The current issue and full text archive of this journal is available on Emerald Insight at:
https://www.emerald.com/insight/2631-6862.htm

The impact of architectural design studio education on perceptions of sustainability

Ayca Nilufer Calikusu, Aysem Berrin Cakmakli and Ipek Gursel Dino
Middle East Technical University, Ankara, Turkey

Received 9 September 2021
Revised 23 January 2022
7 April 2022
7 May 2022
Accepted 14 May 2022

Abstract

Purpose – Since architectural design studio education has critical importance on the students' knowledge, skills, and awareness of sustainability, this study presents a point of view about relations between architectural education and social, economic, environmental sustainability perception of students within the scope of design studios. The primary purpose is to investigate the role of design studio education in the context of sustainability.

Design/methodology/approach – In the study, the Department of Architecture in Middle East Technical University (METU) was selected as a case study. The impact of design studio education on the understanding of sustainability of architecture students was investigated by conducting a survey with students and in depth-interviews with volunteer lecturers. In quantitative research after formulating four hypotheses, the questionnaire was carried out with 237 architecture students from different years. Then by using the thematic analysis method, the qualitative part of the study was conducted with 11 lecturers.

Findings – Findings reveal that the design studio education and theoretical lectures on sustainability are effective in improving students' sustainability understanding.

Originality/value – Architectural education supports the students about comprehensive understanding and knowledge of national and global issues. This article conducted a case study to investigate the impact of the design studio on the perception of sustainability. Data were collected from architecture students and volunteer lecturers of METU between November 2018 and February 2019. The research is original examining the importance of architectural studio education in the development of knowledge, skills, and awareness of sustainability.

Keywords Sustainable development, Higher education, Architectural design studio, Curriculum, Architectural education, Sustainability awareness

Paper type Research paper

1. Introduction

Architectural schools train professionals with a comprehensive understanding and knowledge of national and global issues and confidence. Therefore, in order to deal with current and future sustainability problems, architecture students need to gain knowledge, skills, and awareness of sustainability during their academic life (Altomonte, 2009). A general trend toward increasing sustainability issues in the curricula has become apparent in many architectural schools (Cullingford and Blewitt, 2013). However, graduates from architecture schools usually do not see the opportunity and potential benefits of sustainability in design projects (Sterling, 2013). One of the critical challenges in the integration of sustainability into architectural education is the inadequacy of addressing issues regarding sustainability in the design studios (Rieh *et al.*, 2017). The study aims to contribute to the literature on sustainability in higher education by examining architectural education in the context of the curriculum, students' perceptions, and lecturers' perspectives. The contribution of design studio education and theoretical courses to architectural students' developing knowledge, skills, and awareness about sustainability was investigated. A case study in the Department of Architecture at Middle East Technical University was conducted, where surveys with students and in-depth interviews with studio instructors were held. Based on the findings, the challenges, needs, and suggestions on the integration of sustainability into design studio education were presented to improve the sustainability awareness of architecture students.



Archnet-IJAR: International Journal of Architectural Research
© Emerald Publishing Limited
2631-6862
DOI 10.1108/ARCH-09-2021-0251

2. Sustainable development

Sustainability has become an essential issue in the global agenda in terms of coping with climate change, depletion of natural resources, and ongoing economic crises. With the Stockholm Conference on Human Resources in 1972, the problems on environment and development were first defined and the common issues of sustainable development regarding education were discussed (United Nations, 1972). In the 1980s, the importance of social and economic sustainability issues was emphasized in addition to the environmental aspects, and the term became a multi-focused common agenda with the definition of "meeting our own needs without compromising the needs of future generations" (WCED, 1987). On Agenda 21, local and global measures were addressed based on social equality, environmental protection, and economic growth (United Nations, 1992).

In 1997, The Kyoto Protocol acknowledged that climate change is mainly due to human activities and set targets to reduce greenhouse gas emissions in the participant countries. In 2015, The United Nations (UN) adopted "Transforming Our World: The 2030 Agenda for Sustainable Development" with 17 Sustainable Development Goals and 169 targets that demonstrate the content and tasks of the universal agenda in terms of sustainability (UN, 2015). These goals aimed to draw attention to issues such as spread of health, prosperity, universal peace, and freedom around the world. Sustainable Development Goals relate to the construction industry and built environment both directly and indirectly in terms of resilience in infrastructure and cities as well as other societal and environmental goals (Goel, 2019).

3. Sustainability in higher education

There have been a significant number of activities, organizations, and declarations on sustainability in higher education, which have touched on issues such as integration of sustainability into the curriculum, increasing research and development, training of academic staff, environmental management on campuses, community participation, and social activities.

Education for sustainable development (ESD) was first included in the Stockholm Human Environment Conference in 1972 (UNESCO, 1978). The Stockholm Declaration emphasized the need for environmental education for everyone, from primary school to professional life (Principle 19). In 1977, the importance of environmental education in the protection and development of the world environment was highlighted at the Tbilisi conference by raising awareness of economic, social, political, and ecological issues. Then, UNESCO-UNEP International Environmental Education Program in 1978 included specific learning objectives for awareness (cognitive), attitudes (socio-emotional), and action (behavioral) for sustainable development goals UNESCO (1978). The official initiation of sustainability activities at universities was in 1990 with the Talloires Declaration. In this declaration, the policies and practices that universities should implement on important issues were stated, such as environmental sustainability, responsible human education, sustainability literacy rate for everyone (University Leaders for a Sustainable Future, 1990). At the 1992 World Environment and Development Summit, sustainable development has been on a global agenda, as well as sustainability actions have accelerated in the world with the Report of Agenda 21, which includes topics that promote sustainability education, practices, general awareness (chapter 36), and the importance of scientific research for sustainable development (chapter 35; United Nations, 1992). The Kyoto Declaration was signed by 90 university leaders in 1993, calling for a clear vision to universities for sustainable development. Here, it was emphasized that universities should support not only sustainable development but also environmental education (Wright, 2002). In 1997, Thessaloniki Declaration -International Conference on Environment and Society: Education and Public Awareness for Sustainability- indicated the necessity of sustainability movements at each level of society. It was also

highlighted that universities must address environmental and sustainable development issues (Wright, 2002).

