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Enhancing Assessment Methods in Architectural Design Studio: A Proposal for Criteria-Based Evaluation

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ABSTRACT

This paper evaluates current assessment methods in architectural design studios and proposes a criteria-based approach to enhance evaluation processes. The study utilizes a literature review and case studies to analyze existing practices and highlights the importance of transparent and fair evaluations. By implementing a standardized model with clearly defined assessment criteria, students gain a better understanding of expectations and parameters, fostering creativity and minimizing subjective evaluations. The research emphasizes the significance of promoting students' mental and emotional well-being by providing a clear understanding of assessment processes, thereby reducing stress and anxiety. The findings demonstrate a notable improvement in the consistency of evaluations between instructors and guide assessments. Initially, there was a mean deviation of 32.42% between the assessments made by instructors and guide assessments. However, after implementing the criteria-based evaluation approach, this mean deviation significantly reduced to 8.55%, indicating a more aligned and objective assessment process. The study also includes the results of a poll on self-assessment tasks, where 70% of students acknowledged the positive contribution of self-assessment to project quality. Moreover, 68% of students reported enhanced abilities to provide constructive feedback on their peers' projects through self-assessment, Overall, the study underscores the need for a criteria-based approach in architectural design studios, as it promotes evaluation consistency, quality improvement, and student learning experiences.so that, the research suggests that with further practice and training, the criteria-based evaluation approach can be refined, leading to even more consistent evaluations among assessors.

1. Introduction

The Assessment plays a pivotal role in the learning and teaching process as it allows for the evaluation of students' quality and their achievements. Additionally, it is fundamental to the curriculum, as it determines the success of the learning plan and the desired out-comes. It also holds great importance for teaching staff in educational institutions, as they are expected to make fair, ethical value judgments based on evidence and educational

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standards about their students' level of achievement. Moreover, they need to assign scores that accurately reflect the progress made in the curriculum [1], [2].

The assessment process currently faces challenges, requiring the implementation of evaluation methods based on standards. Furthermore, there is a lack of tools available to evaluate-ate the comprehensive performance of architectural design, apart from those considering certain aspects of the design's performance. As a result, educational institutions are increasing embracing assessment methods that are based on standards, aiming to make the evaluation process less ambiguous and more transparent. [3], [4]. Considering this context, this research aims to address a significant, feasible and researchable issue by conducting a comprehensive survey. The objective is to develop an evaluation method that can accurately assess the performance of architectural designs. By doing so, the study aims to fill the existing gap in the assessment process and provide valuable insights for educational institutions [5].

The importance of assessment in the learning and teaching process cannot be overstated. It serves the purpose of not only evaluating students' knowledge and skills but also guiding instructors in adjusting their teaching methods and curriculum to achieve optimal results. Effective assessment helps identify areas that need improvement, informs instructional decisions, and promotes student-centered learning. Furthermore, assessment plays a vital role in ensuring educational standards are met. It serves as a means to measure the attainment of predetermined learning outcomes and enables instructors to determine if the curriculum has been successful in achieving the desired objectives. By using evidence-based assessment methods, instructors can make informed decisions about curriculum alignment and instructional strategies [3], [4].

However, the assessment process should not only focus on evaluating students' performance but should also consider the ethical and moral values associated with education. Lecturers and educational institutions have a responsibility to ensure that the assessment process is fair, unbiased, and free from any form of discrimination. This includes creating a supportive and inclusive learning environment that allows students to demonstrate their full potential.

The comprehensive assessment should take into account the overall performance of the educational program and the curriculum. The evaluation should not be limited to individual courses or assignments but should provide a holistic understanding of the students' progress and achievements [7], [8]. By doing so, lecturers can identify any gaps or areas that require improvement in the curriculum design or teaching strategies.

To address the challenges and limitations faced by the existing assessment methods, this research aims to develop a standardized evaluation tool for assessing the performance of architectural designs. This tool will enable lecturers to assess the effectiveness of architectural design programs and ensure that students are equipped with the necessary skills and knowledge to meet industry standards. The assessment plays a significant role in the learning and teaching process. It enables instructors to evaluate students' quality, guide instructional decisions, and ensure the attainment of educational standards. However, the assessment process faces challenges, including the lack of comprehensive evaluation tools for architectural design. This research aims to address this issue by developing a standardized evaluation method, which will contribute to the improvement of assessment practices in educational institutions.

Not many examinations had keen on the job of appraisal in engineering education. For in-stance, a past report by Cikis,Cil[5] uncovered that the majority of the plan instructors feel that rules-based assessment had missing in building plan education as well as featuring that albeit the evaluation had the driver in the nature of understudies realizing, there had an indifference toward the job of assessment in design education, e.g., a past report uncovered that it had difficult to explain explicit decision-production without showing the assessment criteria.

Three examinations by Uta Berta et al. [8] uncovered that assessment in the structural plan lobby had comprehensively, emotional. Now, again, a few understudies feel disap-pointed, accept that they had satisfied all necessary work while they had as yet getting terrible grades. While different understudies emotionally had given passing marks, cul-mination of the errand though, they had almost the same. Understudies' disappointment in view of the shortfall of straightforwardness in the assessment process. One more con-centrate by Yusoff et al [4], [5]. had uncovered that exhibition assessment relies upon hu-man understandings, which had extremely abstract.

Uzunoglu proposed a device for evaluating

structural plans, which thinks about general building plan guidelines of structure, capability, development as the primary criteria. Those three principal models incorporate minor rules. Everyone had a relative weighting with the goal that understudies could distinguish the nature of their compositional de-sign. Utaberta, Hassanpour [6], [7].

By given an assessment model that incorporates tasks a portion of their standards in light obviously targets, lecturer's assumptions, carried out systems in the plan lobby. Each assignment had granted relative weight. In any case, awful planned assessment had the ability to prevent learning, twist the advancement course. While very much planned assessment upgrades straightforwardness assumptions, gives open doors to understudies to self-screen, practice [1], [6], [7].

A concentrate by Oluwa tayo et al. uncovered that ostensible consideration had given to the distinctions in assessment measures at the building schools. Notwithstanding their impact on concluding the proficiency rating representing things to come architects, the re-view affirmed that a genuinely tremendous contrast between the scores when the evaluators of various engineering schools or expert establishments utilize various models of assessment parameters [7]–[9] .

The challenge hat instructors face had to track down ways of rousing understudies to partake in new instructing procedures that assist them with accomplishing their objectives, create fruitful projects. Self-evaluation had one of those procedures to upgrade the understudies' assessment abilities, set them up for proficient challenges [7]– [9].

. Currently, guidelines-based training considers understudy self-evaluation as a device to further develop understudy inspiration, commitment, learning. At long last, evaluation isn't an end in itself however a vehicle to improve education.

The design process in architectural studios revolves around small, well-defined projects throughout the semester, as well as a final project that is more comprehensive and on a larger scale [10]. It is expected that students will complete their projects and submit them with proper documentation before the deadline. On submission day, students have the opportunity to view their peers' projects, receive feedback from both peers and experts, and ultimately receive a grade. Educational systems typically have official examination, assessment, or grading policies in place to evaluate student learning [11].

These policies usually provide clear information about the assessment program, including the weightings assigned to different components, and students receive timely and constructive feedback after each assessment. In recent years, universities and instructors worldwide have shown an increased commitment to enhancing the effectiveness of assessment and grading in promoting student learning.[12] When it comes to studio-based educational systems like architecture, appraisal methods and grading systems require particular attention and scrutiny, more so than in other majors and fields. This is because assessing the degree of success in solving defined design problems and translating it into grading symbols is more challenging than evaluating multiple-choice tests or open-ended questions. The main focus of this paper is on grading methods that claim to be criteria based.

