facilitate the connection between practical concepts and theoretical knowledge, a common occurrence in architectural curriculum. This article details the outcomes of the initial pilot for assessment validation.

Methodology

The first part of this exploratory study, which is reported in this article, uses a qualitative approach [11], [12], [13] to measure the cognitive performance in architecture students. The data was collected during Fall 22, Spring 23, and Fall 23, in 4 courses of construction III (62 junior students), 1 course of Constructions I (18 sophomore students), and 4 courses of Sustainability (49 senior students) to a total sample size of n=129 students. All students provided responses. The survey contained both closed- and open-ended questions. The survey aimed for students to self-report their perception regarding the benefits of delivering a mind-map before an examination, and the perception if the mind-map had an impact on the examination. The unit of analysis for the case study [22] consisted of the days leading up to the examination when students worked on the mind-map and to the moment when the examination itself ended. The surveys were administered using Qualtrics software and cleaned up in the Excel software. The answers were coded for evidence of how the mind mapping influenced learning process, learning outcome, and practical skills characteristics in architecture students. Students' answers were coded for content analysis—using a-priori and emerging codes—following Saldana's [14] and Yin's guidelines [15]. The codes were grouped by overarching themes. The sets of questions were divided into the two research questions- The first research question inquired about how do mind mapping helps architecture students learning. The second research question inquired about how do mind mapping connect studio practical-based skills with architecture lecture-based learning.

All the courses examined in this study were instructed by the same teacher responsible for designing the exams. The exams administered across these courses featured identical sets of questions in terms of difficulty, pedagogy, problem-solving approaches, and themes. Each exam comprised five descriptive answers and three questions focused on applying concepts. Examinations were conducted individually and did not permit the use of open books. A standard time limit of 120 minutes was allocated for completing each examination.

Results

The first question of this study was "How do mind maps help in the formation of architecture students?" The answers can be briefly condensed in four specific premises in relation to mind maps: they are a study and learning tool, a creative way to put knowledge into practice, a tool with visual elements that facilitate the understanding of the course, and finally, mind maps are a method to develop architecture skills.

Firstly, **mind maps are great study tools** since the student can use them to summarize and synthesize all the content seen in class, while being able to optimize study time. As a result, one student expressed his appreciation for the tool since "at the time I developed the mind maps, I was studying at the same time". Likewise, another student described mind maps as

"efficient" as a study method. Another important aspect to consider about the performance of mind maps is that its format allows them to be easy to review and memorize before an exam, as one student stated, "I think it is a very positive methodology because it is a great way to review the subject before the exam", being an easily accessible and manageable tool created by oneself.

Mind maps can also be great learning tools since they can be used to extract useful information and main ideas that facilitate study. As indicated by one of the students, "personally it helps me a lot to identify the main ideas about a topic, and at the same time in what I am looking for it helps me to study". In the same way, the use of mind maps allowed students to categorize the topics learnt in class, and thus connecting them in different ways. This was really appreciated as one student stated how the use of minds maps were "an additional opportunity to reinforce learning with topics or subtopics that may have been left a little unclear". Likewise, students indicated that mind maps actually encourage for further investigation of the contents, allowing them a better comprehension of all topics.

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 architecture students in representing technical and practical knowledge in a creative way**, from a completely personal perspective. One student recognized the importance of the tool as it encourages the practice of personal reflection, as he states that "it is a creative way to put knowledge into practice". Similarly, mind mapping

allows information to be organized and incorporated in one's own words, for example one student mentioned that "[mind mapping helped him understand better] because I could understand in my own words what was taught". Therefore, mind maps allow us to summarize all the knowledge in a creative way, building a relationship between the reading and the general understanding of the course. Regarding the main premise, a student explained that “to make the mind map I have to read and understand the whole text to get a main idea", specifying the relationship that the activity created.

