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Integrating Environmental Control and Architectural Design: A Coordinated Teaching Framework that uses multiple Strategies to enhance student skills

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Abstract- This paper aims to formulate a teaching framework for environmental control to develop students' skills. It emphasizes the importance of multiple strategies in architectural education and proposes a coordinated approach between three courses': environmental control, Islamic architecture history, and architectural design.

It reviews pedagogical approaches in architectural education to design a framework for environmental control. That framework achieves the course outcomes for the higher education ministry syllabus and goes in line with both Egyptian and American quality standards.

The framework involves several activities, including lectures that introduce the theoretical background, construction of physical models, teamwork presentations, use of simulation software, usage of laboratory equipment, and visits to distinctive buildings. The framework was implemented on second-year architecture students in two different Egyptian schools: the Architecture Department at Nile Higher Institute, Mansoura, and the Architecture Department at Higher Technological Institute, 10th of Ramadan City.

The framework evaluation implementation was carried out in several ways: direct assessment through the analysis of student learning outcomes assessment scores, and indirect assessment through a student questionnaire. Closed-ended answers were analyzed quantitatively, and open-ended answers were analyzed qualitatively. Feedback was taken from instructors. The results were discussed twice. Once the department council meeting, the second was with a board consisting of industry representatives, students, and alumni. The results were used to adjust the new framework. The findings provide insights for educators. It suggests that the framework could be adapted in other education settings, and further research could investigate the long-term impact on students' professional practice.

Keywords- Environmental control, Architectural learning, teaching framework, Design Education

I. INTRODUCTION

The integration of environmental control principles into architectural design is crucial for promoting sustainable design practices in the built environment [1]. As such, architectural education has a significant role to play in preparing future architects to consider the environmental impact of their designs [2]. Importance of integrating environmental control with other disciplines, such as building physics, construction, and materials science [3][4]. The integration of building physics concepts into an architectural design studio was found to enhance student's

ability to apply sustainable design principles to their design projects [5].

Effective coordination among architecture course instructors enhances the learning experience by aligning teaching objectives, sharing knowledge, and ensuring a comprehensive curriculum [6]. Historical Islamic architecture is distinguished by its unique environmental control tools, which enable natural ventilation, sunlight control, and temperature regulation [7][8]. Architecture schools worldwide need to examine Islamic architectural design principles, as they offer valuable insights into various environmentally conscious control mechanisms [9]. Therefore, the architectural design, and Islamic architecture theories courses were selected to coordinate with environmental control courses in teaching objectives alignment.

Architectural design learners have diverse learning styles: learning by experience, learning by reflecting, learning by thinking and, learning by doing. Educators must recognize and accommodate these varied styles to create an inclusive and effective learning environment. It is also important to combine different learning strategies that match different learners' styles because it found that using them together achieves better results [10].

To achieve these objectives, pedagogical approaches that incorporate environmental control teaching strategies into architectural design education have been explored in previous research [11]. Incorporating a variety of teaching strategies into education courses promotes eagerness, enjoyment, and a more rewarding learning experience [12]. For instance, Studies have shown that simulation software is an effective tool for teaching environmental control principles in architectural design [13][14]. simulation software could be used to design more effective solutions with lower costs and reduce mistakes. Additionally, it can be employed in education to give students hands-on experience with realistic problems [15]. the use of simulation software was found to enhance students' understanding of the impact of design decisions on energy consumption and indoor environmental quality [16]. It also was found to be effective in promoting students' engagement and active learning [17].

Another presumed strategy is the construction of handicraft 3D models, it can enhance students' understanding of environmental control principles. hands-on activities like constructing models can improve students' learning

outcomes and retention of knowledge. It enhances creativity and problem-solving skills [18]. This approach provides a tactile, hands-on experience that allows students to visualize and manipulate building elements, such as shading devices, ventilation systems, and acoustics, in a three-dimensional space [19].

Using environmental laboratory equipment is a crucial strategy for architecture students to gain a deeper understanding of the environmental factors that influence building design. Through laboratory experiments and simulations, students can comprehend complex environmental concepts and apply this knowledge to their design projects [14]. Measuring and analyzing parameters such as temperature, airflow, and natural light using equipment like thermometers, anemometers, and light meters can inform design decisions. Moreover, experiments and simulations provide a safe and controlled environment to test different design strategies and evaluate their performance [20].

Educational trips to distinctive buildings the favorable strategy have a positive impact on students' design skills. Exposure to innovative buildings expand architectural vocabulary and challenge preconceptions about design, helping to develop a critical perspective. Moreover, experiencing a building firsthand allows to understand how design principles are implemented, which inform their future design decisions [21][22].

Presentation skills are vital for architecture students to succeed in future careers. presentation skills enable architects to communicate their ideas to others. They help in gaining credibility and trust which is essential for successful project outcomes. By emphasizing presentation skills in architecture education, educators can prepare students to communicate their design ideas effectively [23]. So, it will be the fifth used educational strategy.

Despite the growing body of research on pedagogical approaches to teach environmental control in architectural design education, few studies have investigated the integration of environmental control with Islamic architecture theories, which are highly relevant to architecture education in Egypt and other Islamic countries. As such, this paper seeks to address this gap in the literature by proposing a teaching framework that integrates environmental control with Islamic architecture theories and architectural design, and uses multiple pedagogical strategies.

II. METHODOLOGY

To meet the research goal, the following steps have been taken as outlined in Figure 1. Initially, an integrated course framework was created based on the literature, comprising of multiple stages, and containing various activities. A co-ordination between the three courses instructors was performed to identify common themes and learning objectives across the courses, and work together to create a cohesive curriculum. In the end of the semester an assessment was performed to the effectiveness of the environmental control course framework. The evaluation employed various methods, including analyzing student CLOs assessment scores, and administering a student questionnaire. The questionnaire's closed-ended responses were assessed quantitatively, while open-ended responses underwent qualitative analysis. The co-relation between the results were analyzed. Assessment outcomes were deliberated in two open discussions: one among department staff and another with a board comprising industry representatives, students, and recent graduates. These discussions informed adjustments to the updated teaching framework.