Grading involves assessing the academic performance of students on a larger scale, which can be for an individual significant assignment or an entire course. The scores or marks obtained by students are often used as the basis for determining grades, especially when they are combined and converted into a different symbolic representation of overall achievement. These symbolic representations can take the form of letter grades (A, B, C, D, etc.), descriptive terms (such as Distinction, Honors, Credit, Pass, etc.), or numerical values (such as 7, 6, ..., 1). Numerical values are typically considered as measurements, making it straightforward to calculate grade point averages (GPAs)[1]–[5].The other symbols are as-signed numerical equivalents according to a predefined table.

The primary objective of this study is to assess the existing foundation of assessment methods in the architectural design studio and propose a more accurate and objective approach. It is crucial to establish criteria-based assessment methods and grading in order to avoid subjective and ambiguous evaluations that can hinder student progress. By adopting transparent, truthful, and equitable decision-making processes, criteria-based assessment ensures fairness and minimizes disputes and dissatisfaction, which can have a negative impact on students' mental and emotional well-being.

It is important to provide students with a clear understanding of the specific aspects of their work that will be assessed and the criteria used for

evaluation. Given the potential for different judges to perceive a work differently, it is imperative to establish a standardized model that defines appropriate assessment criteria and encourages student creativity in the architecture studio [13]. By implementing criterion-based grading in architecture and design, students will be better equipped to understand the assessment criteria and strive to meet the predetermined objectives. Additionally, this approach will enable jurors to assign values more easily based on the pre-established assessment criteria, fostering consistency and objectivity. By incorporating these strategies, the study aims to enhance the precision and objectivity of assessment in the architectural design studio, ultimately benefiting students and improving the overall quality of the learning experience [14].

Establishing appropriate assessment standards is a crucial factor in educational in situations. These standards should be widely accepted and effectively implemented to ensure targeted achievement in the curriculum and education system. They serve as benchmarks for the development of learning systems, particularly in architecture majors, which differ from other disciplines due to their reliance on well-established assessment criteria. [15] Properly defined assessment standards contribute to the effective evaluation and improvement of educational outcomes in architecture programs.

Throughout the architectural curriculum, design studio courses have consistently held a prominent position, being assigned the highest credit weightage and requiring the most weekly contact hours. These courses are supplemented by subjects such as visual communication, construction technology, environmental physics and simulation, parametric tools, history, and theories, which provide valuable support and enhance students' progress as they advance through successive design studio courses. [16] According to Van Wezemae and Silberberger, the subjects of architectural communication and architecture history play a foundational role in the early stages of architectural education, equipping students with essential knowledge that lays the groundwork for their work in design studios. The interrelationship between these subjects and the activities carried out in the de-sign studio is depicted.

Assessment plays a crucial role in the education process and has a significant impact on students' learning. It encourages the adoption of deep learning strategies and contributes to the improvement of education and student outcomes. However, in the architectural de-sign studio at UKM and other departments, there is a lack of sufficient discussion on the assessment framework, despite the use of standard letter grades. Assessment in the architecture design studio is holistic and subjective, considering criteria such as assignments, attendance, activity, and creativity [16-17]. Each of these criteria has underlying sub-components that contribute to the overall assessment process.

2- Methods

The evaluation and assessment of student work in architectural education are essential components of the learning process. A comprehensive assessment system is implemented within the studio design courses curriculum to measure students' understanding, application, and proficiency in architectural design principles and techniques [18]–[20].

2.1Creativity in Design

The concept of creativity within the realm of design revolves around the exploration and expression of innovative and original ideas. It encompasses the ability to think outside the box, challenge conventions, and generate novel solutions to design problems. Creativity within design is not limited to aesthetics but also involves the integration of functionality, user experience, and sustainability. It involves the use of various techniques, such as brain-storming, prototyping, and iteration, to foster imaginative thinking and bring forth unique design concepts. By embracing creativity, designers can create engaging and impactful de-signs that push the boundaries of what is possible and inspire new perspectives.

2.1.1 Culture and Criteria

Creativity plays a vital role in the education of architecture students and in the broader academic context. Within design studios, instructors actively encourage students to embrace creativity in their design ideas and adopt innovative perspectives. However, this creative exploration is not detached from traditional approaches. Instructors also emphasize the importance of utilizing established structural learning processes, evaluation systems, and tools to effectively manage the studio environment.

By balancing creativity with the application of traditional methodologies, students are encouraged to think critically and experiment with novel design concepts while still adhering to established evaluation frameworks. This approach fosters a holistic learning experience that pro-motes both imaginative thinking and a solid understanding of the fundamental principles of architecture [20]–[22].

The creative studio culture requires the incorporation of alternative teaching and learning models that offer constructive and beneficial alternatives. Cropley and Kaufman identified five criteria factors for creativity, including relevance and effectiveness, which encompass correctness, performance, operability, safety, and durability. However, it is suggested that additional criteria such as recognition, convincingness, pleasantness, completeness, gracefulness, harmoniousness, and sustainability are more suitable for assessing creativity within design [23]–[24].

Findings from Rahma and Noraini's survey highlight a significant disparity between stu-dent and professor perceptions of creativity during the design phases. Results depicted in Figure (1,2) indicate that the majority of students and instructors perceive creativity in the design studio as the ability to generate original design solutions, explore unconventional ideas, offer diverse interpretations, work with inspiration, and utilize research and knowledge to address design problems [25]–[26]. However, it is worth noting that sustain-able solutions are not explicitly mentioned or associated with creativity in these findings.

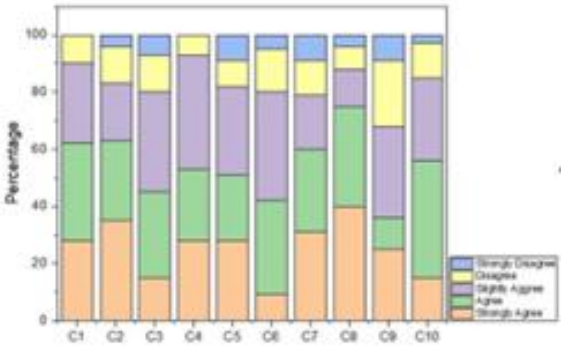

Fig.1 Shows the Staff members perception of creativity [3]

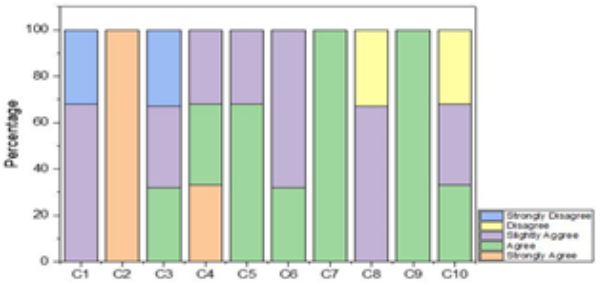

Fig.2 Shows the Students' perception of creativity [3]

According to Figure (1,2) the personal behaviors identified as C1 to C10 are integral to the development of design concepts within the design studio. These behaviors including:

C1: Successfully solving a design problem

C2: Generating original ideas for the design problem

C3: Creating sustainable design solutions

C4: Working with inspiration

C5: Conducting work based on research

C6: Generating original or unconventional ideas

C7: Developing the concept in different ways

C8: Demonstrating self-motivation in idea development

C9: Taking risks in exploring new ideas

C10: Successfully adopting previouslyrejected ideas

These behaviors reflect the key aspects of personal engagement and creative thinking that contribute to the design process within the studio environment.