Likewise, mind maps are also **visual tools that facilitate the training of architecture students**. One student described the role of visual diagrams when studying for the exam, in which the activity "helps to memorize the subject better" as well as allowing him to pick up new information. Graphic tools also allow for a more detailed analysis of knowledge, for example, one student expressed that he felt that "[mind maps] motivate the student to analyze the contents with more attention to detail". Another aspect to consider is that visual diagramming allows organizing ideas based on hierarchy and proximity since, as one student explains, "I had them next to each other and I could understand myself better", demonstrating that mind maps allow understanding the information in a clearer way.

Finally, mind maps help greatly in the shaping of architecture students since they even encourage the **development of skills applied throughout their major**. The practice of drawing and sketching improves graphic expression, as one student explained how valuable the activity had been for him because it "helped him to learn to draw better and to show a better graphic expression". Another student emphasized how the mind mapping activity allowed him to work on that skill, since by summarizing the concepts learned he was able to "practice sketch-type drawing", an activity that is super useful in architecture assignments. Also, mind mapping is a tool that provides greater precision when drawing, as one student stated that working with mind maps helps "to being able to explain a concept clearly and briefly".

The second question of this study was "How do mind maps connect studio practical skills with traditional classes skills?”. The responses can be summarized as them explaining mind maps aim for an analytic approach of topics, improve communication of ideas, develop studying habits, and directly relate to the ability to synthetize.

Mind mapping leads towards **an analytic approach towards of the contents** on the course. A student mentions “they were a complete analysis in retrospective”. For which several skills such as the need to obtain main ideas and summarize content despite the extension leads to the hierarchy of ideas. A student said: “it helped to obtain the most relevant ideas and organize our own”. Additionally, the interest towards detail provides insight. An answer, although referring to architectural skills says they improved their drawings because they were more detailed. They explained: the drawing of an architect must be very precise and clear, such as constructive details and in general everything that is related to building”. This aspect reflects over the acquired skilled developed due to the use of mind maps. Finally, as part of the analytic process there is abstraction. A student said the skills they developed because of using mind maps were: “summarize information and abstract it”.

Another benefit provided by mind maps that is useful in traditional classes is **the improvement of the communication of ideas**. A student explained it: “helps us be precise, straightforward and clear”. Which is further evidenced because they explain complex ideas through brief messages and the creation of diverse text types. An answer said mind maps: “helped explain a concept short and plain”. Considering mind maps work with images and diagrams, the diagramming skills that have as a focus to be intelligible and communicative are developed. Thus, students learn to do this because: “the most complex aspect was to diagram the paper in order for the information to be understood”. All mentioned above, make students focus on working on their communicative skills.

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

Mind mapping before examinations help to **develop positive studying habits**. Students constantly mentioned how having similar classes regarding the same topics “helped them make the mind maps for final exams”. Moreover, the use of mind maps requires organization from students. About the time they take, a student said: “it is a disadvantage how long it takes to do”. But in general, a student thought they were very useful to “organize ideas. And overall positive for any professional area”. Finally, they were a visual study technique which made the acquisition of knowledge faster and benefited visual learners. Students said, “if you are a more visual person this study method is the best” and they thought “it is so much easier to understand things with an explication and graph to represent it”.

Also, the use of mind mapping **expands further summarizing skills**. Some of the students thought the contents of the chosen course were the ones that allowed to apply this methodology. A student answered they could find relations along the topics because “they

were connected and related between them", furthermore, they "could notice the relation along the concepts through the course" without attributing it to mind maps. However, students believe mind maps made them more conscious about the subject as they were required to express their knowledge in their own words. An answer indicated that: "while rewriting the topics learnt in class, I was able to explain myself with more ease". Finally, through this briefness of mind maps students have used them to review previous classes. They thought that "reviewing every topic led to noticing the most relevant ideas through the course"; and considering there were several topics seen: "mind maps help remember".