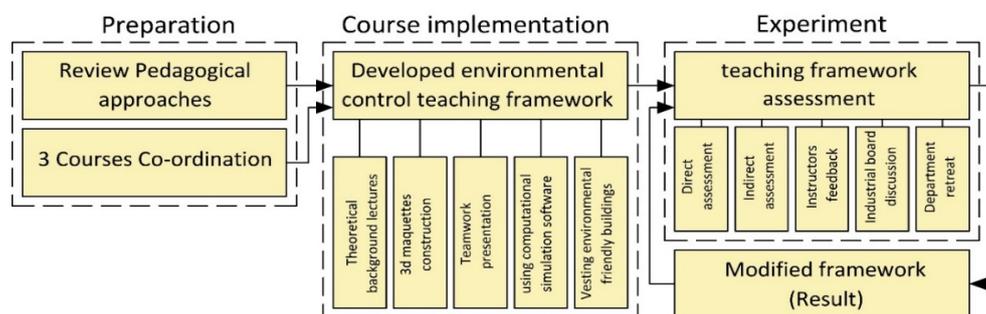


Figure 1: Research methodology steps

III. COURSE IMPLEMENTATION

The study was carried out at two different Egyptian architecture schools. The study included Forty-nine second-level students from the Architecture department of the Nile Higher Institute of Engineering and Technology in Mansoura,

To begin with, a comprehensive course framework was developed, drawing from relevant literature and consisting of multiple stages with diverse activities that match students

as well as Fifty-five second-level students from the Architecture department in Higher technological Institute, 10th of Ramadan city. It was performed during the spring semester at 2022-2023 academic year.

with different learning styles and achieve different learning outcomes as shown in Table 1.

Table I. course framework

	Week1,2	Week 3-5	Week 6	Week 7	Week 8	Week 9-11	Week 12
Course Activities	Course Brief lectures	Syllabus core lectures	Site tour in Fatimid Cairo	Midterm Exam	Students Report Presentation	Equipment's preparation	Report presentation discussion
	Climate consultant software tutorial	Practical applications				3D maquettes modeling	Experiment Enhancement
student written reports correction		Laboratory Physical measurements					
Expected outcomes	Understand course entails	Gain theoretical knowledge	traditional techniques. climatic design. observational skills.	Evaluate knowledge. guide improvement.	Communication skills. demonstrate understanding. team work. critical thinking.	Spatial visualization. model-make proficient. problem solving.	Communication skills. conclusion critical thinking.
	Software interface familiarity	Software proficient				Hands-on experience. scientific rigor. measurements design relevance	Experiment Hands-on experience.

The course learning outcomes were formulated to cover the syllabus set out by the Egyptian ministry of higher education and scientific research [24]. The course outcomes cover the competencies 2,4,5,7,8,10 for engineering graduates that was set by the National authority for quality assurance and accreditation of education [25]. It also covers the student outcomes 1,2,4,5,6 that was set by the Accreditation board for engineering and technology [26].

Then the environmental control course instructor has arranged a co-ordination meeting in the Nile Institute between the architectural design, and Islamic architecture theories courses instructors. A similar co-ordination meeting couldn't be performed in the 10th of Ramadan Institute. It was an opportunity for collaboration and curriculum development. They discussed the ways to integrate the three courses to maximize the benefit of each course. And it was agreed among them on the following: the environmental control instructor will use samples from the studied buildings in the Islamic architecture theories course to explain various environmental control techniques such as Wikalat Al-Ghuri [27], Al-Suhaimy house [28], Qalawun complex [29], Zuweila gate [30], and Zainab Khatoon house [31]. It will be visited in site trip, and the application activities will be on their architecture vocabulary. The design course instructor shall assign the students a school project that will be designed in Islamic architecture different styles. A fixed set of environmental control items will be used in all students designs. And it will be simulated in the environmental control course labs. Environmental and climatic studies for the project location will be developed in the environmental control tutorials.

The instructor held 12 environmental control lectures, each lasting 90 minutes, followed by a 90-minute tutorial. Course topics were as following: an introduction to the world's climatic regions, Egypt's position among them, and the classification of climatic regions within Egypt. Students learn about the hot dry climate, its challenges, and thermal comfort concepts, as well as how to determine and achieve comfort in such a climate. The psychrometric chart was studied to understand temperature, humidity, and thermal comfort relationships, enabling them to make

informed decisions for designing comfortable buildings. Climate elements were investigated like solar radiation, wind patterns, and precipitation, and how they impact architectural design, building form, orientation, and materials. Architectural treatments and design strategies were intentional for thermal comfort in hot arid regions, focusing on passive cooling techniques, shading devices, and natural ventilation to improve building performance.

The Climate Consultant software was introduced, enabling students to identify climatic characteristics for project locations and apply design strategies to achieve year-round thermal comfort in buildings. Climate Consultant is a user-friendly, graphic-based software developed by the US Department of energy it helps professionals analyze a location's climate using weather data, providing insights on temperature, humidity, solar radiation, and wind patterns [32]. From this point, students began to learn about the climatic elements that influence architectural design. They have explored architectural solutions, and design strategies used to achieve thermal comfort in hot arid regions, and link this understanding to the design strategies offered by the Climate Consultant software.

In this context, students visited Al-Muizz Street in the Fatimid Cairo to familiarize themselves with some traditional heritage applications of these strategies. The instructor explained How air moves due to pressure from shaded areas to sunny areas. Also, how wind catchers work in capturing cold winds and directing them inside the building. The effect of domes in mosques on drawing hot air out of the building, and how thick walls of buildings act as thermal insulation. The role of mashrabiya in ventilation and providing balanced lighting without causing glare to the eye. Figure 2 a showing a shot from the site trip.