2.2 Aesthetic Assessment:

Aesthetic assessment involves the interaction of various cognitive and emotional processes, resulting in two key outcomes: aesthetic judgment and aesthetic emotion. Scholars have put forth arguments suggesting that aesthetic evaluation is a cognitive process that relies on abilities such as curiosity, imagination, aesthetic sense, innovative thinking and emotion [28], [31], [32].

Assessment of learning outcomes, processes, inputs, and contextual factors .

* Objective and subjective assessment methods.
* Qualitative and quantitative assessment techniques.
* Direct and indirect evidence of student learning.
* Embedded and additional assessment methods.

These approaches provide a comprehensive framework for assessing aesthetics in various

educational contexts, considering both objective and subjective elements, and employing diverse qualitative and quantitative measures.

2.3 Architectural Design Assessment

In architectural design, studio education revolves around practical application and project-based learning. As a result, the primary teaching method employed is the review or criticism process. The jury assessment holds a significant role in the evaluation of architectural design, often taking on a ceremonial and ritualistic nature. Rather than determining winners or losers, the focus is on selecting well-conceived solutions that effectively ad-dress spatial and social challenges. The jury session serves as a collective event, typically marking the culmination of a design project [28], [32]

2.3.1 The Jury

Juries necessitate the use of teaching tools that serve both assessment and educational purposes. During jury sessions, students present their designs to the jury and engage in defending their concepts while receiving constructive criticism and feedback. The format of these sessions can vary, with students taking part as discussants, audience members, or jurors, both from their own institution and external organizations [29], [30], [33].

2.3.2 Assessment vs. Evaluation

Assessment and evaluation are two distinct yet interconnected processes in the field of education. Assessment refers to the ongoing gathering and analysis of information about student learning and progress. It involves various methods, such as tests, quizzes, pro-jects, observations, and discussions, to gather evidence of students' knowledge, skills, and understanding. Assessment is primarily focused on providing feedback to students and guiding instructional decisions to support their learning and growth. It is formative in nature, aiming to monitor and improve student performance [31]–[34].

On the other hand, evaluation is a broader and more comprehensive process that in-volves making judgments or judgments about the worth, value, or quality of something. In the context of education, evaluation typically refers to the overall assessment of student performance, programs, curriculum, or educational systems. It often involves making summative judgments, such as assigning grades or determining the effectiveness of instructional practices or educational policies [34].

While assessment focuses on gathering evidence and providing feedback to support learning, evaluation concentrates on making judgments about the outcomes or effective-ness of educational endeavors. Both assessment and evaluation are essential components of the educational process, providing valuable information for teachers, students, administrators, and policymakers to make informed decisions and improve educational practices.

2.3.3Assessment Criteria

Studio instructors bear the responsibility of establishing a studio culture that cultivates productive work habits, fosters creative exploration, and facilitates successful learning. Contextual considerations within the studio encompass the quality of site planning and its alignment with the surrounding environment, taking into account fac-tors such as accessibility, landscape design, and parking allocation. The concept criterion pertains to the intangible design layer, focusing on indicators such as the character and uniqueness embodied in the design philosophy, the impressions it creates, and the symbolism it conveys. This criterion emphasizes the conceptual aspects of the design, aiming to create distinctive and meaningful architectural solutions [2], [5], [8].

The final criterion is performance, which encompasses various aspects related to building safety and control systems. It also considers the satisfaction of users' needs, particularly in terms of social interaction, and aims to optimize users' overall experience of the built environment. Studio instructors, therefore, play a crucial role in instilling a studio culture that emphasizes the integration of these criteria. By guiding students to consider context, concept, and performance in their design processes, instructors assist in developing well-rounded architectural solutions that address functional, aesthetic, and experiential aspects.

2.4 The Assessment of design studios

Criterion, as defined by Sadler (1987) and further supported by Sadler (2002), refers to a distinguishing property or characteristic of something that allows for the judgment or estimation of its quality. It serves as

a basis for making decisions or classifications. The term originates from the Greek word "kriterion," meaning a means for judging.

In the context of grading models, criteria are used to assess student performance and determine grades. These criteria can be applied to the entire course or specific assessment tasks, depending on the design of the grading model. Regardless of the specific model used, the interpretation of criteria remains consistent with the general definition provided above. The criteria establish a clear connection between the achievement of course objectives and the assigned grades, without making comparisons to other students' achievements [8].

Overall, criteria play a vital role in the grading process, providing a framework for evaluating student work and aligning it with desired learning outcomes.

a.Individual Evaluation: This is a frequently used tool in design studio teaching to achieve desired learning outcomes. It typically occurs in the early stages of design development and involves personal discussions between students and instructors, where the student's work in the form of drawings and models is reviewed. Occasionally, small groups of students participate in one-on-one discussions to receive feedback on their work.

b.Formative Critique: This assessment is conducted through large-scale presentations of design work, such as posters or wall displays, before the final submission. Evaluative feedback and constructive comments are provided during this presentation.

c.Peer Critique: Typically implemented in upper-level undergraduate design courses, peer critiques are structured by the instructor to assess students' ability to engage in discussions and problem-solving. Students benefit from brainstorming sessions with their peers to identify and address design challenges. Studies suggest that peer assessment can be beneficial and fair when conducted constructively and under supervision.

d.Group Critique: In this type of assessment, students present their work to their lecturer within a group setting, where the lecturer provides feedback. Students have the opportunity to learn from other students' solutions and the related comments provided.

e.Panel Discussion: This assessment method is periodically employed throughout the semester, involving a group of educators and professionals who review and discuss selected projects. It takes place in an interactive and participatory environment. Through this process, students receive indirect feedback on their designs and gain experience in presenting their ideas and expressing their thoughts to the wider community. Additionally, this method helps introduce students to common design terminology and concepts while providing instructors with feedback on the overall progress of the studio and the strengths or weaknesses of the design problems formulated by the faculty.

These various forms and types of assessment offer a comprehensive approach to evaluating student performance and promoting learning within design studios. Each method brings its own benefits and serves to enhance students' understanding, problem-solving abilities, and design skills.

2.5 Criteria-based evaluation

Engineering institutions globally have adopted comparable assessment methodologies to evaluate the design work of students in architectural courses. These assessment strategies heavily rely on the academic background and experience of the course instructors. The assessment process takes into consideration various key performance criteria, including aesthetics, functionality, structural integrity, social impact, environmental considerations, economic viability, and safety, among others. Additionally, sub-models derived from each primary criterion are applied based on the level of the architectural design course within the engineering program. These selected criteria incorporate a combination of subjective and quantitative assessment models, which are utilized to evaluate both qualitative and quantitative information present in architectural design drawings [8], [21]. Quantitative data includes measurable quantities such as lengths, masses, numbers, and rates, while subjective data encompasses subjective aspects of architectural design, such as space, structure, shape, size, surface, balance, unity, diversity, symmetry, proportion, pattern, decoration, and other elements that convey beauty and taste but cannot be measured. However, it is important to note that instructors assign an overall weight or score to each criterion within the assessment guidelines based on the students' achievements. Presently, there is no standardized approach for using an integrated

assessment model that incorporates predefined performance standards and their relative weights to evaluate architectural design projects. Consequently, this type of grading model still relies on the subjective judgment of the course instructor, which may introduce variability and potential discrepancies among different evaluators. [8], [24]. In the final presentation of architectural design courses, students are required to submit comprehensive project documentation, including research studies, conceptual designs, floor plans, sections, elevations, perspectives, details, and project models, following specified formats, scales, and presentation techniques. The course instructors allocate grades based on the collective assessment of the design tasks, including the research report, architectural design drawings, project model, and oral presentation. In this context, the evaluation of students' work in the architectural design course is based on the evidence of achievement, as shown in Fig(3).

