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Research Article

A Systematic Review of Sketching Factors in Architectural Education**

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Abstract

Sketches play a significant role in architectural design. During the past three decades, researchers have studied the characteristics of sketching to understand its different concepts and dimensions. This research aims to fill that gap by systematically reviewing the literature on sketching investigated in architecture, with a focus on the factors influencing sketching practices through a comprehensive analysis of thirty-three articles and book chapters. This study focuses on three main keywords (sketch, design, and architectural education), analyzing research published in the Scopus database from 1997 to 2024, a period of increasing interest in sketch-related research. Using the PRISMA framework and NVivo software, this study conducts a systematic review and qualitative analysis to synthesize existing knowledge on the role of sketches in design studios. The findings highlight the pedagogical value of sketching in architectural education, providing insights for educators and researchers seeking to enhance design teaching methodologies and future research directions.

Keywords: Architecture, Sketch, Design Process, Architectural Education

Mimarlık Eğitiminde Eskizin Faktörlerinin Sistematik Bir İncelemesi

Öz

Eskizler mimari tasarım sürecinde önemli bir rol oynamaktadır. Son otuz yıl boyunca araştırmacılar, eskizin farklı kavram ve boyutlarını anlamak amacıyla çeşitli çalışmalar yürütmüşlerdir. Bu araştırma, mimarlık alanında eskiz üzerine yapılmış literatürü sistematik olarak tarayarak, otuz üç makale ve kitap bölümünü kapsayan kapsamlı bir analiz yoluyla, eskiz pratiğini etkileyen faktörlere odaklanmaktadır. Çalışma, eskizle ilgili araştırmalara ilginin arttığı bir dönem olan 1997-2024 yılları arasında Scopus veri tabanında yayımlanan araştırmaları analiz etmekte ve üç anahtar kelimeye (eskiz, tasarım ve mimarlık eğitimi) odaklanmaktadır. PRISMA rehberliğinde ve NVivo yazılımını kullanarak sistematik bir inceleme ve nitel bir analiz gerçekleştirilen bu çalışmada, eskizlerin tasarım stüdyolarındaki rolüne ilişkin mevcut bilgiler sentezlenmektedir. Bulguların, mimarlık eğitiminde eskiz yapmanın pedagojik değerini vurgularken, tasarım öğretim yöntemlerini geliştirmeyi amaçlayan eğitimciler ile araştırmacılar için önemli çıkarımlar sağlayacağı düşünülmektedir.

Anahtar Kelimeler: Mimarlık, Eskiz, Tasarım Süreci, Mimarlık Eğitimi

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1. Introduction

This article is based on a deep understanding of sketches and finding a suitable answer to the questions: What are the critical sketching factors in architecture? Moreover, why should they be considered in design education? The influential factors of sketches on students in architecture studios are revealed. This analysis of existing references is used to understand sketching better and its importance in using sketching concepts. Despite the crucial role of sketching in architectural design education, more comprehensive research needs to identify the factors and roles that sketches play in architectural education. This gap underscores the need for systematic reviews to understand better the significance of sketching in this context, which is the primary focus of this article. By analyzing various research categories and identifying the critical factors related to sketches, this paper aims to highlight the importance of sketching in architectural education and its evolving relevance in design research.

The remainder of this paper is organized as follows: Section one is an introduction, section two is a literature review, and section three discusses the methodology, including the research objective and survey method. Section four discusses the results in terms of sketch analysis. Finally, section four includes the conclusion of the paper, summarizing the main findings and potential future research directions. Thirty-three documents are examined to systematically analyze the role of sketching in architectural education. These sources are categorized in Table 1 and further detailed in the methodology section. The literature review comprehensively analyzes these texts, highlighting their contributions to sketching research. The overall research process is illustrated in Figure 1.

