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Research on Awareness and Needs of Architecture Students About Energy Efficient Buildings

Mimarlık Öğrencilerinin Enerji Verimli Binalar Hakkında Farkındalık ve İhtiyaçları Üzerine Bir Araştırma

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ABSTRACT

Sustainability and energy efficiency in building design are considered as important topics in today's architectural world. The purpose of this paper is to examine their opinions, requirements, current knowledge level, perception, and awareness regarding the energy efficient buildings on a group of architectural students from two universities. Results shows that architectural journals covering several general subjects were more preferred than academic journals by students. It was also revealed that there is a need for architect-oriented design guideline supported with visual expressions about the subject and students are familiar with some of the related terminologies. Therefore, this study can help the program coordinator in determining the course content and its sources of information related to energy efficient buildings in architecture schools.

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ÖZ

Bina tasarımında sürdürülebilirlik ve enerji verimliliği günümüz mimarlık dünyasında önemli konular olarak kabul edilmektedir. Bu çalışmanın amacı, iki üniversiteden bir grup mimarlık öğrencisinin enerji verimli binalar hakkındaki görüşlerini, gereksinimlerini, mevcut bilgi düzeylerini, algılarını ve farkındalıklarını incelemektir. Sonuçlar, çeşitli genel konuları kapsayan mimarlık dergilerinin öğrenciler tarafından akademik dergilere göre daha çok tercih edildiğini göstermektedir. Konuyla ilgili görsel anlatımlarla desteklenen mimar odaklı tasarım kılavuzuna ihtiyaç olduğu ve öğrencilerin ilgili bazı terminolojilere aşina olduğu ortaya çıkmıştır. Bu çalışma mimarlık bölümlerindeki enerji verimli binalarla ilgili ders içeriğini belirlemede program koordinatörlerine yardımcı olması açısından önemlidir.

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1. INTRODUCTION

Energy and its use are a versatile subject that concerns the whole world today. Nonrenewable energy resources are in the stage of exhaustion, and efforts to seek and create alternative sources are inevitable. Preservation and efficient use of the existing energy resources is important. Industry, transport and household are the main sectors responsible for high energy consumption globally [1]. Today, there are many studies focusing on the use of energy efficiency in the building sector because an important part of the energy and resources consumption belongs to buildings. Approximately 40% of the total energy consumption and about 36% of greenhouse gas emissions in Europe come from buildings [2].

In Turkey energy consumption in the building sector has grown strongly in recent years. It has increased from 19.5 mtoe in 2000 to 32.4 mtoe in 2015 and the annual average increment for energy demand has been 4.4% [3]. Fossil fuels are still a major energy source for all sectors today. Dependency on fossil fuels has not died out completely because the amount of energy production from renewable energy sources cannot meet demand. Fossil fuels are non-renewable and limited in supply and will eventually run out. The usage of fossil fuels has several disadvantages such as global warming and environmental pollution. These make energy efficiency and saving compulsory. All these indicate major necessities for energy efficient buildings urgently. In other words, energy efficiency is an important requirement from a building design perspective. Evidence of increased interest in energy efficient buildings can also be seen in academic literature. A search in Scopus [4], using the terms 'energy efficiency' AND 'building' appearing in the title, abstract or keywords, revealed several papers. Figure 1 shows this trend with the number of documents published worldwide between 1970 and 2018.