"The World Declaration on Higher Education for the 21st Century: Vision and Action" by The UN Commission on Sustainable Development and UNESCO, emphasized the mission of universities to contribute to the development and progress of society. In 2005, The United Nations Decade for Sustainable Development Education launched sustainable development networks and educational practices as a leading institution for sustainability-oriented universities (UNECE, 2005, United Nations, 2005). In the outcome of the United Nations Conference on Sustainable Development (Rio+20) in 2012, the Future We Want, the significance of universities was highlighted in collaborative, interdisciplinary, and cross-border contexts (United Nations, 2012). In "Transforming Our World: The 2030 Agenda for Sustainable Development", published by the UN in 2015, within 17 goals, Goal 4 emphasizes comprehensive and equal quality education for all. It was also stated that the importance of providing access to affordable and high-quality higher education ensures lifelong learning potential (Goal 4.3, United Nations, 2015). In 2017, the Report of Education for Sustainable Development Goals Learning Objectives by UNESCO included specific learning objectives for awareness (cognitive), attitudes (socio-emotional), and action (behavioral) for sustainable development goals (UNESCO, 2017).

Nowadays, universities are making progress in the implementation of sustainable development goals (e.g. campus greening, curriculum renewal, and research orientations) (Barth, 2013; Brinkhurst *et al.*, 2011; Mader *et al.*, 2013; Saadatian *et al.*, 2009). According to the Sustainable Development Solutions Network (SDSN) Guide called "Getting Started with the SDGs in Universities", there are four main areas where universities can contribute to SDGs: education, research, operations and governance, and external leadership (Australia and Edition, 2017). Studies in sustainability in higher education primarily focus on specific ESD (Education for Sustainable Development) knowledge and competencies for both students and academics (Disterheft *et al.*, 2013; Wals, 2014). While some of the approaches highlight the need for more sustainability courses and programs to improve sustainability literacy (Disterheft *et al.*, 2013; Hamón *et al.*, 2020; McFarlane and Ogazon, 2011; Sonetti *et al.*, 2019), others point to the integration of sustainability in all courses and research for curriculum renewal (Brugmann *et al.*, 2019; Caeiro *et al.*, 2013; Chang and Lien, 2020; Gokool-Ramdoo and Rumjaun, 2017; McFarlane and Ogazon, 2011). Additionally, most point to the necessity for new learning methods and reorientation in teaching to integrate sustainability (Disterheft *et al.*, 2013; Sáez de Cámara *et al.*, 2021; Sonetti *et al.*, 2019).

In this context, universities have responsibilities such as promoting interdisciplinary studies on sustainability, including sustainable development in the organizational structures, educating staff, and implementing campus-wide sustainability practices (Leal Filho *et al.*, 2017). Sustainable development activities should not be limited to environmental issues, and it should be integrated sustainability into existing curricula and become an structural component of higher education (Wals, 2014). Institutionalization can be achieved when sustainability is integrated will into the university culture and daily activities (Lozano, 2006; Tilbury, 2011). Systematic studies should be carried out to increase discussions on sustainability, improve interdisciplinary, and develop critical thinking on sustainability (Caeiro *et al.*, 2013).

4. The integration of sustainability in architecture schools

The aim of architectural education is to raise students as creative professional designers, by thinking critically, and ethically, as environmentally conscious and socially responsible individuals (Teymur, 1992). The architecture curriculum is built on architectural practices, needs, and concerns that have changed over the years (Salama *et al.*, 2002). One of the critical

points for a sustainable architectural education curriculum is the preparation of course contents in line with sustainability (Porras Álvarez *et al.*, 2016). The curriculum should support an integrated pedagogy that combines technical and professional issues with a creative and sensitive design approach to environmental, social and economic needs (Altomonte *et al.*, 2014).

In the integration of sustainability into the architectural curriculum, Wright (2003) points out three different approaches to revision: (1) the belief that sustainable design is fundamental to theory and practice lectures (2) embedding environmental control systems (ECS) in the existing courses, and (3) to engage the entire faculty, including the design studio, into all aspect of sustainability. More integrated architectural education improves the approaches of students and also develops a connected understanding of architectural disciplines (Kock *et al.*, 2002). AIA has made suggestions for integrating sustainability into architectural education, i.e. to design studios, architectural history, and theory courses, environmental laboratories, research centers, green campus approaches, and sustainable design certification programs (Gould, 2006). EDUCATE [1] (Environmental Design in University Curricula and Architectural Training in Europe) produced five steps that could support the integration of sustainable design into architectural education: academic education; internship; professional training; professional examination; and continuing professional development. Priorities were identified for developing knowledge, skills, and competence in sustainable design are *comprehensive and multidisciplinary education; lifelong learning; research activities related to sustainability in architectural and urban design practice; access to reliable data; conferences, seminars, courses, organizations, etc* (EDUCATE, 2018).

The design studios have become the main focus of the integration of sustainability into academic programs. By comprehending versatile research on cultural, technical, formal, and programmatic perspectives, design studio education aims to teach all aspects of architectural ideas, including theoretic, aesthetic, history, building technology, and practical skills such as drawing and model making. The studio offers problem-solving practices that also encourage creative thinking, allowing students to develop their drawing, conceptual and critical thinking abilities in the design process (Rawes, 2007). By including sustainability into the studio education, architecture graduates can understand sustainability in the conservation of architectural and urban design, including natural and structured resources, healthy buildings, and communities, as well as culturally significant buildings and spaces (NAAB, 2004). Focusing on transformative education, problem-based learning and collaborative group work, sustainability learning is achieved through inquiry, experience, and reflection (Gould, 2006). This pedagogy helps to relate theory to experience and competence in the future.

Second Nature (2001) stated various needs to integrate sustainability into studio teaching and theoretical lectures:

(1) to find practical methods;

(2) to increase learning tools that can be adapted to sustainable design;

(3) to encourage students towards increasing their knowledge of sustainable design;

(4) to promote design/construction programs for students' sustainability awareness;

(5) to consider basic disciplines of design problem-solving with social, environmental and economic sustainability;

(6) to use the campus as a sustainable tool in studio education.

To learn the principles and practices of sustainability, students need to deal with analytical and synthetic design processes and to balance the environmental, social, and economic

aspects of sustainability with critical assessments. Theoretical lectures should also be diversified as a resource to nurture sustainability issues and studio tutors should make special efforts to increase the relationship and integration of design studios with them (Altomonte *et al.*, 2013). They should exchange information about sustainability with the same and interdisciplinary branches (Khan *et al.*, 2013).

5. Methodology of the study

In this research, the statistical analysis method is used to investigate the relationships and potential correlation between variables using quantitative data. After determining the hypotheses, the sampling procedure is carefully planned in order to test them formally and make an interpretation of the findings. This study investigates the effect of design studio education on the sustainability perceptions of architecture students. By adopting case study research, architectural design studio education is examined in the context of sustainability. Data were collected using questionnaires with the students and in-depth interviews with the lecturers were conducted in the Department of Architecture in the 2018–2019 academic year at METU.

Middle East Technical University was established in 1956 as a public university in Ankara. The educational system of METU consists of 4-year undergraduate, 2-year master, and 4-year doctoral programs. In the 2018–2019 academic year, there were 12 courses on sustainability in the Department of Architecture. Eight of these were offered to undergraduate students, and four were offered to graduate students.