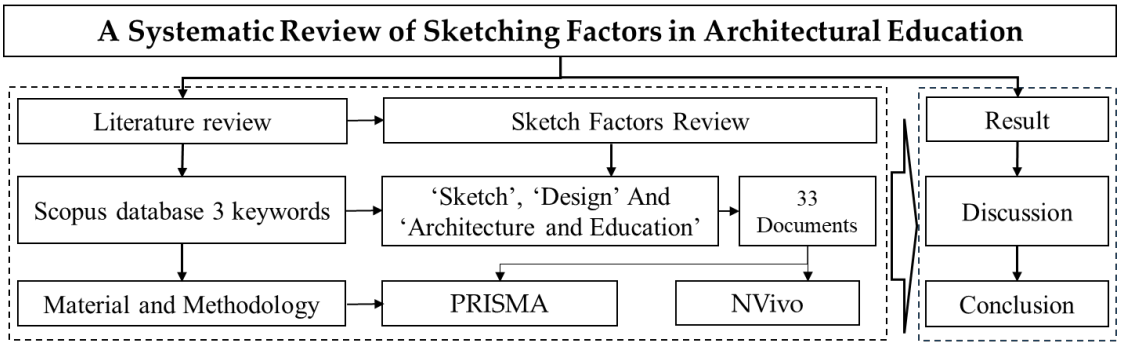

Figure 1. Research Process

2. Literature Review

Sketching has been a fundamental part of architectural design throughout history. The Beaux-Arts movement later formalized sketching as a core educational tool (Carlhian, 1979, s. 7), a practice that continued through the Bauhaus and into the 20th century. During the design process, sketch evolved from a drafting method to a cognitive process supporting design thinking (Merzdorf et al., 2023, s. 873).

Arnheim (1993) explains sketching is the process of externalizing the images in a designer's mind onto paper. It involves the oscillation of arguments, leading to the gradual transformation of these images, and concludes when the designer perceives sufficient coherence. Similarly, Henderson (1991) suggests that sketching encourages students' creative engagement. Goldschmidt (1994) emphasizes that visual thinking is central to design, balancing artistic intuition with rational analysis, which is critical in

architectural education. Suwa and Tversky (1997a) illustrate how freehand sketches serve as external representations, facilitating perceptual and cognitive interactions essential to the design process. Schmid-Kirsch (2010) argues for the continued importance of conventional sketching in modern design, while Soygenis et al. (2010) find that sketching helps students overcome conceptual challenges in architecture education. Clarkson and Eckert (2005) add that sketches and diagrams illustrate differing problem-solving strategies between experts and novices, underscoring sketching's role in design thinking. Similarly, Dorst (2011) identifies systematic visual thinking as a critical trend across education, design, and communication, proposing that design's form-concept process is a logical, structured development where the mind employs methodical strategies to create forms.

Pirrie and Brown (2011) suggest that designers reconsider the traditional roles of sketching in sustainable design practices. Nancy (2013) further expands on this by viewing sketching as a pleasure-driven practice, where meaning emerges organically from lines, traces, and interruptions—diverging from strictly purposeful drawing. McGlynn et al. (2013) points to creating responsive design environments where sketches connect ideals with practical solutions. Tversky (2014) reinforces the importance of cognitive tools like sketches in creative processes, showing how they map ideas into visual forms and provide immediate feedback that fosters iteration in design. Similarly, Javid (2014) and Sharif and Habibi (2015) explore how architecture education promotes creativity, mainly through non-linear problem-solving structures. Ammon (2017) examines the epistemic role of images, including sketches, in generating new design knowledge and envisioning future artifacts. Meanwhile, Roberts et al. (2017) present sketching techniques that bridge professional, ethical, and problem-solving skills in design education.

More recently, Abd Manan and Kennedy (2022) investigated the relationships between mood visualization and architectural sketching, emphasizing the importance of visual and verbal sketches in fostering critical and creative ideas. Their research highlights the necessity for further research on sketching and creative thinking in architecture to propose appropriate design vocabularies and taxonomies for teaching creative design thinking. Putra et al. (2022) explore how sketching enhances visual memory, arguing that students should engage in sketching early in their education to strengthen their ability to recall and manipulate visual information. They suggest these methods to cater to individual student needs, emphasizing the importance of hand-drawing studies. Avotina et al. (2023) argue that sketching is a valuable tool for expressing human creative thought, proposing its significant role in effectively conveying the outcomes of creative processes. Elaby et al. (2023) evaluate the impact of full-scale model design on the creative design abilities of first-year architecture students. The study suggests it is more effective in developing and communicating students' thinking. It also provides empirical evidence on the advantages and limitations of using model studies in design education. Makowska (2023) highlights the role of directing and developing sketching skills, emphasizing how integrating this ability with design thinking aids effective communication in design education.