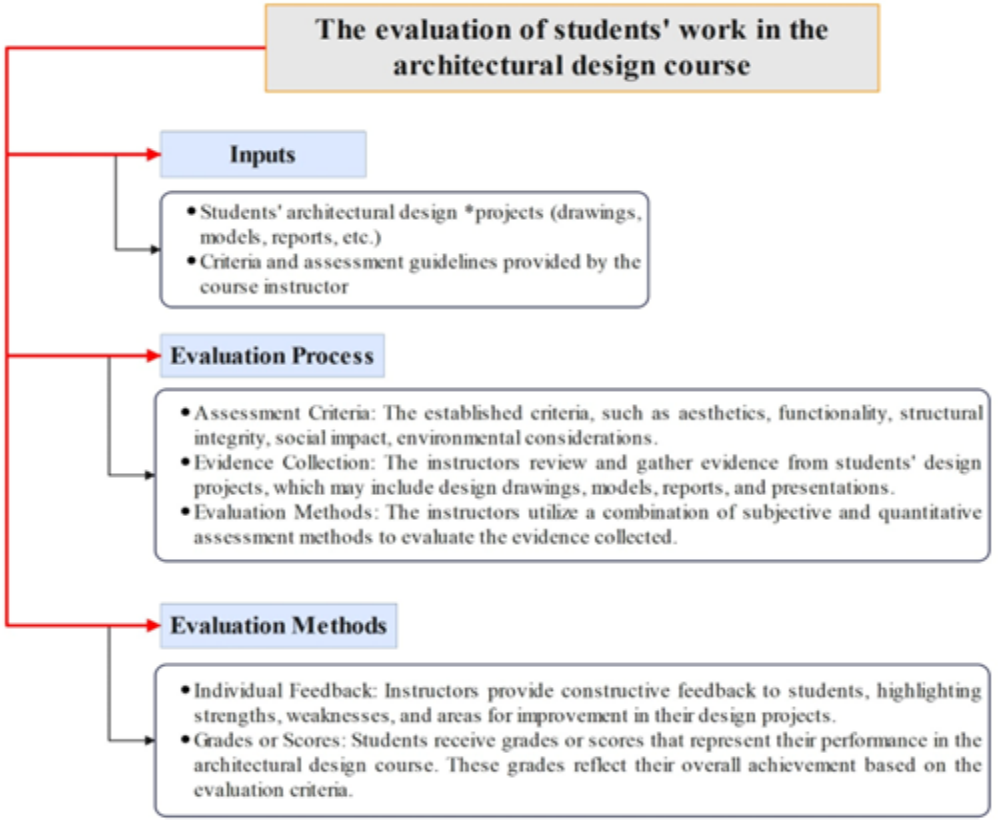

Fig.3 classification of the student's achievement process.

3.Classification of case study

In studio design courses, student achievement can be classified into different levels or categories based on their performance.

Outstanding Achievement: This category includes students who demonstrate exceptional skills, creativity, and mastery of design concepts. Their work displays a high level of innovation, technical proficiency, and critical thinking. They consistently meet or exceed the evaluation criteria and produce outstanding design solutions.

Proficient Achievement: Students in this category

exhibit a solid understanding of de-sign principles and techniques [27]. They consistently produce well-executed designs that meet the evaluation criteria effectively, while they may not reach the level of innovation and excellence seen in the outstanding category, their work demonstrates competence and proficiency.

Adequate Achievement: Students in this category meet the minimum requirements and expectations of the course. Their designs fulfill the basic criteria and demonstrate a satisfactory level of understanding of design principles. However, their work may lack originality or show limited exploration of concepts.

Developing Achievement: Students in this category are still in the process of developing their design skills and understanding [28]. Their work shows potential, but they have not yet fully mastered the design principles and may struggle with executing their ideas. They may require further guidance and practice to improve their design abilities.

Below Expectations: This category includes students who have not met the minimum requirements or adequately demonstrated their understanding of design concepts. Their work may exhibit significant deficiencies in meeting the evaluation criteria. These students may need additional support and remedial measures to improve their performance. As shown in table (1) It's important to note that the specific classification and criteria for student achievement may vary across different studio design courses and institutions The classification is a general framework, and the actual categories and criteria may be adapted to suit the specific context and objectives of the course.

4.Analytical study:

The architectural education, the evaluation and assessment of student work are crucial components of the learning process. The implementation of a comprehensive assessment system within the studio design courses curriculum aims to gauge students' understanding, application, and proficiency in architectural design principles and techniques. Through a combination of theoretical knowledge and practical application, students are challenged to develop their design skills and demonstrate their competence in producing architectural designs. The studio design courses serve as the primary platform for students to engage in hands-on design projects and explore various aspects of architectural design. These courses typically span multiple semesters, providing students with ample time to delve into the intricacies of the design process. Each week, students dedicate a substantial amount of time, often equivalent to five credit hours, to immerse themselves in studio activities [28]–[29].

The assessment of student work in the studio courses encompasses both quantitative and qualitative measures. It involves evaluating the students' design concepts, spatial organization, aesthetics, functionality, and adherence to project requirements. Instructors assess students' work through a combination of individual critiques, group discussions, and formal presentations. This multi-dimensional evaluation process pro-vides students with valuable feedback, enabling them to refine their designs, think critically, and develop their design thinking skills.

The evaluation of student work in the studio courses is often aligned with international and local standards. These standards serve as benchmarks to ensure that students are equipped with the necessary knowledge and skills to meet professional expectations in the field of architecture. By incorporating these standards into the assessment process, students are encouraged to strive for excellence and develop a strong foundation for their future careers in architecture. The studio courses in architecture education often emphasize a collaborative learning environment, where students engage in peer-to-peer discussions, critique sessions, and collaborative projects. This fosters a sense of community and encourages students to learn from one another, share ideas, and gain insights from diverse perspectives. The assessment process also takes into ac-count the students' ability to effectively communicate and present their design ideas, as these skills are essential for successful architectural practice [1]–[4].

The evaluation of student work in the studio design courses curriculum plays a pivotal role in assessing students' understanding, application, and proficiency in architectural design. By incorporating a comprehensive assessment system that aligns with international and local standards, students are provided with valuable feedback, enabling them to refine their designs, think critically, and develop their design thinking skills, The collaborative nature of the studio courses further enhances the learning

experience and prepares students for the challenges and expectations of the architectural profession.

4.1The case study:

The Tourist Resort Studio 6 is an integral part of the studio design courses offered in the field of architecture. This particular studio course focuses on the design and planning of tourist resorts, encompassing various aspects such as site analysis, conceptualization, spatial organization, and integration of amenities. It provides senior students with an immersive learning experience, allowing them to explore and develop their skills in designing unique and captivating tourist destinations. Throughout the duration of the Tourist Resort Studio 6, which typically spans a semester, students engage in a series of design projects centered around the creation of innovative resort concepts. The course emphasizes a balance between theoretical understanding and practical application, ensuring that students not only grasp the fundamental principles of re-sort design but also gain hands-on experience in translating those concepts into tangible designs.