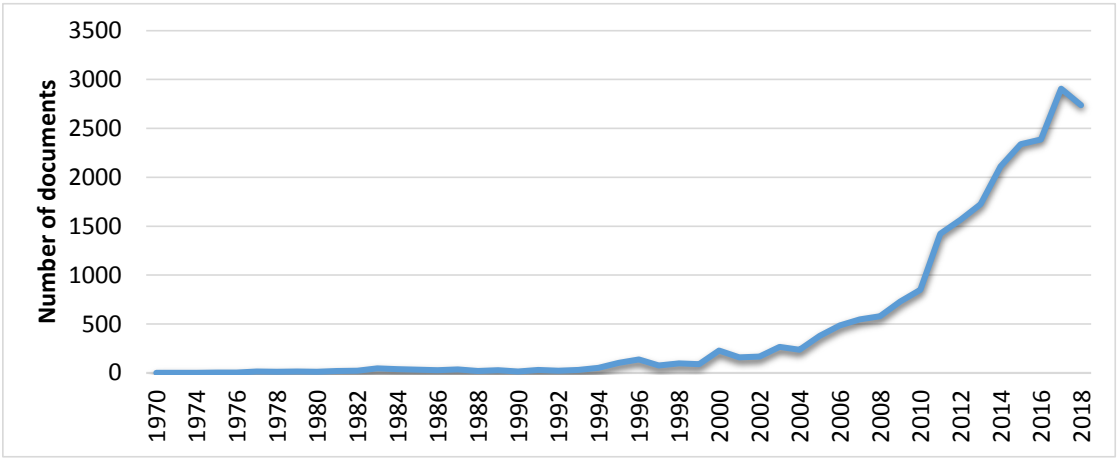

Figure 1. *The number of documents published on the topic of 'energy efficiency' and 'building' between 1970 and 2018*

Energy efficient building can be defined as a building designed to provide a comfortable and healthy indoor condition with minimum energy consumption [5]. It can also be stated as a building using substantially less fossil fuel energy and high renewable energy to ensure the same comfort conditions as a typical building [6]. Therefore, energy efficient buildings require a special design approach. It is clear that energy efficient buildings can require 10-30% lower energy than typical houses [7]. Moreover, annual specific final heating demand of a passive house is lower or equal to 15 kW h/m^2 [8].

Architects are responsible for building design. They also have an important role in reducing energy consumption in buildings. Architecture is accepted as a significant profession that shapes the built environment together with human life and plays an important role in providing basic human needs [9, 10, 11]. Thus, architects should have enough knowledge about energy efficiency for buildings. However, some architects prioritize aesthetic concerns and have little knowledge about energy efficient buildings [12]. All architects should play an important role in the efficient usage of energy in buildings. The existence of architects who have sufficient knowledge, experience and skills in this regard provides a significant contribution to the protection of the environment and saving energy. Energy usage in buildings based on a combination of convenient architectural and energy HVAC design, and effective operations and maintenance of active systems. Therefore, it is important that architecture students who will practice the architecture profession have information about energy efficient building design and show awareness and sensitivity in this regard. Architectural students can contribute to the correct and efficient use of resources with their knowledge, skills and designs in professional life.

Education plays a key role in preparing students for their profession, and education for architects begins at university. The capability and basic knowledge of architects in a specific context profoundly depend on education [13]. Architectural students in universities are trained mostly by academician expert on the different aspects of architecture such as design, structure, engineering, history and practice. It is known that the qualification for a subject require a certain level of knowledge and skill. Therefore, courses in architecture programs are helpful to create basic skills of architectural students [14, 15,16]. Architectural students need enough knowledge about energy conservation principles and techniques, site planning, building form, space organization, material selection, renewable energy usage etc. to be able to design comfortable and energy efficient buildings. Ismail et al. [17] stated that there is no clear framework on how architectural knowledge is integrated into the course plan, what kinds of courses are given, and how students associate this knowledge into practice during building design. Therefore, a conscious approach is needed to provide information for architects during the training phase. High-quality and helpful knowledge is also significant, particularly for decisions at the early stage of design process by the architects and others [18]. Information that is weak, incomplete, unclear or misunderstood may have negative effects on overall building design and its energy performance. An understanding of

students' perceptions of energy efficient buildings may give insight into how they are likely to engage in course practices. The findings help us understand the attitudes and behavioral dispositions of undergraduate architectural students and could help guide the development and delivery of curriculum content for energy efficient buildings. The novelty of this study lies in understanding expectations and perceptions of future architects about course content, format and sources of information, which related to energy efficient buildings. This research specifically aims to better understand architectural students' current knowledge level, requirements, beliefs and perceptions concerning energy efficient buildings. It has focused on the students of architecture because of their important roles as designer for built environment. The other objectives of the study are to:

- Investigate formats of information sources about a specific subject for architectural students,
- Give direction to energy efficient building design for academicians and architectural students from a scientific background.