After the literature review, the varied and hidden effectiveness of sketching in design education is investigated. The essential findings and *new points of view* of researchers on sketching were analyzed and discussed. Zell (2008) argues that a quick sketch does not equate to sloppiness or a lack of precision; instead, sketches serve as a representation method that allows architects to isolate, recall, and record their ideas. Similarly, Fish and Scrivener (1990) describe sketches as two-dimensional representations of three-dimensional visual experiences containing selective and

fragmented information, functionally essential ideas, and unexpected ambiguities. Suwa and Tversky (1996) emphasize that sketching enables designers to discover new connections and features once their thoughts are externalized on paper. Schön and Wiggins (1992) conceptualize sketching as a self-dialogue tool, describing it as '*seeing more seeing*.' Goel (1995) defines sketching as revealing the designer's imagination and thought process, facilitating lateral transitions, and preventing premature design fixation. He introduces the concept of '*lateral and vertical transformation'* to explain how sketching aids creative problem-solving through its semantic, complex, and ambiguous characteristics. Lawson (1990) researched how designers transfer their thoughts and engage in creative thinking. His research provides insights into the cognitive mechanisms behind the design process, reinforcing the role of sketching in fostering innovation. Purcell and Gero (1998) highlight sketching's role in enhancing creativity and novelty. Their work also examines the implications of working memory, image reinterpretation, and mental synthesis in design research, particularly about sketching. Cross (1999) argues that sketching supports design cognition and the recognition of emergent attributes in design solutions. Frascari (2009) expands on this by explaining that architectural sketches undergo a graceful transformation, translating design thinking into built form. He emphasizes that construction drawings are extensions of sketching, bridging conceptual fractures into physical structures. Suwa and Tversky (1996) reinforce that sketching facilitates problem-solving by externalizing and structuring the designer's thought process.

Sketching not only aids creative ideation but also strengthens cognitive processes. Newell and Simon (1972) argue that sketching assists in generating new ideas and supports flexible thinking. Similarly, Cold (1995) views sketching as a means of strengthening mental visualization, while Hanks and Belliston (1977) emphasize its role in transforming abstract ideas into tangible realities. Goldschmidt (1992) further explains that sketches store, transfer, and develop visual images, contributing to design fluency. Beyond cognitive benefits, sketching functions as a visual expression and a graphical language (İnceoğlu et al., 1995, s. 8). It serves multiple roles, including modeling (Zell, 2008, s. 15), knowledge transfer (Laseau, 2001, s. 5), expression and communication tool (Schön & Wiggins, 1992, s. 141) and helps the main structure of thought to transform, store, and reach other focal points (Ching, 1990, s. 3; Goel, 1995, s. 44). For preliminary studies, sketches, conceived as short and straightforward drawings without details, provide limited human memory capacity and mental processing for a comprehensive problem investigation (Schütze et al., 2003, s. 95). Sketching is a method of recording thoughts quickly and unlimitedly. Learning to sketch is like learning to see from a new perspective. It is a way of thinking that can be creative and observational. Table 1 presents 15 documents on sketching in architectural education. The organization is intended to map these perspectives and understandings of the sketch's terms. These terms were created based on studies identified during the literature review that significantly contributed to sketching in architectural education.

Table 1. Concepts Associated with Sketches

	Author	**Terms**
1	Lawson (1990)	Design Thinking
2	Schön and Wiggins (1992)	Seeing more seeing
3	Arnheim (1993)	Visual Exploration and Creative Thinking
4	Goldschmidt (1994, 1992, 2011)	Seen as, Seen that, Dialectic Sketch
5	Goel (1995)	lateral and vertical transformation

Table 1. Concepts Associated with Sketches (Continued)