During the field trip, students eagerly explored historical buildings, gaining insights into traditional environmental control techniques and design strategies. This hands-on experience helped them better understand the practical applications of their classroom learning. Students actively engaged in discussions about the various architectural elements, and their roles in maintaining

thermal comfort and providing natural ventilation and lighting. They were able to connect the historical context and the contemporary sustainable design practices. During the tour, students learned how past architects tackled climate challenges and achieved thermal comfort using local materials and passive design strategies. This inspired

them to integrate these traditional techniques into their own designs specially in their current design course project.

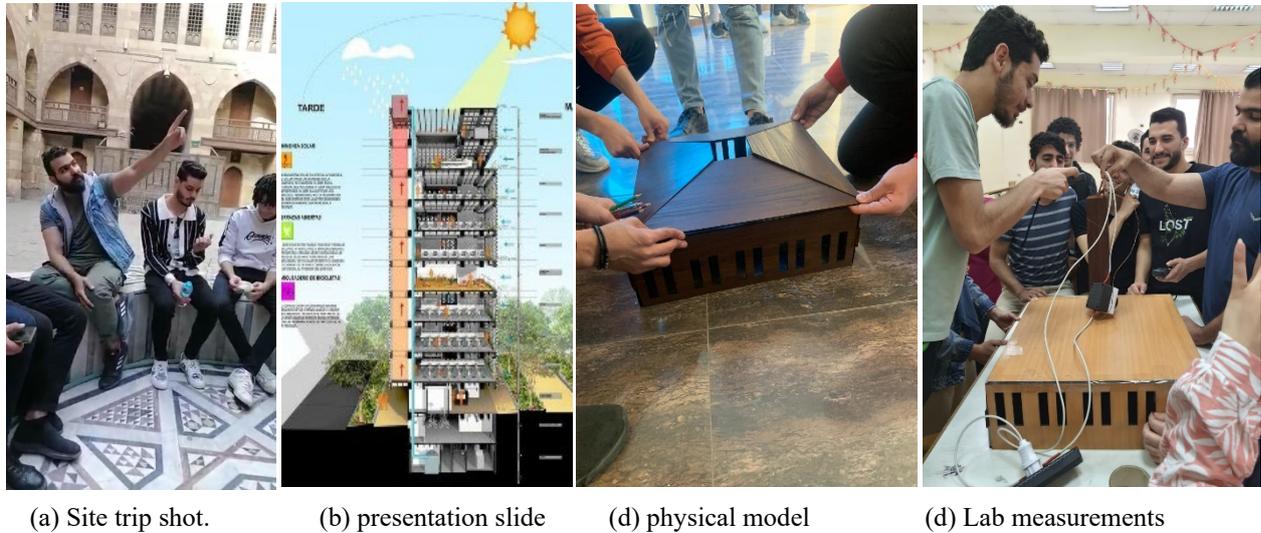


Figure 2. different learning activities.

The students were tasked with reports on various architectural climate treatments, focusing on building design application. The Nile Institute class was divided into six groups, and the 10th of Ramadan Institute class was divided to six groups. All the groups varied between 4-6 students. The reports were submitted in stages, allowing students to progressively develop them. With the guidance of assistant teachers, students were able to delve deeper into various climate-responsive design strategies. This assignment encouraged critical thinking and effective communication skills as students researched, discussed, and presented their findings. During the month of Ramadan, students presented their reports online using a conference meeting app. This approach allowed them to work more efficiently during the fasting month while still ensuring that they received valuable feedback from their instructor. Throughout the presentations and ensuing discussions, students demonstrated a deep understanding of environmental control principles, showcasing the effectiveness of the course in instilling critical knowledge and fostering a meaningful learning experience. Figure 2 b Showing a slide from students' presentations.

They implemented climate treatments in their designs to achieve thermal comfort inside and to generate operational energy. This was done by linking the topic to architectural design, in which students were given a project of a school with an attached mosque in the design course. Students were given the freedom to suggest environmental design techniques they found appropriate for the school building itself.

Afterward, they chose a modern application strategy, the solar chimney, to study in the laboratory and attempted to utilize it as a ventilation and heating technique. Each group were assigned to create a physical model of the mosque within their design project. As shown in Figure 2 c. The air circulation in the 1/50 scale model of the mosque was analyzed by heating air inside the solar chimney and placing ice cubes near the northern facade. This created a pressure difference, causing a cold air current to enter the model's northern openings and exit through the lower opening of the solar chimney, pushing hot air upwards. The airspeed at the upper opening of the solar chimney was measured by a digital anemometer [33] As shown in Figure 2 d for each model to determine the most efficient design based on the highest measured airspeed.

IV. COURSE EVALUATION

A. Direct assessment

A direct assessment was performed to calculate the students' performance in the different assigned tasks the table 2 shows the distribution of assessments grades. The direct assessment results are encouraging, with the majority of Course Learning Outcomes (CLOs) showing satisfactory achievements. CLOs 6, 2, 1, 3, 4, and 6 received high average grades indicating exceptional performance in assignments, midterm, and final exams, showcasing their competence in applying environmental control principles practically. However, some areas for improvement were identified in the assessment. CLOs 5,

and 7 obtained slightly lower average, but they still exceeding the target. Overall, the course's average grade of 83.32% indicates that most students performed well and

achieved the intended learning outcomes as shown in Table 3.

Table 2: Distribution of assessment grades.