This study also can fill a knowledge gap in the existing literature and provides a valuable contribution to the training process and program coordinators for Architecture schools about energy efficient buildings.

It is known that there are a few studies in literature regarding the needs of architectural students for energy efficient buildings. Sustainability has become an important issue in architectural education in order to be more sensitive to the environmental impact of architecture and to raise awareness of future generations [19]. Most studies have been carried out on integrating sustainability knowledge into architectural education. In this sense, Boarin et al. [20] investigated undergraduate and postgraduate architectural programmes offered by three tertiary education providers in different continents (Oceania, Europe and North America) and examined how different architectural programmes applied sustainability education within their course plans. The results show that almost all students see sustainability as an important part of their education; however, student views on sustainability in design differ greatly depends on its goals and design focus of each program. Porras Alvarez et al. [21] analyzed the curricula of 20 selected architecture schools in 11 Asian countries to define and summarize sustainability-related courses. It was found that the percentages of sustainable courses varied from less than 5% to 25% in their curricula. The study by Ismail et al. [17] focused on the type of models that have been used in architectural course plans in selected schools of architecture and examine the level of emphasis in integrating sustainability knowledge in the curriculum. It was found that 10 sampled architecture schools in the United Kingdom and the United States of America have different approaches in associating sustainability knowledge in their plan. Dabaieh et al. [22] investigated a relatively new experience in teaching and learning sustainable architecture trends in a living urban lab environment. The results showed that solving environmental problems and challenges in the building industry is hard

without the knowledge in architecture education necessary to apply suitable climatic conscious design principles. Yeang [23] provided important solutions that adapt environmentally friendly design and energy efficiency systems to architecture to create a design guide. Ceylan [24] was intended to provide a road map for revision of vision of architectural institutions in Turkey, philosophies, programs, and course content on the use of energy resources in an accurate and efficient way. Accordingly needs of architectural education in Turkey a model for an undergraduate program is proposed. The proposed program is valid for Turkey's present conditions and higher education laws. Kayıhan and Tönük [25] discussed the basic principles of sustainable design, sustainable development economically and ecologically and they draw attention to concepts such as sustainability, and also explained the relationship between these concepts and education. Baeumle and Hunt [26] defined the information needs of architectural students who want to design energy efficient and, naturally ventilated buildings. The results showed that architectural students preferred design regulations and case studies rather than technical journals. A design guidance in a visual format using conventions and terminologies was necessary for architects. Gaulmyn and Dupre [27] investigated usage of an energy performance simulation tool, called Easy Approach for Sustainable and Environmental Design (EASED) to train architectural students about innovative sustainable design. The results showed that individual studies were not convincing, and success was achieved during group work. Mavromatidis [28] developed a didactic approach to bring together sustainability and building applied energy efficient methodology in architectural education. It was seen that the applied approach gives trusted results for the pedagogical aim in the nine projects.

Elective courses are an opportunity for students to tailor their professional portfolios privately and support to students' professional and personal improvement and increase their motivation to perform well on selected topics [29]. Ghonim and Ewede [13] studied on providing a basis for associating elective courses into the architectural curriculum by researching the component of elective courses in 30 architectural programs worldwide. This paper raised new questions that broaden the impact of architectural programs on quality and investigate their benefits for those related with architectural accreditation. The study of Hedges et al. [30] provides a research designed specifically to provide a better understanding of the factors that contribute to student’s elective module preferences. The results suggest that programs should increase their knowledge of the factors affecting students' choice of elective courses. Also Ting and Lee [31] examined the characteristics that affect students' choice of university elective courses. The results showed that students worry most about the perceived difficulties of the elective course and avoid enrolling in such an elective course. The reviewed literature showed that research on energy efficient buildings in terms of educational perspective lacks common studies. As a result of this literature review, we may argue that there is a need to understand and examine requirements of architectural students for energy efficient buildings within architectural education.