6	İnceoğlu et al. (1995)	Visual Expression and Graphic Language
7	Laseau (2001)	Seeing a large amount of information
8	Schütze et al. (2003)	Analysis and Communication Tool
9	Jonson (2005)	Design Thought Creation
10	Tversky and Suwa (2009)	Thinking with sketch
11	Dorst (2011)	Creative Leap and Innovative Progress
12	Bar-Eli (2013)	Design Behavior Model
13	Bresciani (2019)	Visual Design Thinking
14	Mao et al. (2020)	Representation Tool
15	Mendoza-collazos (2024)	Early Processes and Visual Potential

3. Methods

This study selected the Scopus database because it offers extensive coverage of peer-reviewed publications. Its comprehensive research methods also facilitate the identification of critical factors related to sketching. This approach enabled a thorough literature examination beyond a superficial review (Table 2). The methodology involved analyzing existing literature and reviewing relevant articles and book chapters.

Table 2. Protocol Framework

Purpose of Review	To examine the significance of sketching in architectural education
Investigation Questions	1 What are the critical sketch factors in architecture? 2 Why should they be considered during design education?
Process of Selecting	Scopus
Search Terms	*'Sketch'* AND '*Design'* AND 'Architecture and Education'
Subject Area	Arts and Humanities and Engineering
Publication Type	Journal Articles, Book and Book Chapters
Time Period	1997- 2024
Data Extraction	The study requires the following information: year, publication type, citations.

3.1. Data Collection and Source Selection

The initial search used the keyword '*Sketch*,' yielding 57,055 references. The term 'Design' was added to refine the focus on design-related sketches, identifying 9,057 additional sources. The subject areas included Arts and Humanities (883 sources) and Engineering (3,674 sources), resulting in 4,261 documents screened. The inclusion criteria prioritized sources relevant to architectural design education and empirical research on sketching practices. Through content analysis, 1,989 journal articles, 209 book chapters, and 59 books were selected, totaling 2,257 documents. Following the initial screening, the most cited sources were identified. At this stage, 20 key sources (10 books and 10 articles) were chosen for detailed keyword analysis. The keywords 'Architecture *and Education'* were added to refine the investigation further, identifying 64 additional documents. After applying the same filters and restricting the results to English-language publications, 21 documents were found. However, some were not directly related to sketching and were filtered out.

Finally, 13 documents were selected for the final analysis. After an iterative refinement, a final set of 33 sources was identified for deeper analysis, focusing on their historical, educational, and cognitive contributions to sketching in design studios. The study adhered to PRISMA (2020) guidelines to ensure transparency and comprehensive

reporting. Analytical and qualitative methods were employed, integrating qualitative content analysis for data interpretation. The research spanned two years, with the latest revision conducted on March 20, 2025, to incorporate additional sources (Figure 2).