	Clos	SOs	Project	Assignment	Presenta tion	Midterm Exam	Final Exam	Total
Course Learning Outcomes	1	6	5	3	-	-	-	8
	2	5	-	-	3	-	-	3
	3	2	5	3	-	10	Q4=15	43
	4	4	-	2	-	5	Q1= 5, Q2= 5	17
	5	4	-	2	-	5	Q3= 10	17
	6	5	-	-	2	-	-	2
	7	1	5	-	-	-	Q5= 15	10
Total			15	10	5	20	50	100

Table 3: actual achieved Distribution of assessment grades

	Clos	SOs	Project	Assignments	resentation	Midterm Exam	Final Exam	Total	Full Grade	Percentag e
Course Learning Outcomes	1	6	4.18	2.93	-	-	-	7.11	8.00	89%
	2	5	-	-	2.93	-	-	2.93	3.00	98%
	3	2	4.75	2.93	-	8.61	11.48	27.77	33.00	84%
	4	4	-	1.98	-	4.32	7.59	13.89	17.00	82%
	5	4	-	-	-	5.86	7.55	13.41	17.00	79%
	6	5	-	-	1.98	-	-	1.98	2.00	99%
	7	1	4.75	-	-	-	11.48	16.23	20.00	81%
Total			13.68	7.84	4.91	18.80	38.09	83.32	100.00	

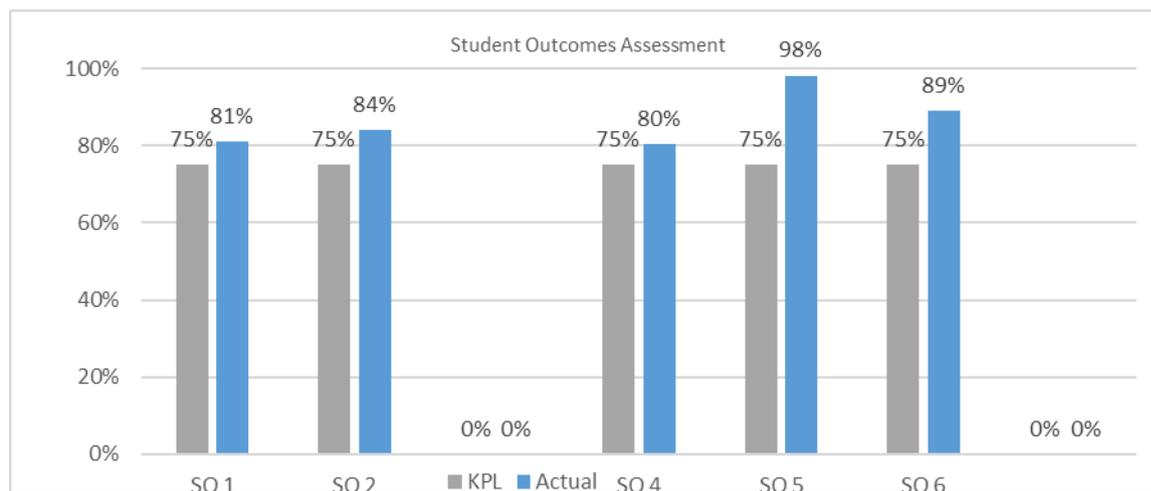


Figure 3: Student Outcomes assessment.

B. The course Survey

Students were invited to voluntarily complete a survey questionnaire, which was designed to encompass the various stages of the course. To encourage candid feedback, no name field was included on the questionnaire to ensure the transparency. The primary goal of this survey was to evaluate student satisfaction with each step of the course procedures, determine how they benefited from each stage, and gather feedback for course improvement.

The questionnaire consisted of both closed-ended and open-ended questions. Responses from the closed-ended questions were collected and subjected to numerical analysis, while open-ended questions were analyzed qualitatively. This approach aimed to provide a comprehensive understanding of the students' perspectives and help refine the course for future iterations. The questionnaire consists of 27 questions and can be categorized into several topics.

The course overall satisfaction feedback

The total number of the sample was 68, varied in the educational institute 27(40%) are the students of Nile Higher Institute, and 41(60%) are the students of Higher technological Institute. As shown in figure 6 based on the results of the questionnaire, it is evident that the majority expressed high satisfaction with this year's environmental control course. The ratings on the satisfaction scale ranged from 4 to 5, with 73.5% of respondents giving the highest rating of 5. This indicates a very positive experience and suggests that the course effectively met the participants' expectations and learning objectives. Moreover, when evaluating the effectiveness of achieving the course goals, 75% of respondents rated it with a score of 5, demonstrating a strong belief that the course successfully achieved its goals. Additionally, the assessment methods

used in evaluating understanding of the material were considered fair and appropriate by the majority of respondents (82.4%), while a small percentage (2.9%) had a moderate level of satisfaction. In terms of suggestions for deletions or additions to the assessment methods, the majority of respondents (83%) did not suggest any changes, indicating overall satisfaction. Regarding the comments provided by the lecturer and assistant staff, a significant majority of respondents (72.1%) found them highly helpful in developing their understanding of the course. Lastly, the in-class discussions of the research were deemed highly beneficial by the majority of respondents (73.5%), further enhancing their understanding of environmental control concepts. These results indicate the success of the course in meeting the needs and expectations of the participants.

