



Developing students' sustainability consciousness: the role of attitude and practice toward incorporating new uses of old buildings into architectural education

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Accepted: 23 May 2024

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Abstract

Higher education institutions play a crucial role in achieving environmental sustainability. According to UI GreenMetric, higher education institutions should, more than ever, implement sustainable development across all subject areas. In this context, the research's main problem is how architectural education can raise students' sustainability consciousness more effectively. This paper aims to increase awareness of how incorporating the content of new uses of old buildings into architectural education can significantly influence students' sustainability consciousness. In addition, this study seeks to determine sustainability consciousness and behaviors differ according to the lessons they take. Reviewing the literature and survey were defined as appropriate for this study. In the questionnaires, it was tried to determine the approach of the students to the concept of sustainability, the effect of the curriculum on this situation, the extent to which sustainable education was integrated into the project courses, and how it was perceived. Descriptive and inferential statistics analyzed the collected data through the Statistical Package for the Social Sciences (SPSS) software. This study will help us better understand the mechanisms behind the development of sustainability behavior by revealing which variables are influential in students' sustainability behaviors. Despite the rich variety, students' sustainability consciousness has rarely been investigated within the scope of attitude and practice toward incorporating adaptive reuse of old buildings into architectural education. This paper is among the few works exploring students' sustainability consciousness using approaches of architectural education.

Keywords Sustainability · Sustainable development · Sustainable education · Refunctioning · Adaptive reuse

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Introduction

The Brundtland Commission at the United Nations (UN) General Assembly 1987 made the most widely used definition of sustainability. In this report, which is included in the literature as the UN Brundtland Report, sustainability is defined as meeting the needs of the present without making it difficult for future generations to meet their own needs (United & Nations, 1987). The construction industry's significant impact on resource consumption and environmental pollution necessitates a paradigm shift towards sustainable environment (Kibert, 2016; Cole, 2005). Sustainability in the building sector covers issues such as the effective use of non-renewable resources, the selection of energy-efficient building materials, designs considering human health and comfort, ensuring cultural continuity, and increasing the life span of the existing building stock (Venetoulis, 2001; Kurnaz, 2021).

Integrating the principles of Quality Education (SDG 4) and Sustainable Cities and Communities (SDG 11) from the United Nations Sustainable Development Goals, there is a distinct linkage between preserving cultural heritage and fostering development strategies, which aligns with sustainable urban planning (United Nations, 2015). Increasing the interaction with the city and the user by reusing the cultural heritage elements and making it sustainable serve this goal (Landorf, 2011). Again, the 9th paragraph of the 8th Goal, which is decent work and economic growth, mentions the production and implementation of policies promoting local culture and products that create job opportunities and sustainable tourism until 2030 (United Nations, 2015). Here, it is aimed to protect and sustain the local culture and to consider a development model by using the products of the local culture. This approach contributes to sustainable economic growth by promoting local culture and creating job opportunities (Licciardi & Amirtahmasebi, 2012; Nocca, 2017). Education, especially university education, is critical to sustainability and sustainable development. Universities are strategically positioned to influence future generations by integrating sustainability into their curricula, thereby fostering a sustainable society (Wright, 2010). Through education, people learn to be more responsible toward nature and the environment (Yuan et al., 2013).

The old buildings, which are stratified by accumulating experiences and play an important role in their contribution to the city development, exactly match the task they undertake in transferring social and cultural data from the past to the future, and the expression of transferring existing resources to the future, which is adopted in the definition of social sustainability (Ahunbay, 2010). The adaptive reuse of cultural heritage, by enhancing interaction with urban contexts and users, serves to sustain cultural continuity while addressing environmental sustainability and to preserve the characteristics of the historical region (Bullen & Love, 2011). The life cycle and sustainability of cities can be measured by the success of existing buildings in adapting to new functions (Kincaid, 2002).

Higher education institutions have significant potential to enable future generations to create a sustainable society (Wright, 2010). Universities can shape their curricula for students with sustainability goals to create a sustainable society (Dagiliute & Liobikiene, 2015; Tuncer, 2008). Although sustainable education methods and approaches have been developing since the last quarter of the 21st century, the practices of this education still need to be adequately studied and developed. This emphasizes the role higher education institutions have in promoting environmental sustainability across various disciplines (Lozano et al., 2013). UI GreenMetric, which allows a comparison of the sustainability of universities,

aims to contribute to innovations and developments in the fields of sustainability and sustainable development in education (Dagiliute et al., 2018). According to UI GreenMetric, higher education institutions should, more than ever, implement sustainable development across all subject areas (Lambrechts & Van Liedekerke, 2014; Marrone et al., 2018). Architectural education, in particular, is crucial in raising students' awareness of sustainability issues (Salama & Wilkinson, 2007; Altomonte et al., 2014). By integrating sustainability into architectural curricula, specifically through project courses focused on the adaptive reuse of old buildings, students can develop a deeper understanding of sustainable design practices (Bodach et al., 2014). In this context, the research's main problem is how architectural education can raise students' sustainability consciousness more effectively.