The following research question was formulated for this study:

RQ1. To what extent does the design studio education affect the perception of sustainability of the architecture students of METU?

Quantitative and qualitative research approaches were adopted in the study. In quantitative data collection, a survey study was carried out with 237 students from different grades at the METU Department of Architecture in order to be representative of the population The participants included 82 students from the first year, 51 students from the second, 47 students from the third, 38 students from the fourth year, and 19 students from the master degree. With the questionnaire, students' points of view on design studio education, the seminars and lectures in the studio, and sustainability issues in the curriculum of the architecture program of METU were investigated. The questionnaire consisted of four parts, including general knowledge, the information about design studios, experiences at the university, and their views on future professional life. The main factors for students' perceptions about sustainability were identified as awareness, knowledge, attitudes, and skills based on the literature review. SPSS Statistics 22 program was used in data analysis to examine the relationship between students' perception of sustainability and design studio education. Four hypotheses were tested for the study. These hypotheses and the corresponding analysis methods are presented below.

H1. Students' perceptions of sustainability have increased over the years. (ANOVA One-way Test)

It investigated the relationship between students' understanding of sustainability (dependent variable) and their degree (independent variable). The students were asked three questions about whether they learned sustainability principles in their previous design studios (knowledge), whether they used sustainability principles in their design projects (design skills), and whether they were aware of this issue (awareness). Answers were graded on a five-point Likert-type scale. Thus, students' understanding of sustainability was evaluated according to the total score of these three questions.

H2. There is a positive relationship between the seminars and lectures on sustainability given in the design studios and sustainability understanding of students. (Pearson Correlation Analysis)
This explored the relationship between instruction (sustainability seminars and lectures) in the design studios and the students' understanding of sustainability. As explained in the previous hypothesis, the total scores of the students' understanding of sustainability were calculated with the answers of the three questions. Then, Pearson's correlation analysis was performed to determine whether there was a linear relationship between the seminars and lectures given in the studio and the sustainability understanding of the students, and if so, what was the direction and severity of this relationship.

H3. The environmental aspect of sustainability is addressed more in comparison to social and economic aspects in the design studios. (One-sample *T*-Test)
It investigated the differences between environmental, social, and economic aspects of sustainability issues in the content, scope, and design processes of the studios of the case study. A one-sample *T*-Test was used to determine whether the mean scores between variables in the analysis were statistically different. Mean scores and frequency were calculated, and the analysis was interpreted.

H4. Students who previously designed a project and received a theoretical lecture on sustainability in the design studios are more prone to doing projects related to sustainability in professional life. (Independent sample *T*-Test)
It examined whether the students who had previously designed a project with sustainability principles and took a theoretical lecture on the same topic in design studios were more likely to do projects related to the subject in their professional life. The Independent Sample *T*-Test was used for this hypothesis. The variables were determined as students who designed projects on sustainability or did not (Independent categorical variable) and their opinions about professional life (Continuous dependent variable). The mean scores were compared, and it was evaluated whether there was a significant difference between them.

During qualitative data collection on design studios, theoretical courses, and workshops/conferences related to sustainability at the METU Department of Architecture, in-depth interviews were conducted with 11 faculty members. To investigate the perceptions of sustainability in architectural education, the interviews were held with different studio tutors from each year of the METU Department of Architecture in the 2018–2019 academic year. One of the instructors is from the 1st grade, two of them are from 2nd grade, four of them are from 3rd grade, and two of them are from the 4th-grade design studios. The interviews aimed to:

(1) gather information on design studio/course programs, project topics, and sustainability courses,

(2) understand the lecturers' personal experiences and views on the integration of sustainability into the design studio, and their suggestions to increase students' knowledge and awareness on sustainability.

The thematic analysis method, which is the process of determining patterns or themes in qualitative data (Maguire and Delahunt, 2017), was applied to identify the critical themes in the interviews. NVivo 12 was used for this analysis, specifically in the organization and management of qualitative data.

6. Findings

This section presents the statistical results of the collected data. Firstly, the demographic characteristics of the participants are presented. The questionnaire was conducted between November 2018 and February 2019 between the end of the first and start of the second semester with 237 architecture students, of which 152 (64%) were female, and 85 (36%) were male. The students' ages were divided into three groups: Age: 18–22, 157 students (66%); Age: 22–26, 68 students (%29); Age > 26, 12 students (%5). Of 237 students, 82 students (34.6%) were first-year, 51 (21.5%) students were second-year, 47 (19.8%) students were third-year, 38 (16%) students were the fourth year, and 19 (8%) students were from master degree. As Gregory (2010) defined, architecture, as a living organism, reflects historical references, trans-disciplinary theories and methods and architectural education should integrate the consequences of all this knowledge. Although the first-year students had less experiences than the other students, they could make a better remembered correlation between their high school theoretical knowledge about architectural sustainability and studio topics. Because of this, it is decided that their feedback is also meaningful for the study and they were added to the sample pool. While the second-year students took up the subject from the introduction to architecture level, the third- and fourth-year students handled the issue more professionally than second- and first-year students and commented after professional and technical education.

6.1 Quantitative research findings

The analysis method for each hypothesis was determined by considering the normality, homogeneity, and data numbers higher than 30. According to the reliability analysis applied for the survey data, Cronbach's alpha value was 0.795. With this value, it was concluded that 80% of the data obtained from the survey were reliable. In order to reduce the limitations of how far the findings can be generalized, the survey can be applied to a bigger sample pool in a larger time frame as a further study.The first hypothesis explored the impact of years on the sustainability perceptions of architecture students at METU. In this hypothesis, it was suggested that the understanding of sustainability has increased over the years due to the students' having different design studios at all levels. The questions asked to measure students' understanding of sustainability were as follows:

(1) Did you learn the principles of sustainability in your previous design studios (knowledge on sustainability)? (Likert scale (1 = Not at all, 5 = Very Much))

(2) Have you ever used the principles of sustainability in your design projects (design skills on sustainability)? (Likert scale (1 = Not at all, 5 = Very Much))

(3) Have you achieved an awareness of the sustainability with your design projects (awareness on sustainability)? (Likert scale (1 = Not at all, 5 = Very Much))

To measure the understanding of sustainability, the scores of knowledge, design skills, and awareness on sustainability were combined in these questions. The answers were evaluated on a five-point Likert-type scale (1 = Not at all, 5 = Too Much). The scale of sustainability understanding mean scores were between 3 and 15. Figure 1 shows the number of students and the mean scores of the students' sustainability understanding by years below.