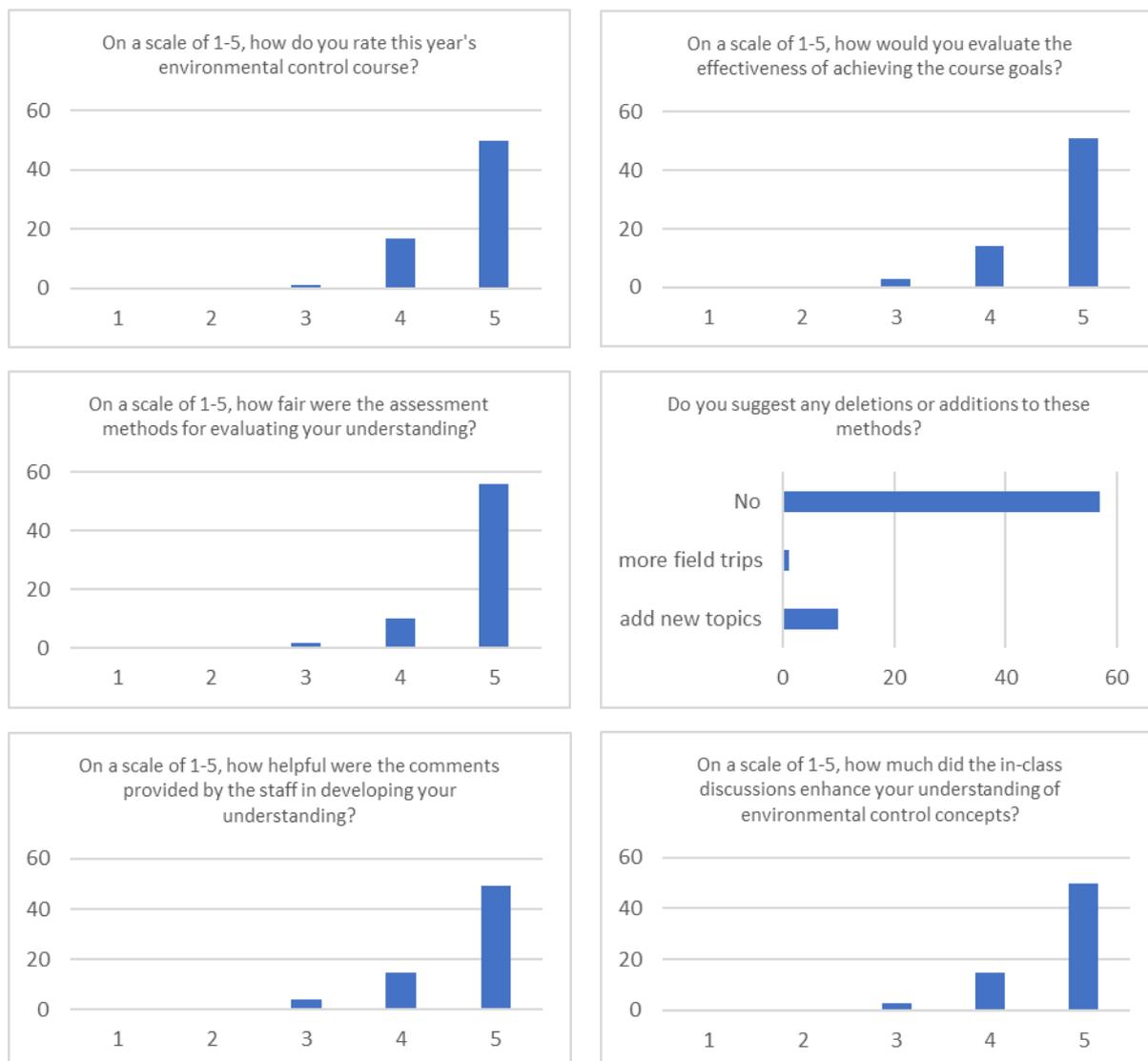


Figure 6: the course overall satisfaction

Discussions most valuable gains

The open-ended question "Mention the most valuable thing you gained from those discussions," yielded insightful responses key themes about the benefits of discussions: The discussions allowed participants to share different perspectives and exchange knowledge, underlining the value of collaborative learning and dialogue with peers and instructors. Respondents appreciated the discussions of practical application of concepts, such as the solar chimney experiment and the mosque project. Discussions were lauded for encouraging creativity, different aspects of research and design consideration, and deeper understanding of environmental control concepts. Respondents valued the opportunity to express their opinions, engage in substantive discussions, and work cooperatively with peers, essential skills for professional growth.

The teamwork feedback

The results overwhelmingly affirm the benefit of group work in enhancing learning outcomes as shown in figure 7, with 73.5% of respondents giving it the highest score and 19.1% rating it just below. Only a small minority (7.4%) provided a neutral rating, and no one rated it low. This data suggests that collaborative activities like group research or model making are highly beneficial to students. The lack of low ratings signifies a general consensus on the value of group work, pointing to its importance in teaching methods. However, the small percentage of neutral responses suggests there may be room for improving the structure or implementation of group tasks.

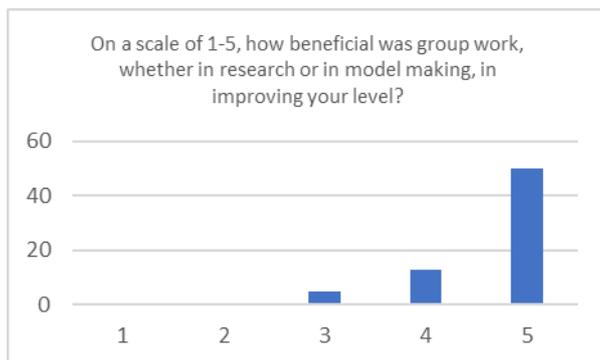


Figure 7: the group work satisfaction

Teamwork most valuable gains

The responses to the question regarding the benefits of teamwork highlight several key themes. Cooperation was seen as valuable, with respondents emphasizing the satisfaction and effectiveness of working together towards common goals. The exchange of information and ideas was also highly regarded, allowing for learning from different perspectives and expanding understanding. Teamwork was seen as contributing to professional

development, improving skills, work management, and practical application of course content. The division of tasks based on individual skills was noted as beneficial, as was the improvement of communication skills and the social aspect of making friends and feeling closer to classmates. Some respondents mentioned the sense of unity and collective spirit that emerged from teamwork, despite being in different teams. However, a few respondents expressed no benefit from it or preferred working alone, highlighting individual differences in learning preferences. Overall, the responses underscore the various advantages of teamwork, but also acknowledge that it may not suit everyone's learning style.

The field trip feedback

As shown in figure 8: The data indicates that the field trip was very effective in demonstrating real-world applications of environmental control principles. A clear majority 82.4%, rated its effectiveness as a 5, the highest score on the scale. Another 14.7% rated it as a 4, suggesting they also found the field trip quite effective. Only a very small percentage, 2.9%, gave a neutral rating of 3, and no respondents rated the effectiveness as low (1 or 2). These results demonstrate that field trips are highly valued for their ability to bridge theory and practice, bringing concepts learned in the classroom to life in a real-world context.

The field trip also scored highly in terms of its effectiveness for benefiting from the applications of environmental control in architectural design projects. A substantial majority, 76.5%, gave the highest rating of 5, and 19.1% gave a rating of 4. Only a few respondents gave neutral (2.9%) or low (1.5%) ratings. This result reinforces the relevance of field trips in providing practical insights and inspiration that can be directly applied to architectural design.