The assessment process within the Tourist Resort Studio 6 is comprehensive and multi-faceted. It encompasses various criteria such as the clarity of design concepts, integration of sustainability principles, utilization of the site's natural features, functionality of resort facilities, and consideration of visitor experiences. Instructors utilize a combination of individual critiques, design presentations, and group discussions to evaluate students' progress and provide constructive feedback. Moreover, the assessment criteria for the Tourist Resort Studio 6 are often aligned with international and local standards in the tourism and hospitality industry. This ensures that students are not only devel-oping their design skills but also gaining an understanding of the industry's best practices and requirements. By adhering to these standards, students are encouraged to think critically, consider market demands, and create resort designs that are both aesthetically pleasing and commercially viable. [1], [5], [8], [14] The collaborative nature of the studio courses is emphasized within the Tourist Resort Studio 6 as well. Students are encouraged to work in teams, fostering a dynamic environment where they can ex-change ideas, challenge each other's concepts, and learn from diverse perspectives. This collaborative approach enhances the overall learning experience, as students benefit from the collective knowledge and creativity of their peers.

The Tourist Resort Studio 6 is a significant component of the studio design courses in architecture education. It provides senior students with an opportunity to delve into the intricacies of designing tourist resorts, combining theoretical knowledge with practical application. Through a comprehensive assessment process aligned with industry standards, students are equipped with the skills and understanding necessary to create innovative and sustainable resort designs. The collaborative nature of the studio further enhances the learning experience, fostering teamwork and encouraging students to think critically and creatively in the realm of resort design.

The Resort Studio 6, students employ a range of skills, drawing inspiration and guidance from project elements such as shown in table3 .to design captivating and innovative resorts. These techniques, including the Plan-Section-Elementary study of form, are crucial for addressing the multifaceted considerations and challenges involved in successful tourism resort design. The Plan-Section-Elementary study of form technique al-lows students to delve into various aspects of resort design, including site analysis, spatial organization, sustainability integration, and the incorporation of amenities. By utilizing this technique, students can effectively address these considerations and challenges.

The Plan provides a bird's-eye view of the resort layout, showcasing the arrangement of buildings, open spaces, and circulation paths. This allows students to visualize the overall spatial organization and ensure efficient flow and connectivity within the resort. The Section technique involves cutting through the resort vertically, providing in-sights into the interior spaces, vertical circulation, and relationships between different levels. This technique helps students understand the scale, proportions, and spatial qualities of the resort's various components. [20], [22], [8], [14] The Elementary study of form focuses on analyzing and manipulating basic architectural elements such as massing, volumes, and proportions. Students can experiment with different forms and compositions to create visually appealing and harmonious resort designs. Additionally, in the design development phase, students further refine their concepts and ideas. They study the main

concept of urban planning and building design, developing facades or elevations and sections that reflect the idea of the main concept. This stage allows for a detailed exploration of the design elements and considerations within the resort.

the Final Sketch stage involves the preparation of all project requirements. This includes creating a comprehensive and visually compelling representation of the resort design, incorporating all the elements and considerations developed throughout the de-sign process, by employing these techniques, students can effectively address the multi-faceted considerations and challenges involved in designing a successful tourism resort. Each technique offers a unique approach and methodology for tackling specific design elements and considerations, ultimately contributing to the creation of captivating and innovative resort concepts.

At the end of the instructional exercise hours, the course instructors assessed the students' Design projects provided feedback, and assigned grades to each student's work. The feedback included identifying errors in the drawings and discussing the Elementary study of form and other relevant aspects.as show in table (2,3)

Table 1. Levels of the cases' achievements in studio course [1]–[4].

Grade type	Achievement level					
Letter Grade	A	B	C	D	E	F
% Bands	90: 100	75: 84	65 -74	50: 66	30: 49	0: 29
Project appreciation	Excellent	Very good	good	Pass	Poor	Very poor
Project Status	Succeed				failed	

Note. In the context of project grades in studio design courses, it is noted that the completion percentage of the project grade aligns with the completion percentage of the studio design course. The evaluation of the project grade is conducted using a combination of quantitative and qualitative performance criteria, taking into consideration both international and local standards. This approach ensures that the assessment of the project aligns with established benchmarks and expectations within the field of studio design.

Table 2: Notable Discrepancies Between Course Coordinator Scoring and Tutors Scoring for skiz-1[1], [5]

Student No.	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*Mean Deviation*
Deviation (%)	*54.6*	*22.7*	*4.4*	*5.6*	*44.8*	*48.7*	*24.8*	*45*	*41.2*	*32.42*

Table 3: Student Portfolio Assessment Rubric [2-5]

Content Variety & Quality of Work	Project Depth	Visual Presentation	Student Participation	Total
Includes a comprehensive range of design projects, research work, and artifacts. projects, research, and artifacts demonstrate high craftsmanship and detail.	Projects show depth of exploration, detailing, and architectural thought.	visuals are well-presented, clear, and visually engaging. The final form of the file and its inclusion of an index	Visuals are well-presented, clear, and visually engaging. The final form of the file and its inclusion of an index	
40%	20%	20%	20%	100%

Prior to assessing skiz-2 of the students' works, the course organizer divided the overall grade into

different components: as shown in table (4) Student Portfolio Assessment Rubric.

This approach aimed to reduce deviations in scoring. However, despite this adjustment, there still exists a significant deviation in the instructors' assessments in certain cases. Additionally, the architecture design drawings of the students continue to exhibit remarkable and repeated errors that need to be addressed.

The course instructors provided students with feedback regarding the strengths and weaknesses of their works, offering suggestions for improvement and bridging the gap between their current status and the intended objectives.

1- The absence of a criteria-based assessment method prompted the course organizer to de-sign and implement a criteria-based assessment model to enhance the accuracy, fairness, reproducibility, and reliability of the assessment process.

2-The course instructors explained the design development process and the finalization of plans and layouts. They emphasized the need for design development prior to implementing technical solutions in the complete drawings, using double lines. In order to ad-dress the significant deviations among the instructors, the course coordinator reviewed the assessment outcomes of the students' works once again. Considering the following points [1], [5], [8], [14]:

3-Architectural design incorporates a range of performance metrics, including functionality, aesthetics, structural integrity, environmental impact, and social considerations, all with the goal of achieving optimal project performance. The complexity of architectural design decisions stems from the fact that each decision relies on multiple evaluation models, which can vary depending on the specific design phase. Consequently, each design phase entails slightly different requirements, leading to the utilization of distinct evaluation models.

4-The proposed models aim to transition from subjective judgment to objective judgment, minimizing the possibility of biased subjective decisions. The course coordinator considered several guidelines focused on evaluating the working drawings to avoid a cumbersome assessment process within the designated course time while incorporating multiple evaluation criteria. The course facilitator assigned relative weights (importance) to each evaluation parameter in the proposed model. The course coordinator instructed the instructors to consider the criteria-based assessment models when evaluating skiz-2 of the students' working. This resulted in further reduction of deviations between the teacher's scoring and the instructor's scoring, as shown in Table 5.