Preserving and refunctioning the historical structure is a fundamental paradigm for promoting the sustainability of the environment (Kurnaz & Aniktar, 2023b). This paper aims to increase awareness of how incorporating the content of new uses of old buildings into architectural education can significantly influence students' sustainability consciousness (Vallero & Brasier, 2008). In addition, this study seeks to determine whether the views and attitudes of the students regarding sustainability behaviors differ according to the courses they take and to reveal the factors that affect sustainability consciousness (Lozano et al., 2015). This paper aims to investigate undergraduate architecture and interior architecture students' consciousness of sustainable design as a function of their attendance at specific project course experiences with the theme of adaptive reuse. This study also aims to increase the share of sustainability and sustainable development topics in the architecture curriculum and to improve undergraduate education on this subject.

Literature review

Architecture education

The formal education for architecture, initiated in the 19th century, marked the genesis of a pedagogical paradigm centered around design studios, a legacy of the Beaux-Arts educational approach, which laid the groundwork for contemporary architectural education (Mallgrave, 2010). The studio method, characterized by hands-on, immersive learning environments—termed ateliers during this era—became seminal in shaping the educational landscape of architecture, a tradition that persists in modern pedagogical strategies (Saint, 1983; Forty, 2000). The Bauhaus, under Walter Gropius's stewardship, further revolutionized this model by integrating craft with fine arts, thereby fostering a holistic design education that amalgamated form, function, and materials, leaving a durable imprint on design pedagogy worldwide (Frampton, 1992). Many methods developed in these foundational periods, such as using sketches, teaching design by experts, and evaluating student work by a jury, are still used in today's design studios and project courses.

Design education today has developed with the use of various protocols, such as the Bologna Process of the European Union and the guidelines of the International Union of Architects (European Commission, 2010; Gokarlan & Tuncer, 2023). Despite these innovations, the quintessence of architectural education—particularly the studio as both a physical and pedagogical space—remains anchored in its historical precedents (Schön, 2017; Webster, 2004). Architecture education has a mixed structure focusing on design, planning-

orientated thinking, and studio courses. The studio is used as a physical space and a pedagogical method. To produce different and alternative design ideas in schools, lessons in studios are taught through discussion and consultation (Kwok, 2001; Frank & Silver, 2017).

Project courses, central to this educational structure, emphasize design, planning, and collaborative learning, fostering an environment where students can cultivate creativity and synthesize knowledge across disciplines (Lawson, 2006; Kuhn, 2001). These courses, designed to simulate professional architectural practice, aim to equip students with the skills necessary to address complex, real-world challenges (Groat & Wang, 2013). This approach is not merely about design in isolation but encompasses a broader educational objective that includes sustainability, cultural and historical preservation, and innovation in response to global and local challenges (Guy & Farmer, 2001).

The integration of sustainable development into architectural curriculum reflects a pedagogical shift towards environmental stewardship and social responsibility, a response to the increasing urgencies posed by climate change and globalization (Guy & Moore, 2004). Education in this domain is not only about imparting knowledge of energy conservation and ecological principles but also about fostering an ethos of preservation and adaptive reuse of the built heritage (Jokilehto, 2017). This contemporary educational trajectory is imbued with the complexities of conserving historical and cultural values while simultaneously fostering innovation and adaptability in architectural design (Stubbs, 2009).

In addition to conservation and survey-restoration courses, both theoretical and applied in architectural education, construction in historical environments and efforts to give new functions to existing structures are also addressed in studio courses throughout the educational period to pursue solutions to thematic problems (Cody & Fong, 2007). The fundamental questions that arise in relation to conservation and creating new uses of old buildings education are how do we impart the necessary skills and knowledge to students and what is that content?

Adaptive reuse

In the face of changing living conditions and new functional needs, structures may be unable to respond to these needs. Although these structures cannot be used functionally, they continue to exist physically because they do not expire their structural life. Adaptive reuse under today's needs ensures the historical, cultural, ecological, and economic sustainability of historical buildings, which are part of the public memory (Douglas, 2006). Maintaining and reusing an existing building is more sustainable than completely renovating or constructing a new one. It has been agreed that the sustainability of the building is only possible by using it, and therefore there is no other way out other than re-functioning. (ICOMOS, 1964).

With the option of adaptive reuse of the buildings, sustainability can be achieved by avoiding many factors that may harm the environment, by saving materials, as well as by maintaining the historical texture and not breaking away from the cultural memory (Aydin & Okuyucu, 2009). At the same time, adaptive reuse is an ecological method because the construction activity is less than the construction of a new building, the use of resources and materials is minimized, less waste material is left behind, and environmental destruction is minimized. Preserving buildings without demolition provides sustainability in energy conservation while contributing to sustainability in terms of cultural heritage protection

and continuity. Re-functionalized buildings can maintain their status of being important and valuable with the information they carry, the social and cultural value of the period they were built, and architectural and historical features (Kurnaz & Aniktar, 2023a).

Kohler (1999) has listed the criteria for sustainable design under three main headings as environmental, economic, and socio-cultural. Re-functioning works provide environmental and economic sustainability regarding resource consumption and waste generation, using the existing one instead of demolishing and rebuilding. In addition, it provides social sustainability by reflecting the architectural identity and cultural values of the past life and creating a bridge between the past and the future.

The adaptive reuse of a building that continues to survive structurally despite its aging is remarkable in terms of sustainability as it prolongs the life of the building (Langston, 2011). Considering the damage that each new building will cause to the natural environment, it is a correct approach in terms of ecological sustainability to reuse the existing building stock with appropriate functions, in an accurate and planned manner, instead of demolishing existing buildings and constructing new ones. In this way, the energy consumption of the building sector can be reduced in an environmentally friendly way (Owojori et al., 2021).