In the analysis, first, it was determined that the data showed normal distribution according to the Shapiro Wilk test ($p > 0.05$). Then, in the correlation test between variables, the Pearson Correlation test was used to find out the relationship between the variables of the degree and sustainability understanding of the students. It was found to be statistically significant at the $p < 0.01$ level. There was a positive correlation between variables ($r = 0.501$).

For the analysis of the data, the Anova One Way Test was carried out to compare the mean scores of the different years (Table 1). As a result of the Anova One-Way Test analysis,

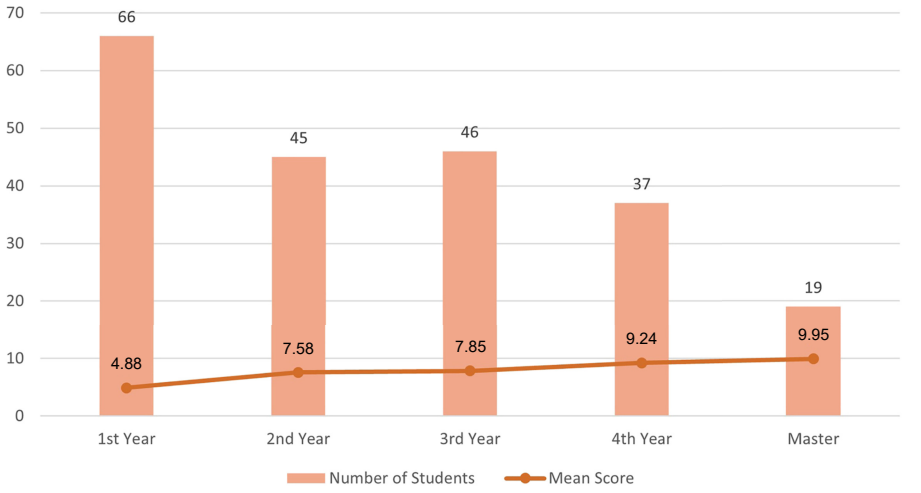


Figure 1.
The number of students and mean scores of the sustainability understanding of students by years

Mean and standard deviations

	Number of students	Mean score	Std. deviation
1st Year	66	4.88	3.051
2nd Year	45	7.58	3.115
3rd Year	46	7.85	2.521
4th Year	37	9.24	2.650
Master	19	9.95	3.407
Total	213	7.30	3.404

Anova one-way test analysis

	Sum of squares	Df	Mean square	*F*	Sig
Between groups	677.069	4	169.267	19.783	0.000
Within groups	1779.701	208	8.556		
Total	2456.770	212			

Note(s): Dependent variable: degree of students
Independent variable: sustainability understanding

Table 1.
Mean and standard deviations of the sustainability understanding of students by years and Anova one-way test analysis

a statistically significant difference was found, as seen in Table 2 (Sig. coefficient $p = 0.00 < 0.01$). With this result, the first hypothesis was confirmed. In other words, the years of education affected the understanding of sustainability in architecture students. It was concluded that the design studio and theoretical courses of architectural education are effective in improving students' sustainability understanding over the years.

With the second hypothesis, the relationship between the sustainability understanding of the participants and theoretical studies such as sustainability seminars and lectures in the design studio was investigated. Pearson correlation analysis was used for this hypothesis. The first variable was the students' sustainability understanding, which was measured with 3 questions explained in the previous hypothesis. The second variable was specified with the following question:

(1) To what extent was the concept of sustainability instructed using seminars, lectures, etc. during the design studios? (Likert scale (1 = Not at all, 5 = Very Much))

		M.14. To what extent was the concept of sustainability instructed by means of seminars, lectures, etc. during the design studios?	Sustainability understanding of students
14. To what extent was the concept of sustainability instructed by means of seminars, lectures, etc. during the design studios?	Pearson correlation	1	*0.697***
	Sig. (2-tailed)		*0.000*
	N	216	209
Sustainability understanding of students	Pearson correlation	*0.697***	1
	Sig. (2-tailed)	*0.000*	
	N	209	213

Note(s): **Correlation is significant at the 0.01 level (2-tailed)

Table 2.
Pearson correlation analysis

Mean scores and standard deviations were calculated for both variables. The total score of the sustainability understanding was the sum of knowledge, design skills, and sustainability awareness scores. The mean score of the sustainability understanding variable was 7.30 (from 3 to 15) and standard deviation was 3,404. The other variable was measured between 1–5 (Likert-type scale, 1 = Not at all, 5 = Very Much). The mean score of this variable was 2,21 and standard deviation was 1,154.

As a result of the Pearson Correlation Analysis, it was concluded that there is a significant ($p = 0 < 0.01$) relationship between discussing the concepts of sustainability in design studios and students' understanding of sustainability (Table 2).

The correlation coefficient was affected by the sample size ranging from −1 to +1. The correlation was evaluated using Evans' (1996) guide for absolute value of r (r = 0.00–0.19 means very weak; r = 0.20–0.39 means weak; r = 0.40–0.59 means moderate; r = 0.60–0.79 means strong; r = 0.80–1.0 means very strong). It revealed a strong positive correlation since the p-value obtained according to the correlation test was 0.697. In other words, as the sustainability seminars and lectures in the studio increases, the understanding of sustainability in students increases.

In hypothesis three, it was found out which aspects of sustainability were addressed more in the design studios of the Architecture Program at METU (Figure 2).

With descriptive statistics by using the One-Sample T-Test, the difference between the sustainability aspects of the students' projects was examined by each year (Table 3).

According to the mean scores of the three aspects of sustainability each year, environmental sustainability was the most studied aspect in the design studios. On the contrary, economic sustainability was the least discussed in all years. As a result, it was confirmed by this hypothesis that the environmental dimension of sustainability in the design studios was elaborated more than social and economic sustainability.

For the fourth hypothesis, the students who participated in the study were first asked whether they were assigned a project and given theoretical lectures about sustainability in studios. According to the answer, it is analyzed whether they are prone to design projects related to sustainability in their future lives. Independent Samples T-Test was used to compare the averages of the two independent groups. For this test, the following question was asked to understand the experience of the students on sustainability in studios for the independent categorical variable.