The students provided a self-assessment of their works and the expected final working drawings for their projects. The course coordinator evaluated the final submissions of the students' works and noted that there were often significant deviations between his assessment and the students' self-assessment. However, the effectiveness of students' self-assessment depends on their attitude, objectivity, and critical response. Ultimately, the quality of the students' final submissions improved significantly compared to their initial submissions, as shown in Figure (4,5) After the completion of the course, the instructors requested the students to fill out a poll. The purpose of the poll was to gather feedback on the course, specifically regarding the self-assessment task and its impact on the nature and quality of their working drawings.

The poll included the following questions:

q1-Did the self-assessment task contribute to improving the nature of your functioning drawings design?

This question aimed to assess whether the students felt that the self-assessment task had a positive influence on the quality and design of their projects. It sought to gather insights into whether the self-assessment process helped students enhance their skills and pro-duce better functioning designs.

q2-Did the self-assessment task help senior students gain expertise in assessing studio design projects?

This question focused on the senior students' perception of the effectiveness of the self-assessment

task in developing their abilities to evaluate working drawings. It aimed to determine whether the self-assessment task was valuable in enhancing their assessment skills and knowledge.

q3- Did you prefer self-assessment tasks throughout the semester or only towards the end of the semester?

This question aimed to gather students' preferences

regarding the timing of self-assessment tasks. It sought to determine if students preferred having self-assessment tasks throughout the semester or if they found it more beneficial to have them only to-wards the end of the semester. This feedback would help the instructors understand the students' preferences and make any necessary adjustments to the course structure.

By gathering responses to these poll questions, the instructors would gain valuable in-sights into the students' perspectives on the effectiveness and timing of the self-assessment tasks, allowing for potential improvements in future iterations of the course.

q4- Did the self-assessment task improve your ability to provide constructive feedback to your peers' studio design projects?

This question aims to assess whether the self-

assessment task helped students develop their skills in providing constructive feedback to their peers' studio design projects. It focuses on the students' perception of the effectiveness of the self-assessment task in enhancing their ability to critically evaluate and provide valuable feedback on the quality and design of their classmates' projects in the studio setting.

Table 4: Criteria-based evaluation model for the studio course.

Achievement Project Requirements	Design Concept	analytical studies	Spatial Organizig	Structure Simulation Safety Requirements	Project Originality	Drawing Quality	Landsca pe design	3D	Sustainability and technology	total
15%	10%	10%	5%	10%	10%	20%	5%	5%	10%	100

Table 5: Decreasing the differences between course coordinator evaluation, tutor evaluation for-skiz no:2

Student No.	1	2	3	4	5	6	7	8	9	Mean Deviation
Deviation (%)	10	7	9	13	18	10	20	6	20	8.55

5.Findings

The findings of the study indicate that there was a notable improvement in the consistency of evaluations between instructors and guide assessments Initially, there was a mean deviation of (32.42%) between the assessments made by instructors and guide assessments. However, after implementing the criteria-based evaluation approach, this mean deviation reduced significantly to (8.55%). The decrease in the mean deviation suggests that the criteria-based evaluation approach helped align the assessments of studio design projects between instructors and guide assessments. This alignment is crucial because it ensures that evaluations are more consistent and reliable across different assessors. It also indicates that the criteria-based evaluation approach was effective in reducing subjectivity and personal bias in the assessment process. Additionally, the study suggests that with more practice and training, the mean deviation among assessors is expected to decrease even further. This finding implies that the criteria-based evaluation approach can be improved over time, leading to more consistent evaluations among assessors. The majority of students provided positive feedback regarding the beneficial impact of the assessment model on the quality of their studio design projects. This positive feedback is supported by Figure (6,7,8,9) which likely presents data illustrating the students' opinions

or perceptions. The assessment model likely helped students understand and meet the evaluation criteria, resulting in improved quality in their design projects.

The findings from the poll on self-assessment tasks in the context of architectural design projects are as follows:

When queried the students about the impact of the self-assessment task on the quality of their projects,

70% of students affirmed its positive contribution, 10% expressed a negative opinion, and 20% indicated a moderate effect. Concerning the utility of the self-assessment task in enhancing senior students' expertise in evaluating studio design projects, 68% responded positively, 2% disagreed, and 30% expressed a partial benefit.

When asked about their preference for self-assessment tasks throughout the semester or solely towards the end, 68% of students favored integrating self-assessment tasks during the semester, while 32% preferred them exclusively towards the end. Regarding the improvement of their ability to provide constructive feedback on their peers' studio design projects through the self-assessment task, 60% reported a positive impact, 3% disagreed, and 37% indicated a partial enhancement.

Overall, the findings suggest that the criteria-based evaluation approach had a positive impact on the consistency of evaluations and the quality of studio design projects. The approach helped align assessments between instructors and guide assessments, and students perceived it as beneficial. The study also highlights the potential for further improvement with additional practice and training in the criteria-based evaluation approach.

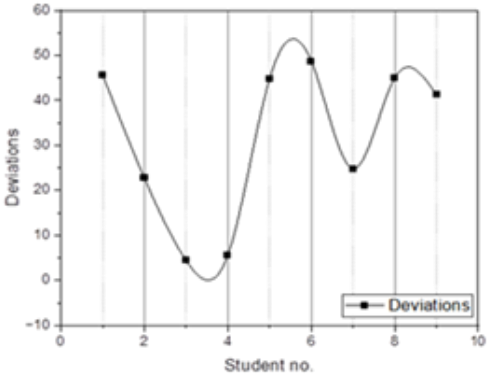

Fig.4 The Initial Submissions of Students Submission.

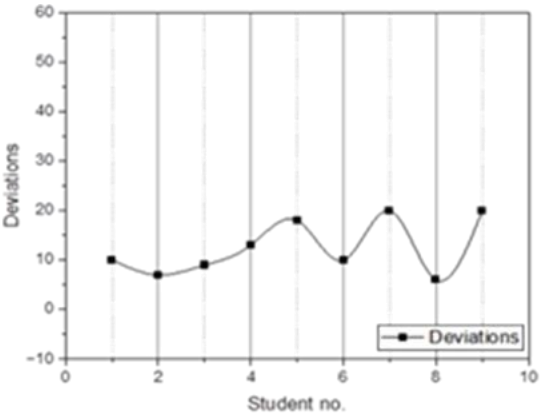

Fig.5 Improving the Final Submission Quality of Students

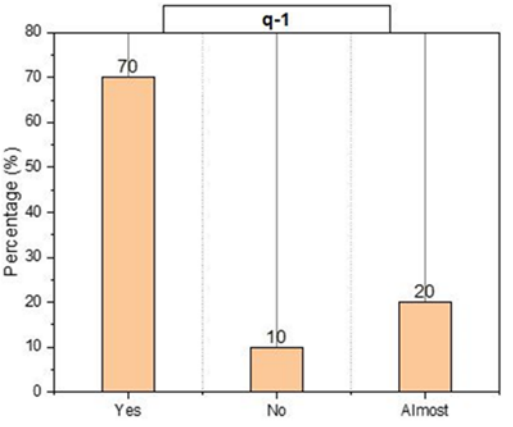

Fig.6 student answer to the q (1) if the self-assessment task contributes to improving the nature of your functioning drawings design.