Project courses experiences with the theme of adaptive reuse

The rapid depletion of resources and the damage caused by the construction industry to the environment have placed sustainability on the academy's agenda. In order to create sustainable cities and environments without consuming the resources of future generations, the concepts of sustainability and sustainable development have taken their place among the priority goals of the whole world (Sev, 2009). Buildings that have lost their old function over time and are planned to be demolished but still physically standing are one of the most critical problems in conflict with the concept of sustainability.

Considering the damage that each new building will cause to the natural environment, it is a correct approach in terms of ecological sustainability to reuse the existing building stock with appropriate functions, in an accurate and planned way, instead of demolishing the existing structures and constructing new ones. In this way, the energy consumption of the building sector can be reduced in an environmentally friendly way. Considering the energy consumed during the demolition process, the waste materials generated, the damage to the environment, the new materials to be used for the construction of the new construction, and the cost of energy to be consumed, the importance of the concept of sustainability in the university education and project course process for the reuse of these structures becomes more apparent. Ensuring sustainability depends on the buildings allowing for transformation and adaptive reuse (Croxtton, 2003).

Universities need to catch up with time, and their education should be sustainable against changes (Alshuwaikhat & Abubakar, 2008). In this way, they can stay up to date in a sustainable and constant change, allowing for continuous change and transformation. Thanks to their practice of being able to change and transform, they can constantly catch up with time.

Academic studies show that significantly higher education students are open to researching and learning the principles of sustainability and sustainable development from various perspectives (Mohammadalizadehkorde & Weaver, 2018; Nejati & Nejati, 2013). Different teaching methods can provide students with detailed information and experience about sustainability. These methods can be integrated into the curriculum of the depart-

ments. Especially the architecture and interior design departments are more responsible in this regard. Adaptive reuse is one of the critical issues in sustainable development. In architectural education, project courses sensitive to the historical environment are of great importance in the context of architecture students and the protection, survival, and adaptive reuse of cultural heritage.

Methodology

Research questions

Researchers argue that more research is needed on the role of attitude and practice toward incorporating new uses of old buildings into architectural education to develop students' sustainability consciousness. The present study aims to close this gap by addressing the following research questions:

- RQ1: To what extent does selecting a theme on the refunctioning of buildings in the project courses enhance students' interest and awareness of environmental, economic, and social sustainability?
- RQ2: Do adaptive reuse courses positively affect sustainability learning outcomes?
- RQ3: What are the opinions of students who take adaptive reuse-themed project courses and those who do not about enhancing the teaching of sustainability and sustainable development?

To answer these questions, the authors use an interdisciplinary approach to study how students define sustainability and sustainable development from the perspectives of studying in different departments and classes.

Research approach

Students studying in higher education take many courses throughout their education life. Do these students have sufficient knowledge about sustainability during their university education? In this context, the authors reviewed and summarized the literature on adaptive reuse and sustainability in higher education, and the main concepts and sub-concepts that constitute the subject of this study were discussed. The research method consists of a survey and statistical analysis to understand students' sustainable awareness and knowledge. Students from Istanbul Sabahattin Zaim University answered multiple-choice questions related to a demographic part, a 'before the course' part, and an 'after the course' part. Some of the students followed an "adaptive reuse project," and some of the students did not.

Students from Istanbul Sabahattin Zaim University must take the design project course according to their academic schedule but can choose the theme. With adaptive reuse design project courses, students investigate the main aspects of sustainable reuse—environmental, societal, inhabitation, and economic—while exploring heritage, history, memory, community, and the influence these factors have on remodeling activities. Students also examine specific examples of theories of reuse and explore strategies for conserving and adapting the existing environment.

A total of 248 students participated in the survey, which was held in January 2023. The answers given by 12 students were not included in the survey evaluation because they were left unfinished for some reason. For this reason, the answers given by 236 students were used within the scope of the study at Istanbul Sabahattin Zaim University. Students were selected from second, third, and fourth-year architecture and interior architecture students. First-year students were not included in the survey, as they were thought not to have sufficient knowledge about architecture and interior architecture education and sustainability.

In the questionnaires, it was tried to determine the approach of the students to the concept of sustainability, the effect of the curriculum on this situation, the extent to which sustainable education was integrated into the project courses, and how it was perceived.

A mixed qualitative and quantitative evaluation model was established. Descriptive and inferential statistics analyzed the collected data through the Statistical Package for the Social Sciences (SPSS) software. The conclusions drawn from these results were detailed in tables, and the study's questions were tested.

Data collection

Within the scope of this study, which aims to collect data through a questionnaire, questions were asked to 100 students from the Department of Architecture and 136 students from the Department of Interior Architecture at Istanbul Sabahattin University.

The survey study examined and interpreted demographic characteristics, gender, university department, grades, and information about whether they took project courses on refunctioning. A mixed qualitative and quantitative evaluation model will be established. SPSS software was used to evaluate and analyze the survey samples. After testing the reliability of the survey, mean, standard deviation, frequency, and percentage were calculated to examine new uses of old buildings in architectural education on the students' sustainability consciousness and to explain the relationships between the dependent and independent variables.

This study consisted of 236 undergraduate students, comprising 149 female students, 95 male students, and 12 students unwilling to specify their gender enrolled in the architecture project or interior architecture project courses in the Istanbul Sabahattin Zaim University during the academic year 2022 and 2023–74 were second years, 80 were third years, and 82 were fourth years students, representing a range of academic disciplines (Table 1).