(1) Within your design studios, have you received any theoretical lectures, or have you carried out any projects related to sustainability? (Categorical (Yes, No))

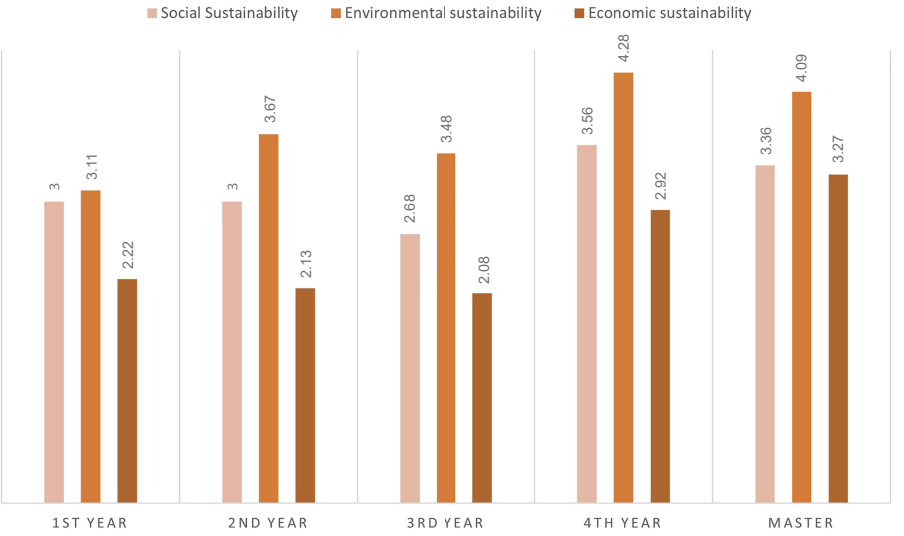


Figure 2.
Mean scores regarding the degree

		Social sustainability	Environmental sustainability	Economic sustainability
Mean scores	1st Year	3.00	3.11	2.22
	2nd Year	3.00	3.67	2.13
	3rd Year	2.68	3.48	2.08
	4th Year	3.56	4.28	2.92
	Master	3.36	4.09	3.27

Table 3.
The mean scores regarding the degree

The continuous dependent variable was determined with the opinions of the students in their future professional life.

(1) In your future professional practices as an architect, do you want to design projects integrated with sustainability concepts? (Likert scale (1 = Not at all, 5 = Very Much))

There were 86 students carrying out a project in METU design studios and taking a theoretical course on sustainability. Mean scores were compared with the remaining 139 students in Table 4.

The mean score of the students who previously carried out a project on sustainability or took theoretical courses on the related topic was 4.57. The other 139 students' mean score was 4.18 in the analysis. The Independent Samples *T*-Test was conducted to compare these mean scores. The results revealed a significant difference between these two groups ($p < 0.05$, Table 4). In other words, students who carried out a sustainability project and took a theoretical lesson on this subject in design studios were more prone to design sustainability projects in their professional lives.

6.2 Qualitative research findings

For the qualitative research of the study, in-depth interviews with 11 faculty members were conducted. Participants were asked about project topics in the studios, the relationship between sustainability and the design studio. By thematic analyses, the responses were

The descriptive statistics of the variables	8. Within your design studios at Middle East Technical University (METU), have you received any theoretical lectures, and have you carried out any projects related to sustainability?	Number	Mean score	Std. deviation
20. In your future professional practices as an architect, do you want to design projects integrated with sustainability concepts?	No	139	4.18	1.085
	Yes	86	4.57	0.695

The result of the independent samples *T*-test	*t*	Df	Sig	Mean difference
20. In your future professional practices as an architect, do you want to design projects integrated with sustainability concepts?	−2.974	223	0.003	−0.390

Table 4. The descriptive statistics of the variables and the result of the independent samples *T*-test

categorized into four main groups. The following statements are the main topics of the answers of the in-depth interviews.

(1) *Lecturers' opinions about sustainability in architectural education:* All lecturers stated that sustainability was a critical topic for architectural design and expressed the need for sustainability to be one of the main issues in architectural design like form, composition, and structure. Two lecturers stated that sustainability was also important issue in the accreditation process and architectural accreditation boards seek sustainability as an assessment tool. As they mentioned, one of the criteria required in the curriculum was sustainable design principles or sustainable development goals. Some participants stated that sustainability is quite parallel to the debate of architecture from Vitruvius. Supporting this claim, one of the lecturers said that the problems dealing with human-environment relations in architecture were common to the most issues of sustainability. Another stated that the essence of architectural design from Vitruvius to the present was based on the concept of sustainability. Some of them expressed that sustainability was not a concept to architecture. According to them, sustainability has a history and came to the front under different names in time, and it was updated under the conditions of that period. According to the proponents of this idea, although it was not mentioned as a term of sustainability, architectural education was directly related to the concept of sustainability. They supported the idea that architecture is designed to create sustainability with its environment to resist the time to be permanent. Most participants also stated that sustainability is a comprehensive, complex, multi-layered, interdisciplinary, and open-ended field. Some stated that the issue is crucial, but the concept of sustainability is at risk of marginalizing and losing its meaning. These lecturers objected to the presentation of sustainability as an artificial and differentiated concept from its essence. The use of the term sustainability in advertising and marketing by many companies is one of the examples that the term is in danger of losing its meaning. Therefore, these lecturers were critical of sustainability.

(2) *Design projects' relevance to sustainability in the studios:* Most of the participants stated that although the main theme of their projects was not sustainability, sustainability issues were discussed in the studios. Although the acquisition of in-depth knowledge on sustainability was not aimed at any of the studio courses, it was stated that they were discussed as part of the design critiques, especially in third and 4th-year design studios. It was mentioned that there was no project or lecture dedicated explicitly to sustainability in the first-year studio. One added that in the learning outcomes of the 1st year design studio, there was no sustainability topic because of the overloaded program. He/she agreed that the need for the integration of sustainability should start from the 2nd year, as sustainability was a more technical field due to its close relationship with materials and technology. Therefore, he/she suggested that second-year students should develop sensitivities on sustainability. Against this argument, some stated that sustainability should be discussed in all design studios, including the first year.

In the 2nd year design studio, two lecturers mentioned that they started with the basic design principles and continued with the discourse of space and the spatial dimensions in the first semester. Some commented that there was not enough time to discuss sustainability issues since the design studios have a heavy workload program. These lecturers supported the architectural approach with a minimum effect on the environment in the design projects. Some of the sustainability issues were climate, topography, environmentally friendly buildings, passive systems, etc.

All the 3rd year lecturers stated that sustainability was implicitly embedded in every project, even if the theme is not explicitly sustainability. One stated that when the project was directly related to sustainability, more detailed studies are carried out and, students could understand the concept more comprehensively. Another lecturer emphasized that when the main theme is not sustainability, the issue is left in the background. Others stated that when a student took the initiative to integrate concepts of sustainability in his-her project, they supported him/her to develop this idea. One expressed that they mostly touch upon the social, cultural sustainability as well as environmental aspect in the design studios. In the 3rd year, some of the sustainability topics included in the design projects were ecosystem, ecological design, natural balance, waste management, energy saving, wind-energy systems, water cleaning systems, sustainable materials, urban agriculture, healthy food production, environmental ethics, etc.