Lastly, a key skill provided in studio classes is to get used to the realization of the sketchbook. The familiarization with diagrams and sketches in practical classes, allowed mind mapping to be an easy-to-handle tool. One student indicated how both skills were connected as they "read the sketchbook notes and when finally understood them, they wrote them down on the mind map". In studio classes, the use of digital tools to sketch is also common, and mind mapping allowed students to foster those skills in traditional classes, as one student stated how this was very effective: "[When doing the mind maps with digital tools, you] begin to understand the ideal layout to generate better understanding."

Discussion

Based on the acquired results, it is evident that students fully endorse the significance of mind maps as valuable tools that facilitate the training process. These visual aids are seen as opportunities to streamline the synthesis and comprehension of the learned content. The students' preference for mind maps stems from the tangible benefits they experience, notably an enhanced performance, as they can establish a personal connection with the subjects through the creation of their own diagrams. Mind maps, as planned and examined, effectively served their purpose as innovative tools for students to participate in a unique learning approach [6]. Evidently, the students perceived mind maps as a significant contribution to their education as architecture students. Beyond exam preparation, they found that the use of mind maps allowed them to apply the skills typically utilized in their role as architects. The conclusions can be supported by the statement of one of the students who considered that the mind maps "[contributed] as a whole, since it meant a recapitulation of all the topics seen in class". We identified specific patterns in the students' feedback indicating a strong affinity for mind maps as study aids. Clearly, students believe that engaging with visuals serves as a dynamic approach to studying, allowing them to internalize content through diagrams and images, thereby enhancing overall comprehension.

Similarly, our findings indicate that students acknowledged the beneficial impact of mind maps in bridging the practical skills employed in architecture classes with those utilized in traditional subjects. The examination of students' utilization of mind maps suggested a substantial enhancement in their analytical approach to the subjects under study. As indicated, "mind maps, therefore, are a strategy or technique that enhances the possibilities of studying, learning and thinking, and adapts to individual and collaborative knowledge construction [7]. The development of specific skills using mind maps is important to consolidate a constant study habit in benefit of the students. Likewise, by employing shared skills in summarizing and synthesizing content, students gain confidence in analyzing

ideas, utilizing mind maps as representations of intricate concepts [8]. The general opinion showed how the use of mind maps helped considerably in all subjects connecting different skills as evidenced by the opinion of one of them: "Yes totally since we have to organize by topics and for us as architects it helps us to see things and to take into account the organization and development for a project". Hence, as students create their own mind maps, there is a significant enhancement in the communication of the represented knowledge. Consequently, we have discerned that employing mind maps as a study method boosts students' confidence by directly linking their skills.

Conclusions and Future Work

The research has demonstrated that the incorporation of mind maps within architecture classes serves as a beneficial tool for the development of skills crucial to students' careers. These advantages encompass the utilization of mind maps as a study and learning method, a means to practically apply knowledge, a tool for enhancing visual comprehension, and a platform for honing drawing skills. Positive outcomes have also emerged in relation to the integration of practical studio skills with traditional academic skills. The specific characteristics of mind maps that bridge both aspects include a focus on analytical approaches to topics, improved communication skills, the cultivation of study skills, and the ability to synthesize content. Overall, mind maps offer numerous advantages for the professional and academic growth of architecture students. As a pedagogical tool, they contribute as a visually engaging method, well-received by most students in the study, who deemed mind maps as an ideal means for comprehending and studying content. In this study, where construction classes were employed to implement the method, the need to establish connections between theoretical and material aspects was emphasized. For future studies, enhancing the student perception survey could expand the analysis of mind map contents. Additionally, incorporating quantitative data would allow for a more in-depth exploration of the impact of mind mapping on students' grades. Furthermore, repeating the research with construction students could provide insights into the tool's impact within the building industry education. Exploring its use in art classes may shed light on its effectiveness for students with different skill sets. Considering that students reported improved performance in various aspects, such as retention, confidence in their knowledge, and discipline, it would be pertinent to include the faculty perspective. A comparative analysis between classes utilizing mind maps and those that do not could provide valuable insights from the instructors' standpoint.

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