In this study, a bivariate statistical technique was used. It is typical of data mining. Its purpose is to segment and divide a set of elements into groups whose elements' characteristics are very similar to each other, with strong internal cohesion, but are dissimilar within groups. This method aims to find patterns that provide a qualitative and quantitative understanding of the data (MacQueen, 1967).

Findings from the field work

This study aims to determine the consciousness of sustainable design at specific project course experiences with the theme of adaptive reuse of the students' training in architecture and interior architecture. In the first part of the questionnaire, demographic and educational

Demographic Variables	Frequency	Percentage (%)
Gender		
Female	129	55%
Male	95	40%
Nonbinary or other	12	5%
Education		
Architecture 2nd year	31	13%
Architecture 3rd year	35	15%
Architecture 4th year	34	14%
Interior Architecture 2nd year	43	18%
Interior Architecture 3rd year	45	19%
Interior Architecture 4th year	48	20%
Course		
Students who take project courses experiences with the theme of adaptive reuse	124	53%
Students who do not take project courses experiences with the theme of adaptive reuse	112	47%

N = 236

Table 1 Demographic data: respondent's profile

data of the students were collected. In order to make a clear comparison, a survey was applied to a similar number of students who took courses with the theme of adaptive reuse from architecture and interior architecture students and those who did not (Table 1).

The statistical data shown below are based on the questions in Section 2 and Section 3 of the survey process, as described above, through which we intend to investigate the degree of environmental knowledge (awareness) and to understand how experiences through adaptive reuse projects foster. The data yielded from the questionnaires were evaluated by different methods, including the average of all participant responses. Descriptive and inferential statistics analyzed the collected data through SPSS. The conclusions drawn from these results are detailed below.

Over half of the students answered the internet (57%) to the multiple-choice question; where did you get your previous knowledge about sustainability and sustainable development before studying at the university? In addition, 31% of the students stated that they learned from books, 28% from television, and 25% from their families. On the other hand, 21% also indicated that they obtained their previous knowledge of sustainability and sustainable development from their friends. Compared to other students, 20 students (8%) reported that they had no previous knowledge about sustainability and sustainable development before studying at the university (Table 2).

The multiple-choice question explored which subjects are taught as part of sustainability and sustainable development at the university. More than half of the students answered this question as energy saving (53%). Also, 48% of the students answered this question about climate change, 41% water use, and 33% using recycled and recyclable materials. Only 24% of the students answered adaptive reuse of buildings, and only 30% answered cultural heritage the same question (Table 2).

	Frequency	Percentage
Q1: Where have you obtained your previous knowledge about sustainability and sustainable development before studying at University?		
Family	59	25%
Books	72	31%
TV	66	28%
Internet	134	57%
Newspapers and Magazines	47	20%
Movies/cinema	38	16%
Adverts	17	7%
Friends	50	21%
Previous schools	25	11%
Local/city government initiatives/events	8	3%
Other	5	2%
No previous knowledge	20	8%
Q2: Which subjects are taught as part of sustainability and sustainable development at university?		
Alternative futures	58	25%
Responses to climate change	113	48%
Cultural and historical diversity	68	29%
Ecosystems and ecological principles	67	28%
Waste management	70	30%
Water use	97	41%
Energy saving	126	53%
Sustainable development goals	25	11%
Resources management	44	19%
Cultural heritage	71	30%
Rural and urban development	41	17%
Adaptive reuse of buildings	57	24%
Using recycled and recyclable materials	79	33%

N = 236

Table 2 Investigation for the degree of environmental knowledge (awareness)

	Mean	Std. Deviation
Q3: To what extent did choosing a theme on adaptive reuse of buildings in the project course change your attitude towards sustainable design?		
cultivated my initiative to pay attention to sustainability.	5,0377	0,954
helped me better understand the role of adaptive reuse in society.	4,8944	0,841
made me interested in adaptive reuse.	6,1282	1,024
taught me skills and know-how to carry out adaptive reuse.	5,7634	0,876
developed my perspective on the concepts of identity, context, and memory, which are inputs to social sustainability.	4,6014	0,795

N = 124

Table 3 Understanding how experiences through adaptive reuse projects foster

Table 3 presents the accumulated mean score and standard deviation for each item in question 3 of the questionnaire. In this section, detailed information was obtained from the students about how selecting the theme of refunctionalization of buildings in project courses enhances students' interest and awareness sustainability issues (RQ1). This question

was asked to 124 students who took project course experiences with the theme of adaptive reuse. The research instruments were developed using a 7-point Likert scale. Table 3 tabulates the mean score for the students' experiences through adaptive reuse projects foster. If we examine the table in terms of experience, we see that most respondents indicated that adaptive reuse education at university made them interested in adaptive reuse ($M=6,13$; $SD=1,02$) and taught them skills and know-how to carry out it ($M=5,76$; $SD=0,88$). Also, they answered that adaptive reuse education at my university cultivated their initiative to pay attention to sustainability ($M=5,04$; $SD=0,95$).

In the survey study, the fourth and fifth questions aimed to compare the sustainability awareness among the students who took the project course and those who did not take place (Table 4). With these questions, detailed information was obtained from students about how adaptive reuse courses affect sustainability learning outcomes (RQ2). The research instruments were developed using a 7-point Likert scale. Regarding the question about how important sustainability is, the students who took the project course stated that it was essential ($M=6,21$). However, the students who did not take the project course reported that it was less critical ($M=4,78$). Regarding the research question about how important it is to include sustainability learning in the project classroom, the students who took the project course with the theme of adaptive reuse before answered that it is very important ($M=6,04$). In contrast, the students who did not take the project course with the theme of adaptive reuse answered that it is not very important ($M=3,41$).