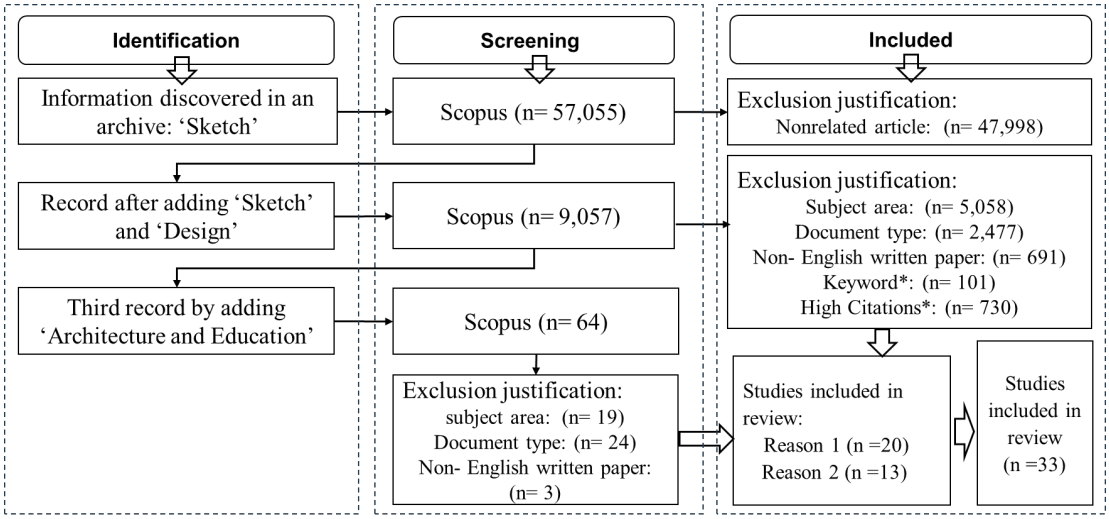

Figure 2. PRISMA Flow Diagram for Article Selection

3.2. Content Analysis with NVivo

To systematically analyze the data from these thirty-three sources, NVivo 15 software was utilized. NVivo's automatic coding feature identified recurring themes and patterns across literature. This enabled the rapid categorization of text segments according to the sketching factors identified during the preliminary literature review. The automatic coding efficiently grouped text under specific nodes related to sketching and identifying eight factors with the highest frequency. Given the limitations of NVivo's automated methods, a mixed approach (combining both automatic and manual coding) was adopted to ensure a more thorough and accurate interpretation of the data. The aim was not solely to categorize the articles but to validate and deepen our understanding of the sketching factors present in literature. NVivo enabled the identification of hidden or superficial factors related to sketching, which may have been less apparent during the manual review process. This deeper layer of analysis reinforces the idea that sketching is not merely a design tool but a core cognitive and creative practice within design education.

4. Results

This article examined the factors contributing to architectural education sketching to address the research questions. The twenty most cited sources (10 books and 10 articles) were analyzed to identify recurring themes and critical aspects of sketching. Additionally, thirteen more documents were added to the analysis by incorporating the terms Architecture and Education. These sources were systematically examined to extract significant factors, recurring themes, and conceptual contributions to sketching in architectural education. A temporal analysis of the reviewed literature reveals an increasing academic interest in sketching. Moreover, the keywords used to identify the articles have been documented to highlight the research focus across different studies. Suwa and Tversky (1997b), Suwa et al., (1998, 2000) and Goldschmidt (1994, 2017) were among the authors with the most references and articles on sketches. Table 3 presents a detailed breakdown of the selected articles and book chapters, highlighting

their contributions to the understanding of sketching in architectural design and education.

Table 3. Concepts Mentioned in the Sources on Sketches and Design in The Article, book, and Book Chapter

Type	Row	Author/s	Year	Citations	Factor/s	Keywords
Article (Sketch and Design)	1	Dorst	2011	1191	- Form-Concept - Visual Thinking - Creative - Communication	- Design Practice - Problem Solving - Reasoning
	2	Bezemer and Kress	2008	587	- Digital Media - Communication	- Writing - Representation - Multimedia
	3	Suwa and Tversky	1997 b	468	- Freehand Sketches - Representation - Early Design Stages, - Perceptual	- Architectural Design - Design Cognition - Drawings - Perception - Protocol Analysis
	4	Henderson	1991	425	- Computer-Aided Design	- Visual Representations
	5	Purcell and Gero	1998	400	- Role of Sketches - Innovation - Creativity - Working Memory - Image Reinterpretation - Mental Synthesis	- Drawings - Sketches in Design - Imagery And Design - Creative Design
	6	Goldschmidt	1994	320	- Visual Thinking - Developing and Designing Ideas	- Visual Thinking - Sketching - Cognitive Design
	7	Suwa et al.	1998	307	- Designers' Cognitive - Perceptual - Conceptual - Design Ideas - Role of Sketches	- Design Processes - Design Cognition - Protocol Analysis -
	8	Suwa et al.	2000	267	- Conceptual Design Process - Problem-Space - Analysis Tool	- Conceptual Design - Design Cognition - Design Process - Drawing - Design Perception
	9	Shah et al.,	2001	262	- Innovative - Solution Concepts - Design Solution - Communication - Mental Image	-
	10	Jonson	2005	228	- Conceptual Tool - Self-Report - Design Situation	- Conceptual Design - Design Process - Design Tools - Drawing - Design Ideation
Book and Book	11	Nancy	2013	66	- Rethinking Drawing - Desire To Transcend Knowledge	-
	12	Buchanan	2009	39	- Developing Detailed - Scale Drawings - Thinking	-

Table 3. Concepts Mentioned in the Sources on Sketches and Design in The Article, book, and Book Chapter (Continued)