As stated by the lecturers, the focus of the 4th year design studios was architectural and urban programs. One stated that while the first term of the studio was mainly about an urban design project, in the second term, they were carrying out a project within the scale of a building complex. In this degree, the design studios were mainly included with lecturers from different disciplines, including sustainability. The lecturers mentioned that sustainability has always been in the project's expectations and learning outcomes. Also, they emphasized that there were seminars and lectures on sustainability to support students in this year's design studio. In the 4th year design studios, it was stated that all dimensions of sustainability were the subject of discussion due to the project topics. In the 4th year, some of the subjects of sustainability were the urban, cultural, social, economic, urban policies, industrial heritage, cultural history, agriculture, resource consumption, climate, energy efficiency, solar energy, photovoltaic systems, sustainable materials, transportation, etc.

(3) *The integration of sustainability into the architectural curriculum:* Most participants stated that it is difficult to integrate sustainability into the curriculum. According to

them, one challenge was that sustainability is a multi-disciplinary and comprehensive issue. Some added that there is a need for more lecturers and experts on sustainability in the faculty. One lecturer expressed that one of the challenges of integration of sustainability requires a broad perspective and a form of understanding. Another challenge in integration was the gap between theoretical courses and the studios. To reuse the knowledge in the theoretical courses into the studio, one suggested better communication between these two. Some stressed that sustainability courses should be taken simultaneously with the design studio. Most of the participants mentioned that sometimes there were sustainability lectures by experts from other disciplines in the studios. So, students had a better perception of sustainability on the projects when the concept was visible at the design phases.

In the curriculum of the Department of Architecture, sustainability was included in studios and courses, whether explicitly or implicitly. Most lecturers expressed the need for more theoretical lectures on sustainability for effective and interdisciplinary integration. As some lecturers stated, there were elective courses on sustainability in the department, but they usually dealt with environmental sustainability issues. The need to increase and diversify the theoretical compulsory courses related to all aspects of sustainability was stressed.

(4) *Suggestions for increasing sustainability awareness of the students:* For better integration of sustainability into architectural education, some stated that sustainability issues should be included in all stages of design education starting from the first year. Others expressed that it should be discussed from the third year due to limited time. It was also emphasized that there should be instructors who specialize in sustainability in studios. Some of the participants stated that student societies related to sustainability should be supported, and some activities, workshops, and trips should be organized on sustainability issues. Some added that seminars on sustainability could also be offered to faculty members and staff. One stated that in order to involve sustainability in daily life, starting from the micro scale, first, it should be developed a sensitivity to the faculty building and the campus. Others also mentioned that more attention should be paid to campus sustainability.

7. Conclusion

Higher education has a unique position in the development and change of society as well as creating sustainability awareness. This study focused on architectural education in the context of environmental, social, and economic sustainability. It was aimed to contribute to the sustainability literature in architectural education by studying the effect of design studios on architectural students' perception of sustainability. The conclusion of the research was based on the results of the surveys conducted with students and interviews with the lecturers of METU.

While this study mainly focused on the sustainability understanding of the students, it explored the role of sustainability in architectural education. One of the critical outcomes of the study was that sustainability is not a new concept. The concept of sustainability started with environmental awareness, and has been placed in architectural education through environmental debates. When the change of sustainability concept in time was evaluated from an architectural perspective, it was observed that the concept was used as the environmental design in the 1970s, green design in the 1980s, ecological design in the late 1980 and 1990s, and sustainable design from the mid-1990s to the present. The terminological change of sustainability in architecture points out to the expanding

architectural theory and practice related to sustainability. However, the reflection of this process in architectural education has been the association of the term sustainability with environmental issues. In this study, the imbalance between sustainability aspects discussed in design studios was one of the striking results. The sustainability-related projects in the design studios at METU mostly focused on environmental and social sustainability. Although economic issues were mentioned in the studios and courses, there were no specific lectures related to this topic. The imbalance between the three aspects of sustainability in architectural education can cause students to reconcile sustainability issues with environmental problems. Students often related sustainability to projects that include concepts such as green building and renewable energy, but not the other dimensions. Students need to comprehend all three aspects of sustainability in order to solve sustainability problems. The relationship between the design studios and theoretical sustainability courses should be collaborative and supportive of promoting and achieving this awareness. In addition to the theoretical courses, the lectures, presentations, and seminars can be given in the studio environment, which contributes to the students' sustainability awareness. After the students have sufficient knowledge about the concept of sustainability, they should also be supported by studio instructors.

If sustainability is not identified as a design requirement and one of the outcomes of the project, it will remain as a superfluous topic in the design studios. For this reason, sustainability is becoming a concept included in the detail and concept processes rather than the initial ideas of the projects. To avoid these concerns, systematic integration is needed in architectural education. Architecture curricula need to be re-evaluated by creating opportunities for the sustainability concept. In order to consider sustainability as one of the design requirements in the studios, architecture schools need to increase the number of sustainability courses, to have enough faculty members in this field, and to enhance sustainability awareness for all faculty members, and to help the development of students' sustainability understandings. In addition, sustainability should be supported by extracurricular and student-oriented activities such as educational trips, workshops, seminars, conferences, exhibitions. The acceptance of the belief in sustainability should be supported by the university's culture and daily activities. As such, students can have knowledge, awareness, and skills on sustainability.

The integration of sustainability concepts in university education is also highly urgent and critical regarding the increasing threats of climate change. Anthropogenic climate change is directly related to the greenhouse emissions and environmental degradation due to the built environment, and therefore architecture has an enormous responsibility to reduce the negative impact of climate change and reduce the vulnerabilities of cities, buildings and occupants under worsening living conditions. Knowledge of and implementation of sustainability concepts are highly relevant for climate change mitigation and adaptation in higher education and architectural curricula. However, sustainability concepts and sustainable practices should also go beyond the curricula, such that it is deeply rooted is the strategies, policies, actions and investments of the universities. Moreover, current societal challenges such as social equity, poverty, well-being, education, diversity or empowerment can be addressed only when such issues are embraced and practically implemented by the whole university community, from students to staff. Future efforts, therefore, should focus on long-term strategies to transform architectural education from both social and environmental perspectives.

Note

1. The European Commission Energy Agency for Competitiveness and Innovation (EACI) launched the Environmental Design in University Curricula and Architectural Training in Europe (EDUCATE) project in the Intelligent Energy Europe 2008 Program.

References

Altomonte, S. (2009), "Environmental education for sustainable architecture", *Review of European Studies*, Vol. 1, p. 12.

Altomonte, S., Reimer, H., Rutherford, P. and Wilson, R. (2013), "Towards education for sustainability in university curricula and in the practice of design", *29th Conference, Sustainable Architecture for a Renewable Future*, Munich, 10-12 September 2013, PLEA.