With this analysis, the different perspectives of the students who took and did not take project courses with the theme of adaptive reuse about what kind of teaching methods should be used to teach sustainability at the university were examined. In this section, answers were sought for RQ3. Students who took the project course on adaptive reuse stated that conservation and preservation of the environment is the most important method for teaching sustainability and sustainable development. In addition, they stated that giving preference for sustainability issues and constructing energy-efficient buildings are important teaching methods. In order to further improve the teaching of sustainability and sustainable development in project courses, the students answered that the teaching adaptive reuse theme in more project courses teaching method should be used (Table 5).

Students who did not take the project course on adaptive reuse stated that constructing energy-efficient buildings is the most important method for teaching sustainability and sustainable development. In addition, they stated that giving preference for sustainability issues and reducing, reusing, and recycling waste are important teaching methods. In order to further improve the teaching of sustainability and sustainable development in project courses, the students answered that more field visits in more project courses teaching method should be used (Table 5).

	Students who take	Students who do not
	project courses	take project courses
	Mean	Mean
Q4: How important do you think sustainability is?	6,21	4,78
Q5: How important is it to include sustainability learning in the project	6,04	3,41

Table 4 Comparison on sustainability consciousness between students who take project courses and those who did not

	Students who take project courses	Students who do not take project courses
What types of teaching should be used to teach sustainability and sustainable development at the university?		
Conservation and preservation of environment	<u>6,12</u>	4,29
Constructing energy efficient buildings	4,25	<u>5,01</u>
Constructing buildings from sustainable materials	3,84	4,14
Reducing, reusing and recycling of waste	4,06	4,54
Greening/landscaping	3,37	3,48
Undertaking energy conservation measures	3,71	3,73
Use of renewable energy resources	3,72	3,67
Support for sustainable practices	3,50	3,48
Giving preference for sustainability issues	4,43	4,66
What types of teaching should be used to further enhance the teaching of sustainability and sustainable development in project courses?		
Teaching adaptive reuse theme in more project courses	<u>6,23</u>	3,96
More field visits	3,87	<u>5,04</u>
Teaching similar approaches/examples and project work more	4,47	4,37
Using more ecological and natural science examples	2,52	3,17
More teaching by experts	2,91	3,46

Note: Underlined values display the highest values of each component.

Table 5 Sustainable criteria for teaching

Discussion

According to the results obtained from the surveys analysis, most students stated that sustainability and sustainable development should be a part of the curriculum in departments such as architecture. There has been an intense statement that sustainability principles can contribute to architectural education. This viewpoint is strongly supported by Altomonte's (2009) findings, which emphasize the increasing demand for the integration of sustainability in architectural education. Altomonte (2009) highlights the necessity for architectural curricula to evolve, ensuring that sustainable environmental design is not only included but is a fundamental component of the education system. Most students surveyed reported that they knew little about sustainability and sustainable development before their tertiary education and that their university course experience contributed significantly to their sustainability knowledge. This study showed that although the students' perception of sustainability and sustainable development before education was mostly internet-oriented, they learned many sustainability sub-titles and criteria with their university education. This is further supported by findings from Leal Filho et al. (2019) and Wright and Wilton (2012), who argue that exposure to sustainability topics significantly enhances students' understanding and commitment to sustainable practices. This situation points out how important the attitude and practice towards education in the university is to improve the students' sustainability and sustainable development awareness.

Most students reported that their project course experiences with the adaptive reuse theme contributed significantly to their sustainability and sustainable development knowledge. The content of the course increased students' adaptive reuse education at university, interested them in adaptive reuse, and taught them skills and know-how to carry out it. Most of the students surveyed reported that the project courses with the theme of refunctioning had a significant impact on them and aroused greater understanding and awareness. With this result, an answer was found to the question of to what extent the selection of the theme

of refunctionalization of buildings in the project courses investigated with RQ1 increases students' interest and awareness in sustainability issues.

The results of the study's RQ2, "do adaptive reuse courses positively affect sustainability learning outcomes?" showed that they positively affect sustainability learning outcomes through surveys and research. This aligns with the findings of Holden et al. (2008), who analyzed the effectiveness of integrating practical sustainability themes into educational curricula. Their study underlines the importance of experiential learning in sustainability education, suggesting that such approaches significantly enhance students' practical skills and deepen their commitment to sustainable practices.

With RQ3, the suggestions and opinions of the students who did and did not take adaptive reuse-themed project courses on the development of teaching sustainability and sustainable development were investigated. This research question also draws attention to the deficiencies of sustainable course contents and practices in architectural education. To address these gaps, this study, in line with König (2013), recommends a curriculum that is more inclusive of interdisciplinary approaches, which can enhance the effectiveness of sustainability education by linking theoretical knowledge with practical applications.

In architectural education, students' consciousness and knowledge about sustainability and sustainable development can be increased by training on new building design in the historic environment. In the architecture and interior architecture departments, the courses aiming to reuse buildings that have lost their function rather than demolishing them allow students to design sustainable solutions regarding environmental, social, and economic aspects. This study helps us better understand the mechanisms behind the development of sustainability behavior by revealing which variables are influential in students' sustainability behaviors. Understanding these mechanisms is crucial for educators aiming to improve sustainability outcomes in architectural education, as noted by Moore (2005). It also contributes to the research to raise environmental sustainability awareness.