Similarly, the field trip was seen as highly beneficial for the subject of History and Theories of Islamic Architecture. A significant majority of respondents, 80.9%, gave it the highest rating, while 11.8% rated it as a 4. However, a slightly higher proportion gave neutral (5.9%) or low (1.5%) ratings compared to the other questions. This might suggest that while most students found the field trip beneficial for this subject, there may be room for enhancing its relevance or the way in which it is integrated with the subject's content. Despite this, the overall high scores suggest that the field trip effectively supplemented learning in this area.

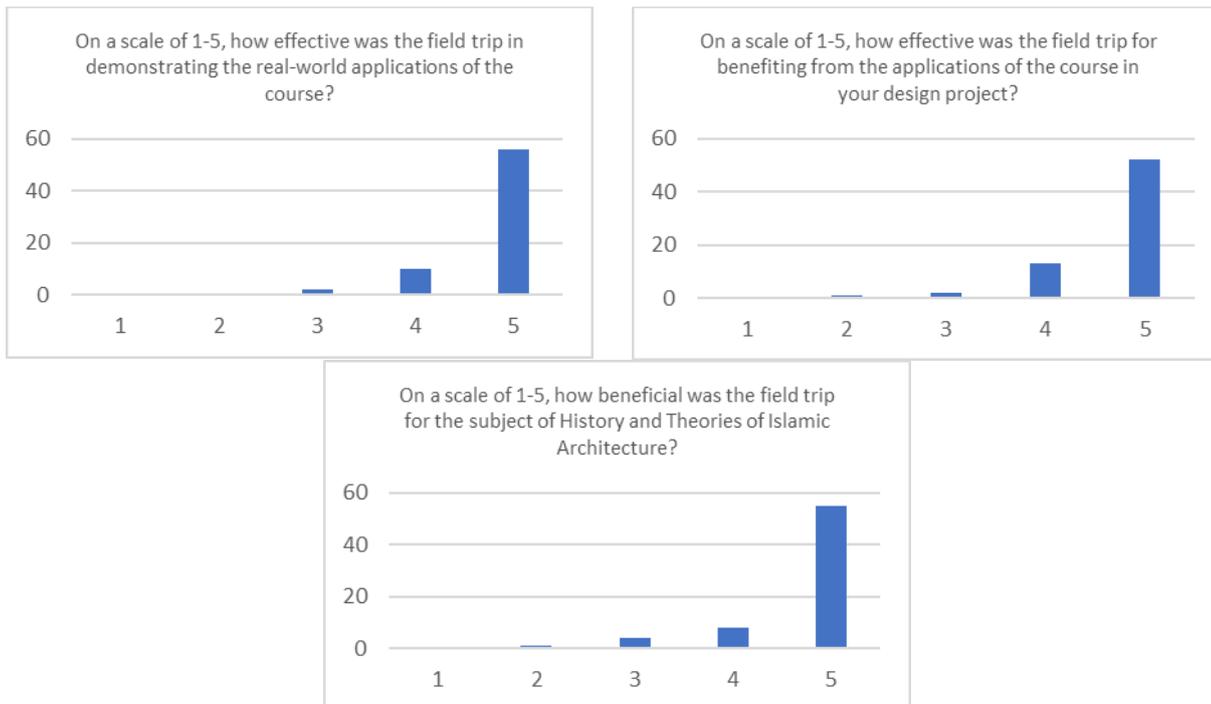


Figure 8: the Field trip satisfaction

Field trip most valuable gains

Upon analysis of the answers to the open-ended question, "Mention the most beneficial thing you gained from the field trip," a few key themes become apparent: Many respondents mentioned that the field trip allowed them to see the theories and concepts they learned in lectures in practice. Examples include witnessing environmental treatments in operation, observing the style and construction of Islamic architecture, and understanding the interplay of air movement and pressure differences. This practical understanding seems to have significantly enhanced their grasp of the course content, linking theory with reality. A large proportion of the respondents appreciated the depth of knowledge gained, especially in relation to Islamic architecture and its elements. Notably, specific mentions of Al-Suhaimi House suggest that this site were particularly educational. Respondents also valued gaining insights into the history and cultural significance of ancient Islamic eras. Respondents found value in understanding the design methods and treatments used in Islamic architecture, which they could apply to their own design projects. A few respondents mentioned personal benefits, such as forming friendships, visual nourishment, and even enjoying local cuisine. Interestingly, there were also responses that didn't align with the general themes, they were unable to attend. These outlier responses remind us that not every participant may have had the opportunity to benefit from the field trip.

The laboratory usage feedback

The results of the questionnaire question regarding the effectiveness of lab equipment usage activities in

understanding environmental control principles show that a significant majority of respondents (72.1%) rated their experience as a 5, indicating a high level of effectiveness. With 14.7% rating it as 4, this suggests that the lab activities were largely successful in facilitating understanding of the subject matter. However, a non-negligible proportion (13.2%) of respondents rated their experience as 3 or below, indicating some level of dissatisfaction or room for improvement.

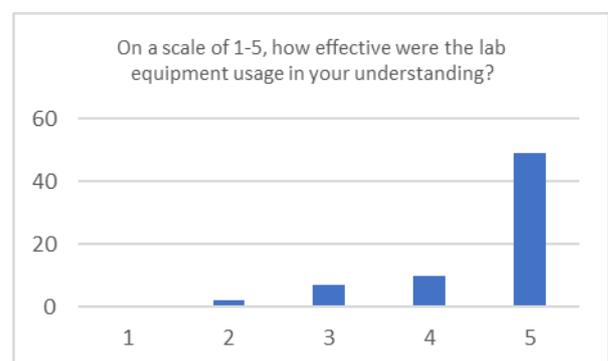


Figure 9: the lab equipment satisfaction

Laboratory most valuable gains

Upon analysis of the answers to the open-ended question, "Mention the most beneficial thing you gained from using the laboratory for physical measurements" a few key themes become apparent: Many students highlighted the value of applying theoretical knowledge in a practical setting. This allowed to see their studies in a tangible way, whether through investigating the results of experiments or seeing the practical operation of concepts

they'd studied. A significant portion of the responses revolve around the use of various measuring devices. This includes gaining familiarity with these devices, understanding their use, and applying them in practical scenarios. Some students mentioned that they were unaware of the existence of certain devices before the lab experience. Several students appreciated the ability to produce accurate and truthful outputs from their experiments. This indicates an enhanced understanding of the data collection process, analysis, and interpretation, which are vital skills in scientific research. Some responses indicate that the students found value in overcoming mistakes during practical work. This suggests that the lab experience facilitated learning through problem-solving and error analysis, which are important aspects of the scientific process.