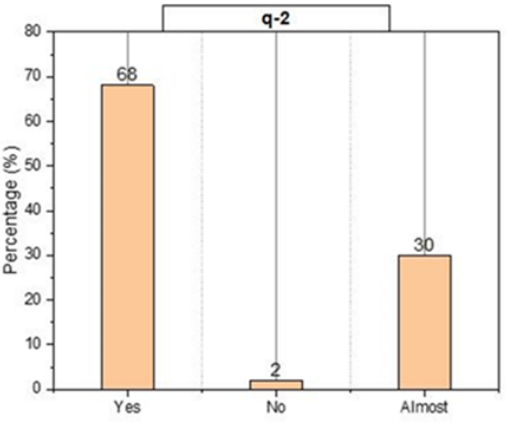

Fig.7 Improving the Final Submission Quality of Students

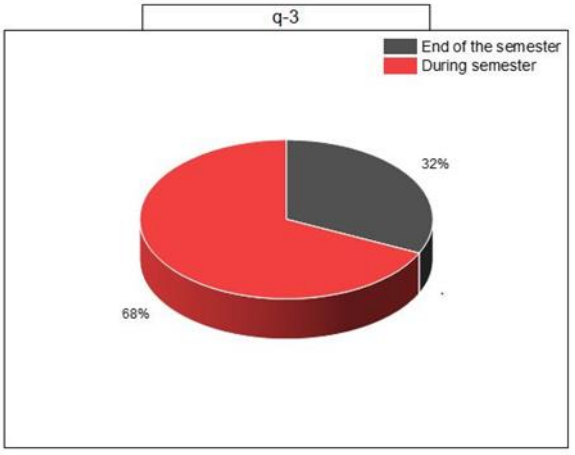

Fig.8 Improving the Final Submission Quality of Students.

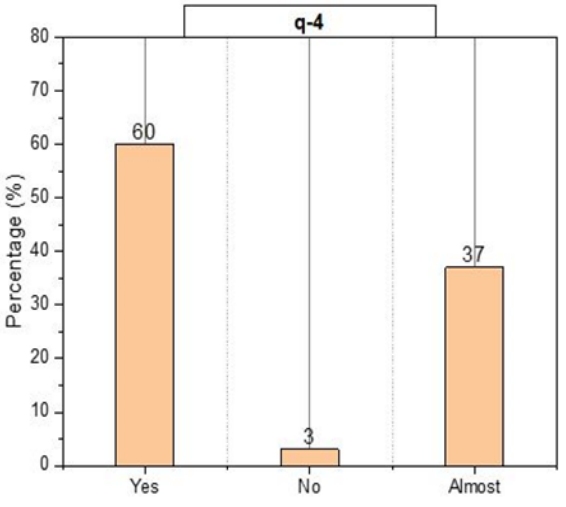

Fig.9 Improving the Final Submission Quality of Students

6-Discussion

The transformation of the assessment process from subjective and emotional choices influenced by personal moments to objective decisions based on factual evidence was a necessary step based on previous research studies This study successfully addressed the existing knowledge gap in the assessment of architectural design by introducing an objective criteria-based assessment model for evaluating students' studio design projects. The implementation of this model resulted in a reduction in deviation among multiple evaluators and positively impacted the students' designing.

One of the strengths of this research is the development of an assessment model that is suitable, reproducible, editable, and free from significant errors. Mistakes in assigning scores using this model were minimal and easily detectable and correctable. The proposed model may require slightly more time compared to the current comprehensive reviewing model used for studio design projects. Nevertheless, one could argue that a thorough, ac-curate, and fair assessment of students' work is worth the additional time investment.

In this study, the researcher limited the application of self-assessment to the final submission of the project. However, students expressed a preference for self-assessment throughout the semester to facilitate adequate preparation and enhance their experience in assessing studio design projects. Therefore, implementing self-assessment tasks during the course period can serve not only as an evaluative tool but also as a learning tool, thereby improving students' performance and their understanding of their own design outcomes. Additionally, self-assessment tasks transform students from passive recipients to active participants in the assessment process. The proposed criteria-based assessment model effectively places assessment at the forefront of the learning hierarchy, significantly reducing subjective and arbitrary decisions. This research supports the previous recommendation emphasizing the importance of standardized grading criteria as the foundation for a unified evaluation system, ensuring fairness and consistency across every institution of architecture.

Finally, this study provides an educational assessment tool that significantly con-tributes to the advancement of assessment methodologies in architectural design during the construction documentation phase. The proposed model supports evaluators in making accurate and fair decisions while promoting consistency and reducing deviation among different evaluators.

7-CONCLUSION

In conclusion, this study addressed the need for a more objective and standardized approach to the assessment of architectural design projects. By implementing a crite-ria-based assessment model, the study achieved its objectives of reducing deviation among evaluators and improving the quality of students' studio design projects.

8-Recommendations

Further Refinement of the Criteria-Based Assessment Model: While the proposed cri-teria-based assessment model showed promise in improving consistency and reducing deviation among evaluators, there is room for further refinement. Future research can focus on fine-tuning the criteria and assessment rubrics to ensure their effectiveness in evaluat-ing a wide range of design projects and accommodating varying levels of complexity.

Longitudinal Studies: This study primarily focused on the short-term impact of the criteria-based assessment model on students' studio design projects. Conducting longitu-dinal studies that track students' progress and performance over an extended period can provide valuable insights into the long-term effectiveness of the assessment model and its impact on students' development as designers.

Comparison with Other Assessment Approaches: It would be beneficial to compare the criteria-based assessment model with other existing assessment approaches, such as holistic or portfolio-based evaluations. Comparative studies can shed light on the relative strengths and weaknesses of different assessment methods and inform educators and in-stitutions about the most effective approaches for evaluating architectural design projects.

9- limitation

Short-Term Evaluation: The study primarily focused on the short-term impact of the criteria-based assessment model on students' studio design projects. Long-term effects, such as the transferability of skills to real-world scenarios or the impact on students' fu-ture professional practice, were not extensively explored. Future research could consider longitudinal studies to examine the sustained effects of the assessment model over time.

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References:

[1] Peter.B, Fay.D, Yufan.Z, and Lucinda.B, "The impact of classroom design on pupils' learning: Final results ofaholistic, multi-level analysis," Build. Environ., vol. 89, no.12, pp. 118–133, 2015, doi: 10.1016/j.buildenv.2015.02.013.

[2] Nangkula U and Badiossadat. H, "Reconstructing a Framework for Criteria-based Assessment and Grading in Architecture Design Studio," Procedia - Soc. Behav. Sci., vol. 60 no. 2, pp. 142–149, 2012, doi: 10.1016/j.sbspro.2012.09.360.

[3] Ibraheem. N., "Assessment of Architectural Design Studio: A Review," Am. J. Civ. Eng. Archit., vol. 9, no. 3, pp. 88–94, 2021, doi: 10.12691/ajcea-9-3-2.

[4] Upeksha.H and Preben..H, "Design studio practice in the context of architectural education: a narrative literature review," Int. J. Technol. Des. Educ., vol. 32, no. 4, pp. 2343–2364, 2022, doi: 10.1007/s10798-021-09694-2.

[5] Nangkula.U, Badiossadat. H, and Mohd.B, "An evaluation of criteria-based assessment and grading in architecture design," Res. J. Appl. Sci. Eng. Technol., vol. 5, no. 2, pp. 346–352, 2013, doi: 10.19026/rjaset.5.4956.

[6] Lyndsay.R. B, Alfonso.H, and Birgit. S, "Learning by Comparison: The Benefits of Co-Teaching for University Professors' Professional Development," Front. Educ., vol. 6, no.12, pp. 1–15, 2021, doi: 10.3389/feduc.2021.776991.