Conclusion

The fact that construction activities consume a large part of the raw materials and energy in the world has increased the responsibility of architects and planners. It has made sustainability and sustainable development issues a vital topic in the design agenda (Suwartha & Sari, 2013). A sustainable future will be possible with the inclusion of renewable energy, recyclable materials, a design approach that is sensitive to human health and the environment, and sustainable practices such as adaptive reuse in the curriculum of the architecture departments. When the curricula of higher education institutions are examined, architecture is directly related to sustainability.

This study determines the pedagogical importance of sustainability in the departments' curricula. It reveals how these curricula affect the awareness and approach of architecture students to sustainability. Moreover, the study is concerned with examining architecture education and its content and investigating project courses as the central pedagogical environment of design education.

Evaluating the effects of project courses with the theme of adaptive reuse on students' awareness of sustainability by measuring their knowledge of sustainability before and after the course is still an area that needs to be adequately researched in the literature. It is very

important to organize the curricula and contents to develop an awareness of architecture students who will serve the building industry in the future on sustainability and sustainable development. The study suggests that creating an architecture curriculum more effectively is necessary for students to learn and practice adaptive reuse, which is essential for sustainable living. This way, it presents data proving that students' sustainability awareness can be improved.

The theoretical and practical experience gained from project courses included in the curriculum played an effective role in the development of students' perspectives on sustainability. However, when the answers given to questions by the students who had taken project courses were examined, it was observed that awareness of sustainability and creating new uses of old buildings education should be encouraged from more basic educational levels. Sustainability and creating new uses of old buildings awareness will only develop with the understanding of responsibility and those educational institutions and instructors have essential roles in this context. It is thought that establishing interdisciplinary working groups at the higher education level and incorporating this awareness into students' educational processes are very important (Srivastava, 2015; Karaoglu et al., 2012).

The ongoing refinement of educational practices and curricula to include more robust and comprehensive sustainability training is vital for ensuring that the next generation of architects is well-equipped to meet the challenges of sustainable development (Zuo & Zhao, 2014). As every discipline should, architecture education should renew itself over time and become better able to meet the needs of the age. The methods applied in design education should be reviewed, and experiments should be carried out in project courses with different approaches to obtain pedagogically helpful results.

This article provides data that allows for a better understanding of the role of higher education in promoting sustainable living and less energy-consuming practices. More research needs to be done to convey the importance of sustainability to all students, and university curricula should be revised according to the principles of sustainable development.

Limitations

Despite the rich variety, students' sustainability consciousness has rarely been investigated within the scope of attitude and practice toward incorporating adaptive reuse of old buildings into architectural education. This paper is among the few works exploring students' sustainability consciousness using approaches of architectural education. This study will help fill the gap in the literature in terms of the way it is handled.

However, the present research has limitations. This study faced several limitations. Future research may take the study sample more extensively. Thus, researchers can observe the differences of the sample groups in more detail. Besides, the findings of this study are considered limited because it focuses on students from more than one university. Future studies should include more than one university. Despite the increasing academic research on sustainability and sustainable development, there still needs to be a significant gap in research in the education system to improve students' awareness of sustainability.

Declarations

Conflict of interest No potential conflict of interest was reported by the author(s).