Altomonte, S., Rutherford, P. and Wilson, R. (2014), "Mapping the way forward: education for sustainability in architecture and urban design", *Corporate Social Responsibility and Environmental Management*, Vol. 21, pp. 143-154.

Australia, N.Z. and Edition, P. (2017), *Sustainable Development Solutions Network–Australia*, Pacific, Melbourne.

Barth, M. (2013), "Many roads lead to sustainability: a process-oriented analysis of change in higher education", *International Journal of Sustainability in Higher Education*, Vol. 14 No. 2, pp. 160-175.

Brinkhurst, M., Rose, P., Maurice, G. and Ackerman, J.D. (2011), "Achieving campus sustainability: top-down, bottom-up, or neither?", *International Journal of Sustainability in Higher Education*, Vol. 12 No. 4, pp. 338-354.

Brugmann, R., Côté, N., Postma, N., Shaw, E.A., Pal, D. and Robinson, J.B. (2019), "Expanding student engagement in sustainability: using SDG-and CEL-focused inventories to transform curriculum at the University of Toronto", *Sustainability*, Vol. 11 No. 2, p. 530.

Caeiro, S., Leal Filho, W., Jabbour, C. and Azeiteiro, U. (2013), *Sustainability Assessment Tools in Higher Education Institutions: Mapping Trends and Good Practices Around the World*, Springer International Publishing, Cham.

Chang, Y.-C. and Lien, H.-L. (2020), "Mapping course sustainability by embedding the SDGs inventory into the university curriculum: a case study from national university of Kaohsiung in Taiwan", *Sustainability*, Vol. 12 No. 10, p. 4274.

Cullingford, C. and Blewitt, J. (2013), *The Sustainability Curriculum: The Challenge for Higher Education*, Routledge, London.

Disterheft, A., Caeiro, S., Azeiteiro, U.M. and Leal Filho, W. (2013), "Sustainability science and education for sustainable development in universities: a way for transition", *Sustainability Assessment Tools in Higher Education Institutions*, Springer, pp. 3-27.

Environmental Design in University Curricula and Architectural Training in Europe (EDUCATE) (2018), "Intelligent energy Europe", available at: https://ec.europa.eu/energy/intelligent/projects/en/projects/educate (accessed 07 April 2022).

Evans, J.D. (1996), *Straightforward Statistics for the Behavioral Sciences*, Brooks/Cole, Pacific Grove, California.

Goel, A. (2019), "Sustainability in construction and built environment: a 'wicked problem'", *Smart and Sustainable Built Environment*, Vol. 8 No. 1, pp. 2-15.

Gokool-Ramdoo, S. and Rumjaun, A.B. (2017), "Education for sustainable development: connecting the dots for sustainability", *Journal of Learning for Development*, Vol. 4 No. 1, pp. 72-89.

Gould, K.L. (2006), *Ecology and Design: Ecological Literacy in Architecture Education, 2006 Report and Proposal*, American Institute of Architects, Washington, DC.

Gregory, M. (2010), "Bubble up: alternative approaches to research in the academic architecture studio", *Archnet-IJAR: International Journal of Architectural Research*, Vol. 4, pp. 61-75.

Hamón, L.A.S., Martinho, A.P., Ramos, M.R. and Aldaz, C.E.B. (2020), "Do Spanish students become more sustainable after the implementation of sustainable practices by universities?", *Sustainability*, Vol. 12 No. 18, p. 7502.

Khan, A.Z., Vandevyvere, H. and Allacker, K. (2013), "Design for the ecological age: rethinking the role of sustainability in architectural education", *Journal of Architectural Education*, Vol. 67, pp. 175-185.

Kock, A., Schwennsen, K., Dutton, T. and Smith, D. (2002), *The Redesign of Studio Culture*, A Report of the AIAS Studio Culture Force, AIAS-American Institute of Architecture Students, Washington.

Leal Filho, W., Brandli, L., Castro, P. and Newman, J. (2017), *Handbook of Theory and Practice of Sustainable Development in Higher Education*, Springer International Publishing, Cham.

Lozano, R. (2006), "A tool for a graphical assessment of sustainability in universities (GASU)", *Journal of Cleaner Production*, Vol. 14, pp. 963-972.

Mader, C., Scott, G. and Razak, D.A. (2013), "Effective change management, governance and policy for sustainability transformation in higher education", *Sustainability Accounting, Management and Policy Journal*, Vol. 4 No. 3, pp. 264-284.

Maguire, M. and Delahunt, B. (2017), "Doing a thematic analysis: a practical, step-by-step guide for learning and teaching scholars", *All Ireland Journal of Higher Education*, Vol. 9 No. 3, pp. 3351-3359.

McFarlane, D.A. and Ogazon, A.G. (2011), "The challenges of sustainability education", *Journal of Multidisciplinary Research (1947-2900)*, Vol. 3 No. 3, pp. 81-107.

NAAB (2004), *NAAB Conditions for Accreditation for Professional Degree Programs in Architecture*, 2004 Edition, National Architectural Accrediting Board, Washington, District of Columbia.

Porras Álvarez, S., Lee, K., Park, J. and Rieh, S.-Y. (2016), "A comparative study on sustainability in architectural education in Asia – with a focus on professional degree curricula", *Sustainability*, Vol. 8, p. 290.

Rawes, P. (2007), "Reflective subjects in Kant and architectural design education", *Journal of Aesthetic Education*, Vol. 41 No. 1, pp. 74-89.

Rieh, S.-Y., Lee, B.-Y., Oh, J.-G., Schuetze, T., Porras Álvarez, S., Lee, K. and Park, J. (2017), "Integration of sustainability into architectural education at accredited Korean universities", *Sustainability*, Vol. 9 No. 7, p. 1121.

Saadatian, O., Salleh, E., Tahir, O. and Dola, K. (2009), "Observations of sustainability practices in Malaysian research universities: highlighting particular strengths", *Pertanika Journal of Social Sciences and Humanities*, Vol. 17 No. 2, pp. 225-244.

Sáez de Cámara, E., Fernández, I. and Castillo-Eguskitza, N. (2021), "A holistic approach to integrate and evaluate sustainable development in higher education. The case study of the university of the Basque country", *Sustainability (2071-1050)*, Vol. 13 No. 1, p. 392.

Salama, A.M., O'reilly, W. and Noschis, K. (2002), *Architectural Education Today: Cross-Cultural Perspectives*, ARTI-ARCH, Comportements, Lausanne.

Second Nature (2001), "Second Nature", available at: https://secondnature.org/ (accessed 07 April 2022).