2. MATERIAL AND METHOD

This paper is organized in the following way: firstly, an introduction and literature survey, secondly, the general methodology is defined. In section 3 the key findings from the survey and recommendations are discussed to potentially better engage architects with scientific information. A detailed analysis was also conducted on the views and preferences expressed by the students. Finally, the results are summarized, and the main conclusions presented.

For the purpose of this research study, an exploratory approach was taken. The survey was selected as a type of main methodology. The basic concern was to keep the questionnaire as short as possible and to obtain reliable information. Thus, a clear and short survey was prepared for B.Sc. architectural students. At the undergraduate level, official course outlines of available Turkish architecture programs at state universities were reviewed and total number of ECTS (The European Credit Transfer and Accumulation System) credits of compulsory courses exclusively and specifically focused on energy efficiency was calculated to see rate in curriculum. It was found that the average ECTS credit of the courses in the programs was 5.7 (The standard deviation: 2.2). Then two architectural programs including related courses having average credit value were selected: Balikesir and Trakya Universities. The students from two universities have also similar mean scores to be able to obtain registration rights for architecture according to YOK statistics. The survey was applied to gather information directly on energy efficient building and its design from the students. They were conducted during the courses and questionnaires were collected before students left classrooms to reach a high response rate. The questionnaire was applied to second, third and fourth-year architectural students in the 2018-2019 fall term.

The survey, totaling 18 questions, consisted of four parts: personal information (1), the general knowledge and perception of participants on energy efficient building (2), preferred information resources together with their format about energy efficient building and its design (3) and barriers for energy efficient building (4). The questionnaire includes mostly closed-ended and a few open-ended questions which were developed in view of the findings of similar studies previously conducted such as Baeumle and Hunt (2018) and are specifically designed to measure architecture students' awareness and needs about energy efficient buildings [26].

Main views and preferences of students were taken by answering the following questions:

- Which journals have you read or are interested in reading?
- Have you attended a seminar, conference and/or presentation about energy efficient buildings?
- Have you heard the following terms before?
- When designing an energy efficient building, which of the following sources would you use to help your design?

- Which expert(s) would you like to consult when designing an energy efficient building?
- If a design guide was to be written specifically for architects on energy efficient buildings which subjects should be included?
- Which of the following presentation style(s) is suitable for design guide?
- Where should the design guide be published?

The authors conducted a preliminary survey to test the research instrument and to identify items that should be revised and to check the sequencing of the questions. It was applied to sixteen randomly chosen architectural students in the study population. As a result, no major adverse comments were received from the students. Then the pilot study questionnaire, after slight modifications was prepared as the final questionnaire for the main study.

Once all changes were made, the survey questionnaires were deployed in two universities, Balikesir and Trakya. A total of 479 respondents (303 from Balikesir University and 176 from Trakya University) participated voluntarily in the survey. 460 were acceptable, representing a usable response rate of 98 percent. The collected data was analyzed and interpreted by using Statistical Package for Social Science (SPSS) version 22. The Quantitative survey data was reported statistically.

The demographics characteristics of the respondents are shown in Table 1. In Balikesir University (BAUN), the sample consists of 303 students of which 136 (44.9%) were female and 167 (55.1%) were male. In Trakya University (TU), the number of female respondents was 97 (55.1%), while the male respondents numbered 79 (44.9%).