References

- Ahunbay, Z. (2010). *Tarihi çevre Koruma restorasyon (historic environment conservation restoration)*. YEM Publishing.
- Alshuwaikhat, H. M., & Abubakar, I. (2008). An integrated approach to achieving campus sustainability: Assessment of the current campus environmental management practices. *Journal of Cleaner Production*, 16(16), 1777–1785. <https://doi.org/10.1016/j.jclepro.2023.05.008>
- Altomonte, S. (2009). Environmental education for sustainable architecture. *Review of European Studies*, 1(2).
- Altomonte, S., Rutherford, P., & Wilson, R. (2014). Mapping the way forward: Education for sustainability in architecture and urban design. *Corporate Social Responsibility and Environmental Management*, 21(3), 143–154.
- Aydin, D., & Okuyucu, E. S. (2009). Assessing the Afyonkarahisar Millet Hamam in the context of reuse adaptation and sociocultural sustainability. *Megaron Dergisi*, 4(1), 35–44.
- Bodach, S., Lang, W., & Hamhaber, J. (2014). Climate responsive building design strategies of vernacular architecture in Nepal. *Energy and Buildings*, 81, 227–242.
- Bullen, P. A., & Love, P. E. (2011). Adaptive reuse of heritage buildings. *Structural Survey*, 29(5), 411–421. <https://doi.org/10.1108/02630801111182439>
- Cody, J., & Fong, K. (2007). Built heritage conservation education. *Built Environment*, 33(3), 265–274.
- Cole, R. J. (2005). Building environmental assessment methods: Redefining intentions and roles. *Building Research & Information*, 33(5), 455–467. <https://doi.org/10.1080/09613210500219063>
- Croxtan, R. (2003). *Disassembly and deconstruction*. Architectural Record.
- Dagiliute, R., & Liobikiene, G. (2015). University contributions to environmental sustainability: Challenges and opportunities from the Lithuanian case. *Journal of Cleaner Production* 108(Part A), 891–899. <https://doi.org/10.1016/j.jclepro.2015.07.015>
- Dagiliute, R., Liobikiene, G., & Minelgaite, A. (2018). Sustainability at universities: Students' perceptions from green and non-green universities. *Journal of Cleaner Production*, 181, 473–482. <https://doi.org/10.1016/j.jclepro.2018.01.213>
- Douglas, J. (2006). *Building adaptation*. Routledge.
- European Commission. (2010). *The Bologna process and architecture education*. European Commission.
- Forty, A. (2000). *Words and buildings: A vocabulary of modern architecture* (Vol. 268). Thames & Hudson.
- Frampton, K. (1992). *Modern architecture: A critical history*. Thames & Hudson.
- Frank, A., & Silver, C. (2017). *Teaching urban and regional planning*. Elgar.
- Gokarslan, A. B., & Tuncer, H. (2023). Conservation courses effects on architecture students' conservation awareness: Analyses of Isparta and Burdur Houses. *Journal of Architectural Sciences and Applications*, 8(1), 370–384.
- Groat, L. N., & Wang, D. (2013). *Architectural research methods*. Wiley.
- Guy, S., & Farmer, G. (2001). Reinterpreting sustainable architecture: The place of technology. *Journal of Architectural Education*, 54(3), 140–148.
- Guy, S., & Moore, S. A. (Eds.). (2004). *Sustainable architectures: Cultures and natures in Europe and North America*. Routledge.
- Holden, M., Elverum, D., Nesbit, S., Robinson, J., Yen, D., & Moore, J. (2008). Learning teaching in the sustainability classroom. *Ecological Economics*, 64(3), 521–533.
- ICOMOS. (1964). *Venice Charter*. Retrieved March 13, 2023, from http://www.icomos.org.tr/Dosyalar/ICO-MOSTR_tr0243603001536681730.pdf
- Jokilehto, J. (2017). *A history of architectural conservation*. Routledge.
- Karaoglu, A. S., Oz, A. K., Aydin, M., & Guner, S. (2012). Conservation education in the higher education system of Turkey in terms of international legislations: General evaluation & proposals 2. *Journal of Restoration and Conservation Studies*, 9, 49–64. Retrieved from <https://dergipark.org.tr/tr/pub/restorasyon/issue/48690/619448>
- Kibert, C. J. (2016). *Sustainable construction: Green building design and delivery*. Wiley.
- Kincaid, D. (2002). Adapting buildings for changing uses: Guidelines for change of use refurbishment. London: Routledge. ISBN: 978-1-135-80817-4.
- Kohler, N. (1999). The relevance of green building challenge: An observer's perspective. *Building Research & Information*, 27(4), 309–320. <https://doi.org/10.1080/096132199369426>
- König, A. (Ed.). (2013). *Regenerative sustainable development of universities and cities: The role of living laboratories*. Edward Elgar Publishing.
- Kuhn, S. (2001). Learning from the architecture studio: Implications for project-based pedagogy. *International Journal of Engineering Education*, 17(4/5), 349–352.