Computer program's role in environmental designs

The use of computer programs in visualizing and analyzing environmental control designs has received a very positive response from the respondents as shown in figure 10. A significant majority of the students (66.2%) gave the highest rating, indicating that they found the computer programs extremely useful for visualizing and analyzing designs. An additional 25% of respondents provided a rating of 4 out of 5, underscoring the general satisfaction with the use of these digital tools in the course. However, it is important to acknowledge that a small proportion of the respondents, totaling 8.8%, gave ratings of 2 or 3. This suggests that there might be a need for further support or training for a small subset of students to fully utilize and benefit from the computer programs. Despite this, the overall feedback is highly positive, demonstrating the role of digital tools in enhancing the understanding of environmental control concepts in design.

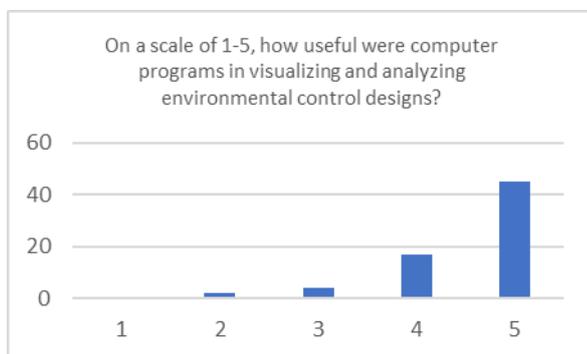


Figure 10: Computer apps satisfaction

Impactful Learning Activities feedback

When analyzing the responses to the open-ended question " which activities had the most impact on your understanding of the subject? And why?", there are several themes that recur throughout the responses. Here is a

categorization of these responses, with an analysis and comments:

Field Visits: The majority of respondents mentioned field visits as being impactful. they felt that seeing the concepts applied in real-life situations enhanced their understanding and appreciation more than theoretical examples. For instance, it allowed them to observe the historical ventilation openings and their action.

Practical Experiments: Several respondents highlighted the practical experiments and hands-on activities. Specific mention was made to a mosque maquette project and solar chimney experiment. Respondents stated these activities allowed them to observe variations in environmental conditions and understand the impact of design elements, thereby providing a deeper understanding.

Group Work: Some respondents pointed out that working in a group and cooperating with their peers had a significant impact on their understanding. This enabled them to exchange ideas and benefit from each other's. Group work was seen as effective when applied to projects, such as the architectural model experiments.

Teaching and Lectures: A few respondents mentioned the teaching and explanation provided by the instructors, and how this contributed to their understanding. They found the lectures to be simple and clear, helping them to grasp the basic fundamentals.

All Activities: A handful of respondents felt that all activities were important and beneficial. They expressed that they all were complementary to each other.

In sum, these methods allowed them to directly apply the theoretical knowledge they gained and witness the real-world impacts of different environmental designs. The combination of these activities, along with clear lectures, seems to have a comprehensive learning experience.

Contents Alignment with Duration Feedback

Looking at the results in figure 11, it appears that a majority of the students (69.1%) felt that the content of the course was well-aligned with the duration of the semester, giving it the highest rating of 5. This suggests that most students believed the course material was adequately. An additional 19.1% gave a rating of 4, further demonstrating satisfaction with the course duration. However, it's important to acknowledge that a small portion (11.8%) felt less satisfactory, with 1 student giving the lowest rating of 1 and 7 students rating it a 3. This indicates that there may be room for improvement in distributing the contents, although overall, the course seems to be well-structured in terms of content duration for the majority.

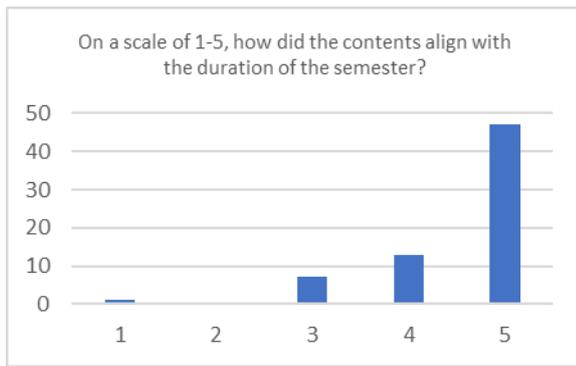


Figure 11: contents alignment with duration

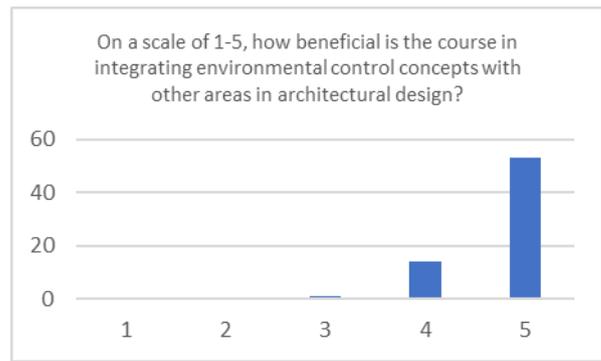


Figure 12: Integrating environmental control concepts with architectural design

Enhancements for Course Content and Structure

for the open-ended question “Do you suggest adding or removing specific topics from the course?” The majority did not suggest any changes to the course content. However, a number of students provided feedback on potential areas of enhancement. A common theme amongst these suggestions is more practical applications on modern solutions in environmental design. For instance, adding content on parametric design solutions, while others called for green architecture topics. The expansion of scientific material to match continuous developments was also recommended. Moreover, some students expressed a desire to delve deeper into specific topics such as solar breakers, solar panels, and green roofs. In terms of course structure, one student suggested that the course might be more beneficial if it is taught in the first semester. They also suggest a high level of engagement with the course, with one student noting that they were learning without getting bored or tired, finding the online sessions less stressful and more conducive.