	13	Goldschmidt	2017	30	- Visual Representations - Process Of Design - Sketch - Idea	- Cognition - Designing - Feedback - Representation - Sketching
	14	Roberts et al.	2017	22	- Alternative Ideas - Problem-Solving - Create New Ideas	Interaction Design - Sketching - Design Process
	15	Clarkson and Eckert	2005	12	- Design Thinking - Representations - Analysis Tool	- Design Process - Development - Management - Planning
	16	McGlynn et al.	2013	11	- Design Ideas - Build Environment	- Product Design - Architecture
	17	Ammon	2017	6	- Role Of Images in Design - Design Knowledge - Images	- Design Images - Design Knowledge - Design Tools - Visual Thinking
	18	Mittelberg et al.	2017	3	- Digital Design Tools - Communicate Ideas - Sketches On Paper - Gesture Studies - Creative Dialogic Processes	- Architectural Design - Creative Process - Embodiment - Gesture - Immersion
	19	Amoroso	2016	2	- Hybrid Design - Visual Communication	-
	20	Tversky	2014	2	- Mind Expands - Represent Thought - Creative Thought - Discovery Of Ideas	- Design Perception - Creativity - Diagram - Redesign - Sketch
Article and Book Capture (Sketch, Design and Architecture	21	Nyka et al.	2020	18	- Critical Thinking - Solution Proposals	-
	22	Soygenis et al.	2010	16	- Creativity - Thinking - Contact - Problem Solving	-
	23	Ceylan	2019	12	- Graphic Presentations - Contact - Design Perception	- Architectural Education - Digital Tools in Architecture - Technology in Architectural Design
	24	Yüksel and Uyaroğlu	2021	16	- Critical Thinking Skills - Representation Tool - Thinking Tool	- Architectural Education - Basic Design Education - Design Process - Experiential Learning
	25	Javid	2014	3	- Problem Solving - Thinking - Creatively - Thinking Visually - New Idea - Design Perception	- Creativity - Design - Diagram - Puzzle-Solving - Sketch - Visual Thinking
	26	Li and Amoroso	2023	1	- Digital Design - Visual Communication	- Digital Landscapes - Visual Communications
	27	Sharif and Habibi	2015	-	- Flexibility - Variability - Creativity	- Architectural Design - Authenticity And Novelty - Creativity - Innovation

Table 3. Concepts Mentioned in the Sources on Sketches and Design in The Article, book, and Book Chapter (Continued)

	28	Tofte	2017	-	- Design Thinking	- Sketchbooks, Undergraduate Education
	29	Abd Manan and Kennedy	2022	-	- Creative Thinking - Visual Communication - Imaginative Thinking - Conceptual Thinking - Explaining The Idea - Design Perception	- Architectural Design Concept - Imaginative Thinking - Semiology - Sketching - Visualization
	30	Avotina et al.	2023	-	- Expressing Thought - Creative Thinking - Encouraging Learning - Contact	- Communication of Idea - Creative Thinking - Design, Drawing - Sketches
	31	Agirbas	2023	-	- Creative Thinking - Visualization - Design Tool - Analysis Tool	- Architectural Education; Basic Design; Digital Sketch - Online Education - Students' Perspective - Teaching Methodology
	32	Makowska	2023	-	- Thinking Tool - Contact - Flexible Thinking - Innovation	-
	33	Güngör and Üstün	2024	-	- Design Problems - Concept Studies - Critical Thinking - Representations	- Vertical Studio System - Thought and Imagination

5. Discussion

According to the literature review, sketches are not just tools for drawing but are also integral to teaching architecture, especially in studios. The rising number of studies after 2018 suggests increasing recognition of the value of sketching. This growing interest highlights the need for ongoing critical evaluation of how sketches are integrated into contemporary architectural education (Figure 3).