Sonetti, G., Brown, M. and Naboni, E. (2019), "About the triggering of UN sustainable development goals and regenerative sustainability in higher education", *Sustainability*, Vol. 11 No. 1, p. 254.

Sterling, S. (2013), "The sustainable university: challenge and response", *The Sustainable University: Progress and Prospects*, Vol. 2, p. 17.

Teymur, N. (1992), *Architectural Education: Issues in Educational Practice and Policy*, Question Press, London.

Tilbury, D. (2011), "Higher education for sustainability: a global overview of commitment and progress", *Higher Education in the World*, Vol. 4, pp. 18-28.

UNECE (2005), *UNECE Strategy for Education for Sustainable Development*, Economic Commission for Europe, Committee on Environmental Policy, Vilnius, available at: https://unece.org/esd-strategy.

UNESCO (1978), "Intergovernmental conference on environmental education final report", *Intergovernmental Conference on Environmental Education, organized by UNESCO in Co-operation with UNEP*, Paris.

UNESCO (2017), *Education for Sustainable Development Goals Learning Objectives*, Vol. 7, United Nations Educational, Scientific and Cultural Organization, available at: https://www.unesco.de/sites/default/files/2018-08/unesco_education_for_sustainable_development_goals.pdf (accessed 07 April 2022).

United Nations (1972), "Declaration of the United Nations conference on the human environment", (n.d.), *Declaration of the United Nations Conference on the Human Environment – A/CONF.48/14/Rev.1 Chapter I – UN Documents: Gathering a Body of Global Agreements*, available at: http://www.un-documents.net/unchedec.htm (accessed 07 April 2022).

United Nations (1992), *Agenda 21: Programme of Action for Sustainable Development: Rio Declaration on Environment and Development: Statement of Forest Principles*, UN Department of Public Information, New York.

United Nations (2005), *2005 World Summit Outcome: Resolution/Adopted by the General Assembly*, General Assembly (60th sess.: 2005-2006), UN, available at: https://www.un.org/en/development/desa/population/migration/generalassembly/docs/globalcompact/A_RES_60_1.pdf (accessed 07 April 2022).

United Nations (2012), *The Future We Want*, United Nations Conference on Sustainable Development, Rio de Janeiro, available at: https://www.unenvironment.org/resources/report/rio20-outcome-document-future-we-want (accessed 07 April 2022).

United Nations (2015), *Transforming Our World: The 2030 Agenda for Sustainable Development*, Department of Economic and Social Affairs, (n.d.). available at: https://sdgs.un.org/2030agenda (accessed 10 January 2021).

University Leaders for a Sustainable Future (ULSF) (1990), "Talloires declaration", available at: http://ulsf.org/talloires-declaration/ (accessed 07 April 2022).

Wals, A.E. (2014), "Sustainability in higher education in the context of the UN DESD: a review of learning and institutionalization processes", *Journal of Cleaner Production*, Vol. 62, pp. 8-15.

World Commission on Environment and Development (1987), *Our Common Future*, Oxford University Press, Oxford.

Wright, T.S. (2002), "Definitions and frameworks for environmental sustainability in higher education", *Higher Education Policy*, Vol. 15, pp. 105-120.

Wright, J. (2003), "Introducing sustainability into the architecture curriculum in the United States", *International Journal of Sustainability in Higher Education*, Vol. 4, pp. 100-105.

Further reading

Colucci-Gray, L., Camino, E., Barbiero, G. and Gray, D. (2006), "From scientific literacy to sustainability literacy: an ecological framework for education", *Science Education*, Vol. 90, pp. 227-252.

Fadeeva, Z., Galkute, L., Mader, C., Scott, G. and Mohun, S. (2014), *Sustainable Development and Quality Assurance in Higher Education: Transformation of Learning and Society*, Palgrave Macmillan, New York, pp. 49-65.

Glyphis, J. (2001), "How can the architect contribute to a sustainable world", *Proceedings of the Wingspread Conference*, pp. 24-26.

Gough, S. and Scott, W. (2003), *Sustainable Development and Learning: Framing the Issues*, Routledge, London, pp. 111-116.

National Research Council (1999), *Our Common Journey: A Transition toward Sustainability*, National Academies Press, Washington, DC.

Orr, D.W. (1992), *Ecological Literacy: Education and the Transition to a Postmodern World*, Suny Press, New York.

Porras, I.M. (2009), "The city and international law: in pursuit of sustainable development", *Fordham Urban Law Journal*, Vol. 36, p. 537.

Stevenson, F., Roberts, A.S. and Altomonte, S. (2009), "Designs on the planet: a workshop series on architectural education and the challenges of climate change", *Presented at: 26th International Conference on Passive and Low Energy Architecture (PLEA 2009)*, Quebec, pp. 22-24, available at: http://orca.cf.ac.uk/14089/.

UNESCO (2006), "Framework for the UNDESD international implementation scheme", (n.d.), available at: https://unesdoc.unesco.org/ark:/48223/pf0000148650 (accessed 07 April 2022).

About the authors

Ayca Nilufer Calikusu is a research assistant in Middle East Technical University. She completed her M.Arch degree at Middle East Technical University, Department of Architecture. She is a PhD candidate in the same department. Her main fields of interest are sustainable architectural education, sustainable campus and sustainability in higher education.

Dr Aysem Berrin Cakmakli is an instructor at the Architecture department at the Middle East Technical University, Turkey. She received her Ph.D. from the Middle East Technical University, Faculty of Architecture in Building Science. The title of her Ph.D. dissertation is "*Life Cycle Assessment of Building Materials in Hotel Refurbishment Projects: A Case Study in Ankara*". Her main fields of interest are ecological and sustainable architecture and building materials, energy efficiency and life cycle assessment of buildings and building performance evaluations. She is teaching environmental design lectures, appropriate building materials lectures, building detailing modelling and basic design studio. Berrin's current research focuses on urban heat island issues, their impacts on climate change and projected mitigation strategies. Aysem Berrin Cakmakli is the corresponding author and can be contacted at: cakmakli@metu.edu.tr

Dr Ipek Gursel Dino completed her M.Arch degree at Middle East Technical University, Department of Architecture. She pursued her studies further in computational design at Carnegie Mellon University in USA (M.Arch, 2005) and Technische Universiteit Delft in the Netherlands (PhD, 2010). She has led and participated in research projects in both USA and Europe on the development of computational tools and methods for architectural design and parametric systems. Dr. Gürsel-Dino is currently working as a faculty member at METU Department of Architecture, where she acts as advisor to graduate students and teaches in computational design and analysis methods in architecture.

For instructions on how to order reprints of this article, please visit our website:
www.emeraldgrouppublishing.com/licensing/reprints.htm
Or contact us for further details: **permissions@emeraldinsight.com**