Course effect on architectural design feedback

Integration of environmental control concepts with architectural design is overwhelmingly positive as shown in figure 12. A significant majority (77.9%) rated the course's benefits at the highest level. Additionally, 20.6% rated this aspect of the course as a 4 out of 5, reinforcing the view that the course has been successful in this area. It's noteworthy that very few students (only 1.5%) gave a neutral rating, and none of the respondents felt the course was ineffective or very ineffective in this respect. These results suggest that the approach to integrating environmental control principles with broader architectural design is well-received, and the curriculum designers have created a strong relevant link.

Difficult topics

The responses to the open-ended question regarding challenging topics in course indicate that the majority of respondents did not find any specific difficulties. However, a small number of individuals expressed difficulties in implementing environmentally-friendly designs on buildings. This highlights the need for further support in bridging the gap between theory and practice, specifically in translating sustainable design principles into practical applications. Instructors can consider providing additional practical exercises to help students navigate these challenges.

Improvement suggestions

The respondents' suggestions for improving the Environmental Control course in the coming year revolve around enhancing practical applications, interactive learning, and real-world experiences. They recommend incorporating more diverse activities, increasing the focus on the practical aspect during project review, and conducting additional practical experiments. Other suggestions include incorporating simulation programs, organizing field trips, utilizing teaching assistants, and adhering to a specific schedule. Students also emphasize the importance of modern devices, practical demonstrations, and examples for better understanding. The feedback overall highlights a desire for a comprehensive and immersive learning experience that bridges the gap between theory and practice.

Course effect on critical thinking

Based on the respondents' answers to the question about whether the course helped them in critically thinking about environmental control issues and finding solutions for design materials, it is clear that the majority of participants responded with a resounding "yes." This indicates that the course successfully facilitated critical thinking and problem-solving skills in relation to environmental control and design materials. Respondents mentioned specific aspects such as considering the type of outdoor space, understanding airflow, and shaping building mass to create

air currents. Some participants even expressed a complete change in perspective towards environmental architecture and a newfound appreciation for its importance. Overall, the responses highlight the course's effectiveness in fostering critical thinking abilities and enabling students to analyze environmental control issues and develop solutions within the context of design materials.

Course effect on understanding experimental methodology

The responses to the open-ended question regarding whether the course helped participants understand the experimental methodology of scientific research were unanimously positive, with all respondents answering "yes." This indicates that the course effectively provided the necessary knowledge and understanding of experimental methodologies in scientific research.

C. Instructors feedback

The researcher interviewed each of the co-ordination courses' instructors in order to get their feedback about the environmental control course. The architectural design instructor feedback: The course has had a positive impact on students' performance in the design project. It has improved their understanding of sustainability and environmental considerations, leading to the incorporation of environmentally-friendly design strategies in their projects. Students demonstrate a deeper understanding of the relationship between the built environment and its surroundings, considering factors like climate and site conditions in their designs.

The Islamic architecture instructor feedback: the students became more familiar with the historical Islamic buildings. They can recall the names of the buildings they visited during the field trip as they demonstrated a deeper understanding of traditional environmental control techniques in the buildings they have visited. The course has enhanced their critical thinking abilities and enabled them to adapt traditional Islamic design principles to modern environmental requirements.

The Environmental control instructor feedback: The students have shown a solid understanding of the concepts and principles, and have successfully applied them in practical situations. The students' collaborative spirit, critical thinking skills, and eagerness to explore new areas. Despite the positive response of Mansoura students to the field trip in Cairo, they appeared to be less focused and more fatigued compared to the students from Tenth of Ramadan. Therefore, it may be more appropriate in the future to organize a field trip to local examples in Mansoura, which could be more beneficial. Furthermore, the practical experience was specifically conducted to study the solar chimney technique, which is not commonly found in Egypt except in Aswan. It may be more suitable in the future to study wind catchers in the historic areas of Cairo, as it is more relevant to the students' surroundings. The 10th of Ramadan students seemed to be less satisfied

than the Nile students. They are used visit the historical places in Cairo, and they hadn't the chance to have a multiple course co-ordination like the Nile students.

D. The industrial board feedback

The industrial board commends the course framework and the students' performance in the course. They appreciate the level of knowledge and practical skills demonstrated by the students. The board suggests incorporating more industry-related case studies, practical projects, and guest speakers to bridge the gap between theory and industry application.

V. CONCLUSION

This study highlights the importance of developing a teaching framework by integrating multiple teaching strategies and coordinating efforts among instructors, the study aimed to enhance students' skills and their ability to apply environmental control principles in their projects. The implemented framework, which included various activities proved to be successful in improving students' knowledge and skills. The framework promoted engagement, active learning, and received high levels of satisfaction from the students. The evaluation of the framework, conducted through direct assessment and a student questionnaire, provided valuable insights. The feedback from instructors and the industrial board further contributed to the refinement of the teaching framework, ensuring its alignment with the requirements of the local and American quality assurance standards. The findings of this study have implications for architecture educators, as the developed framework can be adapted and implemented in other education settings. Further research could explore the long-term impact of this teaching approach on students' learning outcomes and their professional practice.

Overall, this study emphasizes the significance of incorporating diverse teaching strategies, practical experiences, and collaboration among instructors to enhance the environmental control course in architectural education. By doing so, students are equipped with the necessary skills and knowledge to excel in their future careers as architects.

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