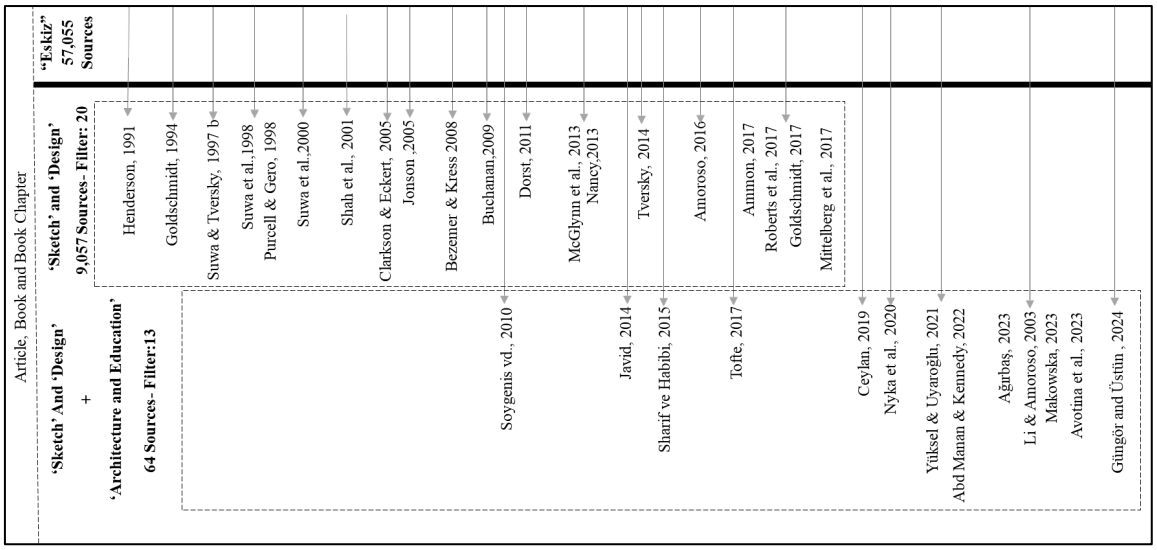

Figure 3. Examining the Literature Sources on Sketches (1991-2024)

This study analyzed the importance of sketching in architectural education. The first filtering step focused on articles related to 'Sketch' and 'Design,' which primarily explored sketching across various design processes. The second step narrowed the selection by using the keyword 'Architecture and Education,' focusing on literature directly related to architectural education: the first group prioritized articles, books and book chapters with high citation counts. In the second group, all articles were examined in greater depth to ensure a comprehensive understanding of sketching's role in architectural education. After a detailed review of the comments and the extraction of sketch-related factors from the documents, NVivo software was used to re-examine these factors carefully. This process aimed to assess their importance from the perspective of artificial intelligence and to compare the results with the factors identified by the author. These thirty-three sources were examined by NVivo software, and automatic coding was used for each article. When the NVivo method was applied, it identified a broad range of factors, including some unrelated to architectural education. These unrelated factors were filtered out to maintain the study's focus, ensuring that only those directly relevant to architectural education were considered. A comparison between NVivo and manual methods was then conducted to analyze the key sketching-related factors and their frequency of occurrence in the selected articles. While the manual method specifically identified and categorized factors directly associated with sketching, NVivo provided a broader but more superficial overview, capturing all recurring themes without distinguishing their direct relevance to sketching in architectural education.

Table 4 compares manually identified factors and those generated through NVivo analysis, illustrating their alignment while revealing the varying terminologies used in different studies. Notably, NVivo analysis highlighted the prominence of terms such as *'Design Thinking', 'Creative Design Skills*,' and '*Design Perception,'* frequently appearing in academic sketching discussions. The frequent appearance of keywords such as '*Thinking*' and '*Design Perception'* suggests that sketches are not merely representational tools but serve as cognitive and problem-solving instruments in architecture. Through manual and NVivo analysis, the literature identified 14 factors, some closely related, such as Thinking and Conceptual tools, Design and Visual tools, Perception and Imagination, Design Idea and Representation, creativity and Innovation, Problem-Solving, and Solution and Analysis Tool. These were consolidated into eight primary categories, reflecting the nuanced role of sketching in architectural education.