- Kurnaz, A. (2021). Green building certificate systems as a greenwashing strategy in architecture. *Bartın University International Journal of Natural and Applied Sciences*, 4(1), 72–88. Retrieved from <https://dergipark.org.tr/tr/pub/jonas/issue/60051/892270>
- Kurnaz, A., & Aniktar, S. (2023a). Examination of rural architecture that shapes sustainable tourism in emerging economies through stakeholder perspectives: Sile, Istanbul. *Current Issues in Tourism*, 1–17. <https://doi.org/10.1080/13683500.2023.2223913>
- Kurnaz, A., & Aniktar, S. (2023b). From power plant to energy museum: Spatial perception of Santralistanbul. *Digital International Journal of Architecture Art Heritage*, 2(2), 43–67. Retrieved from <https://dergipark.org.tr/tr/pub/jah/issue/77399/1282911>
- Kwok, R. (2001). Education in urban planning. *Habitat international*, 91–101.
- Lambrechts, W., & Van Liedekerke, L. (2014). Using ecological footprint analysis in higher education: Campus operations, policy development and educational purposes. *Ecological Indicators*, 45, 402–406. <https://doi.org/10.1016/j.ecolind.2014.04.043>
- Landorf, C. (2011). Evaluating social sustainability in historic urban environments. *International Journal of Heritage Studies*, 17(5), 463–477. <https://doi.org/10.1080/13527258.2011.563788>
- Langston, C. (2011). Green adaptive reuse: Issues and strategies for the built environment. In D. Wu (Ed.), *Modeling risk management in sustainable construction*. *Computational risk management*. Springer. https://doi.org/10.1007/978-3-642-15243-6_23
- Lawson, B. (2006). *How designers think*. Routledge.
- Leal Filho, W., Vargas, V. R., Salvia, A. L., Brandli, L. L., Pallant, E., Klavins, M., & Vaccari, M. (2019). The role of higher education institutions in sustainability initiatives at the local level. *Journal of Cleaner Production*, 233, 1004–1015.
- Licciardi, G., & Amirtahmasebi, R. (Eds.). (2012). *The economics of uniqueness: Investing in historic city cores and cultural heritage assets for sustainable development*. World Bank.
- Lozano, R., Lukman, R., Lozano, F. J., Huisingh, D., & Lambrechts, W. (2013). Declarations for sustainability in higher education: Becoming better leaders, through addressing the university system. *Journal of Cleaner Production*, 48, 10–19. <https://doi.org/10.1016/j.jclepro.2011.10.006>
- Lozano, R., Ceulemans, K., Alonso-Almeida, M., Huisingh, D., Lozano, F. J., Waas, T., Lambrechts, W., Lukman, R., & Hugé, J. (2015). A review of commitment and implementation of sustainable development in higher education: Results from a worldwide survey. *Journal of Cleaner Production*, 108, 1–18. <https://doi.org/10.1016/j.jclepro.2014.09.048>
- MacQueen, J. B. (1967). Some methods for classification and analysis of multivariate observations. In Proceedings of fifth Berkeley Symposium on mathematical statistics and probability (Vol. 1, pp. 281–297): Statistic, University of CA Press, Berkeley, CA. Retrieved December 14, 2022, from <https://projecteuclid.org/euclid.bsm/1200512992>
- Mallgrave, H. F. (2010). *The architect's brain: Neuroscience, creativity, and architecture*. Wiley.
- Marrone, P., Orsini, F., Asdrubali, F., & Guattari, C. (2018). Environmental performance of universities: Proposal for implementing campus urban morphology as an evaluation parameter in Green Metric. *Sustainable Cities and Society*, 42, 226–239. <https://doi.org/10.1016/j.scs.2018.07.012>
- Mohammadalizadehkorde, M., & Weaver, R. (2018). Universities as models of sustainable energy-consuming communities? Review of selected literature. *Sustainability*, 10(9), 3250. <https://doi.org/10.3390/su10093250>
- Moore, J. (2005). Barriers and pathways to creating sustainability education programs: Policy, rhetoric and reality. *Environmental Education Research*, 11(5), 537–555.
- Nejati, M., & Nejati, M. (2013). Assessment of sustainable university factors from the perspective of university students. *Journal of Cleaner Production*, 48, 101–107. <https://doi.org/10.1016/j.jclepro.2012.09.006>
- Nocca, F. (2017). The role of cultural heritage in sustainable development: Multidimensional indicators as decision-making tool. *Sustainability*, 9(10), 1882. <https://doi.org/10.3390/su9101882>
- Owojori, O. M., Okoro, C. S., & Chileshe, N. (2021). Current Status and Emerging trends on the adaptive reuse of buildings: A bibliometric analysis. *Sustainability*, 13(21), 11646. <https://doi.org/10.3390/su132111646>
- Saint, A. (1983). *The image of the architect* Yale University Press. New Haven and London.
- Salama, A. M., & Wilkinson, N. (2007). *Design studio pedagogy: Horizons for the future*. The Urban International.
- Schön, D. A. (2017). *The reflective practitioner: How professionals think in action*. Routledge.
- Sev, A. (2009). *Sustainable architecture*. Istanbul YEM Publishing.
- Srivastava, S. (2015). A study of awareness of cultural heritage among the teachers at the university level. *Universal Journal of Educational Research*, 3(5), 336–344. <https://doi.org/10.13189/ujer.2015.030505>
- Stubbs, J. H. (2009). *Time honored: A global view of architectural conservation*. Wiley.

- Suwartha, N., & Sari, R. F. (2013). Evaluating UI GreenMetric as a tool to support green universities development: Assessment of the year 2011 ranking. *Journal of Cleaner Production*, *61*, 46–53. <https://doi.org/10.1016/j.jclepro.2013.02.034>
- Tuncer, G. (2008). University students' perception on sustainable development: A case study from Turkey. *International Research in Geographical and Environmental Education*, *17*(3), 212–226. <https://doi.org/10.1080/10382040802168297>
- United Nations. (2015). *Transforming our world: The 2030 Agenda for Sustainable Development*. A/RES/70/1. <https://sustainabledevelopment.un.org/content/documents/21252030%20Agenda%20for%20Sustainable%20Development%20web.pdf> (accessed 08 March 2024).
- United, & Nations. (1987). *Report of the world commission on environment and development: Our common future (Brundtland Report)*. <https://sustainabledevelopment.un.org/content/documents/5987our-common-future.pdf> (accessed 23 January 2023).
- Vallero, D. A., & Brasier, C. (2008). *Sustainable design: The science of sustainability and green engineering*. Wiley.
- Venetoulis, J. (2001). Assessing the ecological impact of a university: The ecological footprint for the University of Redlands. *International Journal of Sustainability in Higher Education*, *2*(2), 180–197. <https://doi.org/10.1108/14676370110388381>
- Webster, H. (2004). Facilitating critically reflective learning: Excavating the role of the design tutor in architectural education. *Art Design & Communication in Higher Education*, *2*(3), 101–111.
- Wright, T. (2010). University presidents' conceptualizations of sustainability in higher education. *International Journal of Sustainability in Higher Education*, *11*(1), 61–73. <https://doi.org/10.1108/14676371011010057>
- Wright, T., & Wilton, H. (2012). Facilities management directors' conceptualizations of sustainability in higher education. *Journal of Cleaner Production*, *31*, 118–125.
- Yuan, X., Zuo, J., & Huisingh, D. (2013). Green universities in China – what matters? *Journal of Cleaner Production*, *61*, 36–45. <https://doi.org/10.1016/j.jclepro.2012.12.030>
- Zuo, J., & Zhao, Z. Y. (2014). Green building research—current status and future agenda: A review. *Renewable and Sustainable Energy Reviews*, *30*, 271–281.

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