[7] Pei-Huang.D and Naai-Jung.S, "Trends and research issues of augmented reality studies in architectural and civil engineering education-A review of academic journal publications," Appl. Sci., vol. 9, no. 9, 2019, doi: 10.3390/app9091840.

[8] Nangkula. B, Mohd. B, and Adi.A, "A Comprehensive Learning of Architecture Education: Understanding Critique Session as Learning Process and Criteria-based Assessment in the Architecture Design Studio," Procedia - Soc. Behav. Sci., vol. 102, no.8,2012, pp. 21–32, 2013, doi: 10.1016/j.sbspro.2013.10.709.

[9] Mai.E, Dina.T, and Zeyad. El, "Collaborative pedagogy in architectural design studio: A case study in applying collaborative design," Alexandria Eng. J., vol. 58, no.1, pp.163–170, 2019, doi: 10.1016/j.aej.2018.03.005.

[10] Laila. Kh and Asharf. N, "Changing skills for architecture students employability: Analysis of job market versus architecture education in Egypt," Ain Shams Eng. J., vol. 11, no. 3, pp. 811–821, 2020, doi: 10.1016/j.asej.2019.11.006.

[11] Fathi.B, "Reflections on architectural design education: The return of rationalism in the studio," Front. Archit. Res.,vol.3,no.4,pp.424–430,2014, doi: 10.1016/j.foar.2014.08.004.

[12] Thomas. F, "Circular causality and indeterminism in machines for design," Front. Archit. Res., vol. 3, no. 4, pp. 368–375, 2014, doi: 10.1016/j.foar.2014.06.003.

[13] Dana.B,"UC Santa Barbara UC Santa Barbara Electronic Theses and Dissertations," Front. Archit. Res vol. 4, no. 5 p. 118, 2022.

[14] Mahmoud..D, Ahmed,.S, and Bahaa.E, "An effective architectural criticism teaching framework link and enhance design skills," vol. 54, no. 04, pp. 2096–3246, 2022, doi: 10.6084/m9.figshare.22032188.

[15] Malek..J and Ashraf. A, "A Decade of Research on the Effectiveness of Augmented Reality on Students with Special Disability in Higher Education," Contemp. Educ. Technol.,vol.14,no.1,pp. 1–16, 2022, doi: 10.30935/cedtech/11369.

[16] Emilio.S, Mariana..Z, Antonio.R, and María.C, "Sustainability of educational technologies: An approach to augmented reality research," Sustain., vol. 12, no. 10, 2020, doi: 10.3390/su12104091.

[17] Cecilia.G, Jorge.A, Kinshuk, Joan.D, and Juan.B, "Augmented Reality in Education: An Overview of Twenty-Five Years of Research," Contemp. Educ.

Technol.,vol.13,no.3,pp.302, 2021, doi: 10.30935/cedtech/10865.
[18] Nicol.W, "Online communication design education: the importance of the social environment," Stud. High. Educ., vol. 0, no. 0, pp. 1–11, 2019, doi: 10.1080/03075079.2019.1605501.
[19] Peter.L, "Embedded creativity: Teaching design thinking via distance education," Int. J. Technol. Des. Educ., vol. 23, no. 3, pp. 749–765, 2013, doi: 10.1007/s10798-012-9214-8.
[20] Kenneth.T, "Effects of school design on student outcomes," J. Educ. Adm., vol. 47, no. 3, pp. 381–399, 2009, doi: 10.1108/09578230910955809.
[21] Manar. A, Khalid. Al, and Asmaa. H, "Overview on the criticism process in architecture pedagogy," Alexandria Eng. J., vol. 59, no. 2, pp. 753–762, 2020, doi: 10.1016/j.aej.2020.01.019.
[22] Babalola. O and Carlos. K, "Technical drawing course, video games, gender, and type of school on spatial ability," J. Educ. Res., vol. 112, no. 5, pp. 575–589, 2019, doi: 10.1080/00220671.2019.1592092.
[23] Fehmi. D, "Architectural design students' explorations through conceptual diagrams," Des. J., vol. 16, no. 1, pp. 103–124, 2013, doi: 10.2752/175630613X13328375149002.
[24] Anthony.W, and Michael. O, "Assessing Creativity in the Context of Architectural Design Education," Proc. Des. Res. Soc., vol.13,no.3 pp. 1–9, 2010.
[25] Sandra.Y, "A Case Study of Teachers of Elementary Gifted Students and Their Perceptions of Best Practices for Teaching Visual Spatial Activities in the Classroom," vol.5, no.1 2021. [Online].
[26] Mohamed.E, Essam.O, Saleh.B, Ahmed. A, 'Analytical Examination of Dynamic Elements in Modern Architectural Facades for Advanced Structural Aesthetics', Frontiers in Built Environment, VOL.10,NO.PP.121,2024,doi.org/10.3389/fbuil.2024.1302380.
[27] Shannon.Ch, John. M, and Gavin. D, "Using architecture design studio pedagogies to enhance engineering education," Int. J. Eng. Educ., vol. 32, no. 1, pp. 364–383, 2016, doi: 10.21427/D7V62S.
[28] Ledewitz.S, "Studio of Design Teaching in," J. Archit. Educ., vol. 38, no. 2, pp. 2–8, 1985, doi: 10.2307/1424811.
[29] Helena.W, "Architectural Education after Schön: Cracks, Blurs, Boundaries and Beyond," J. Educ. Built Environ., vol. 3, no. 2, pp. 63–74, 2008, doi: 10.11120/jebe.2008.03020063.
[30] NIGEL. C, and KEES. D, "Design Expertise Amongst Student Designers," J. Art Des. Educ., vol. 13, no. 1, pp. 39–56, 1994, doi: 10.1111/j.1476-8070.1994.tb00356.x.
[31] Russell. R and Tam. N, "Supporting more inclusive learning with social networking: A case study of blended socialised design education," J. Learn. Des., vol. 6, no. 3, pp. 29–44, 2013, doi: 10.5204/jld.v6i3.127.
[32] Mohamed. E and Ahmed. Al , "Develop Acoustic and Fire-Resistant Ceilings by Investigating Structure of Insulated Ceilings on Parametric Optimization," Civ. Eng. Archit., vol. 12, no. 1, pp. 459–477, 2024, doi: 10.13189/cea.2024.120134.
[33] Alessia. M, "The acoustic designer: Joining soundscape and architectural acoustics in architectural design education," Build. Acoust., vol. 27, no. 2, pp. 83–112, 2020, doi: 10.1177/1351010X19893593.
[34] Anh.T, Steve.K, Anthony.W, and William.S, Collaborative building design education using Building Information Modelling (CodeBIM),PP10-174. 2013. https://ltr.edu.au/resources/PP10_1745_Mills_Report_2013.pdf
[35] Richard. T, "Southern drift: The learning styles of first-and third-year students of the built environment," Archit. Sci. Rev., vol. 50,no.3,pp.246–255, 2007, doi: 10.3763/asre.2007.5030.
[36] Ivana .J, Dragoljub. K, and Uroš. B, "Razumijevanje informacija grafički različito oblikovanih legendi u procesu učenja," Teh. Vjesn., vol. 23, no. 5, pp. 1395–1403, 2016, doi: 10.17559/TV-20150310102017.
[37] Yuval. K and Avinoam.M, "PRODUCTION OF SPACE THROUGH ACTION AND BODY," no. Iconarch Iv.PP.883-902 .2020,Retrievedfromhttps://iconarch.ktun.edu.tr/index.php/iconarch/article/view/297