Table 4. Categories literature of sketches Factors from Manual and NVivo

Manual Factors				**NVivo Factors**		
	Category	**Count**	**Code**	**Category**	**Count**	**Code**
1	Thinking Tool	35	Thinking	Design	182	Creative Design Skills
			Visual Thinking			Design Concept
			Critical Thinking			Design Development
			Creative Thinking			Design Images
						Design Idea
						Design Language
			Flexible Thinking			Design Practice
						Design Problem
			Expressing Thought			Design Tasks
						Design Studios
						Design Thinking
2	Visual tools	30	Visual Abstraction	Thinking	44	Figurative Thinking
			Visualization			Visual Thinking
			Visual Memory			Creative Thinking
			Visual Communication			Divergent Thinking Ability
						Spatial Thinking
						Thinking Exercises

Table 4. Categories literature of sketches Factors from Manual and NVivo (Continued)

						Thinking Outcomes
						Thinking Results
3	Perception	23	Imaginative Thinking	Learning Process	43	Active Learning
						Design Learning
			Cognitive Awareness			Effective Learning
4	Representation	14	Conceptualization	Modeling	43	Physical Modelling
			Representation Tool			Commercial Real-Time Model
						Sketch Base Modeling
						Architectural Sketch Modelling
5	Creativity	12	Creative Thinking	Creativity	38	Creative Thinking
			Innovation			Experimental Approaches
			Creative idea			Creative Idea
						Creative and Concept
6	Communication	9	Visual Communications	Problem-Solving	29	Design Problems
			Graphic Communication			Solution Proposals
						Main Problem
						Problem-Solving Strategies
7	Problem-Solving	8	Design Problems	Visualization	22	Data Visualization Process
			Solving Problems			Visualization Concepts
			Identifying Problems			Visualization Representation
						Visual Language
						Visual communication
8	Analysis Tool	6	Analytical Drawing	Perception	14	sensory perception
			Evaluation Strategies			Design Perception

6. Conclusion

This research provides a systematic review of the role and significance of sketches in architectural design education. Sketch factors were identified through a comprehensive analysis of thirty-three articles and book chapters drawn from the Scopus database to determine sketches' importance and effects. After a thorough manual review of the literature, NVivo was employed to systematically categorize and assess each factor's significance. The analysis identified key factors in sketching practices within architectural education, including *'Thinking Tools,' Visual Tools,' 'Perception,' Representation,' 'Creativity,' 'Communication,' 'Problem-Solving.' And 'Analysis Tools'*. These eight concepts were selected based on their frequent occurrence as abstract terms in the literature. Although other concepts are important, their high number, overlapping meanings, and infrequent occurrence led to a more focused and selective analysis. These selected concepts provide a structured framework for examining the subject and defining the research scope. Additional concepts related to sketching, such as the *'Working Memory,' 'Reinterpretation Tool,' 'Mental Synthesis,' 'Creating New Thoughts,' 'Free Expression,' 'Criticism Tool,' and 'Concept Development,*' appeared less frequently. An analysis of the keywords used in the studies reveals that sketch-related concepts are frequently employed to define the articles' thematic scope and research focus.

By analyzing the literature on sketching, this study highlights its crucial role in architectural studios, emphasizing the factors that contribute to its importance in design education. Sketching is not merely a tool limited to pen and paper; its significance lies in its role in the design process. Sketches serve as a purposeful means of conveying a designer's thought process. They can take various forms, from traditional pen-and-paper drawings to digital tablet-based representations, particularly in the early stages of design. The findings highlight that despite the increasing integration of digital technology,

sketches remain essential for fostering creativity, exploring ideas, and communicating design concepts effectively; sketching bridges abstract thought and tangible design, making it an indispensable tool in the architectural design process. Future research should further investigate the role of sketching in design education, particularly its impact on students' cognitive and creative development. Instead of viewing sketching solely as a representational tool, studies should explore its profound influence on design thinking, problem-solving, and conceptualization processes. Examining how sketching interacts with emerging digital tools could provide new insights into its evolving role in architectural pedagogy. Ultimately, this research underscores the need to preserve and adapt sketching practices in modern design education. By recognizing its multifaceted contributions beyond a mere tool, educators can ensure that future architects continue to benefit from sketching as an essential medium for design exploration and innovation.

Author Contribution

The authors declare that they have contributed equally to the manuscript.

Conflict of Interest Statement

The authors of the study declare that there is no financial or other substantive conflict of interest that could influence the results or interpretations of this work.

Research and Publication Ethics Statement

This study was conducted in accordance with research and publication ethics, and did not require ethics committee approval.

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