Table 1. Subject demographics

Balıkesir University	**Age**				**Number**	**Proportion**
	Ave	**Min**	**Max**	**SD**		
Male	21.40	18	30	1.711	167	55.1%
Female	20.95	18	33	1.926	136	44.9%
Second year student	19.64	18	33	1.651	86	28.4%
Third year student	20.86	19	26	1.008	84	27.7%
Fourth year student	22.42	20	30	1.426	133	43.9%
Trakya University	**Age**				**Number**	**Proportion**
	Ave	**Min**	**Max**	**SD**		
Male	22.11	19	41	3.385	79	44.9%
Female	20.82	19	27	1.354	97	55.1%
Second year student	20.51	19	28	1.423	71	40.3%
Third year student	21.41	20	32	1.768	85	48.3%
Fourth year student	24.55	21	41	5.042	20	11.4%
Balıkesir + Trakya University	**Age**				**Number**	**Proportion**
	Ave	**Min**	**Max**	**SD**		
Male	21.6	18	41	3.115	246	51.3%
Female	20.6	18	33	1.122	233	48.7%
Second year student	19.8	18	33	1.501	157	32.7%
Third year student	21.2	19	32	1.456	169	35.2%
Fourth year student	23.9	20	41	4.796	153	31.9%

3. THE RESEARCH FINDINGS

This section shows the main results of the survey parts. The opinions and preferences of architectural students are highlighted by using charts and tables.

3.1 The General knowledge and awareness of participants

The questions of this part refer to the general knowledge of participants on energy efficient buildings. Firstly, three different journals were determined regarded as either of a technical, an interdisciplinary and a design-related nature. "Megaron" which is an interdisciplinary journal was preferred as they span a broad spectrum of architecture research topics. "Yapı" journal is a magazine that gives ample space to new projects and applications from Turkey and around the world. "Thermal Science and Technology" is an academic journal that enables the publishing of original, theoretical, numerical and experimental studies in the field of heat science and technique. Later, which journal articles that were read and interesting to read were inquired about. The results show that in Balıkesir University, Yapı Journal was the most read paper by participants (Figure 2). The vast majority of the participants expressed willingness to read Journal of Thermal Science and Technology and Megaron Journal whereas only a small percentage, 13-14% read at all. It shows that the students from Balıkesir University were mostly interested reading journals related to energy efficient buildings. A similar situation was encountered with students from Trakya University. Yapı Journal was the most widely read journal. Journal of Thermal Science and Technology and Megaron Journal were papers interesting to read. The reason for the high read rate of Yapı Journal can be related to its scope because it covers a wide range of topics such as new projects from Turkey and around the world, environment, urbanism, architectural theory and history, technology and materials, industrial design and art. Other journals generally publish scientific papers. These mean that mostly architectural journals about general subjects appeals to architectural students.

Understanding of perceived knowledge of architectural students about energy efficient buildings is significant. Therefore, their knowledge levels were directly asked to the participants. The results were evaluated according to the educational year (Table 2). It was found that 8.2%, 4.7% and 5.2% of the participants from second, third and fourth educational year students in Balıkesir University selected no information about energy efficient buildings. According to the syllabus of Balıkesir University for architecture, building physic course (compulsory) are given to the third year students and one elective course about climate conscious building design in the third year. Thus, minimum rate for "none" may be happened in that year. The rate increased little in the fourth year. This may be because students have difficulty remembering the knowledge learned previously and there are not many elective courses for fourth year students. In Trakya University, we may deduce that the number of the participants voted

none is decreasing in years. Nobody from the fourth-year students choose none. It was seen in the syllabus of Trakya University for architecture that building physic course is in the third year and there is one more elective course related to energy efficiency in the fourth year. As a result, when a particular topic or issue in a course is given to students, they may be familiar with that subject. Most of the students from the two universities voted little and very little. Also, the number of students who voted much and too much did not reach a high rate. These results can reflect the importance of courses or activities related to a specific subject.

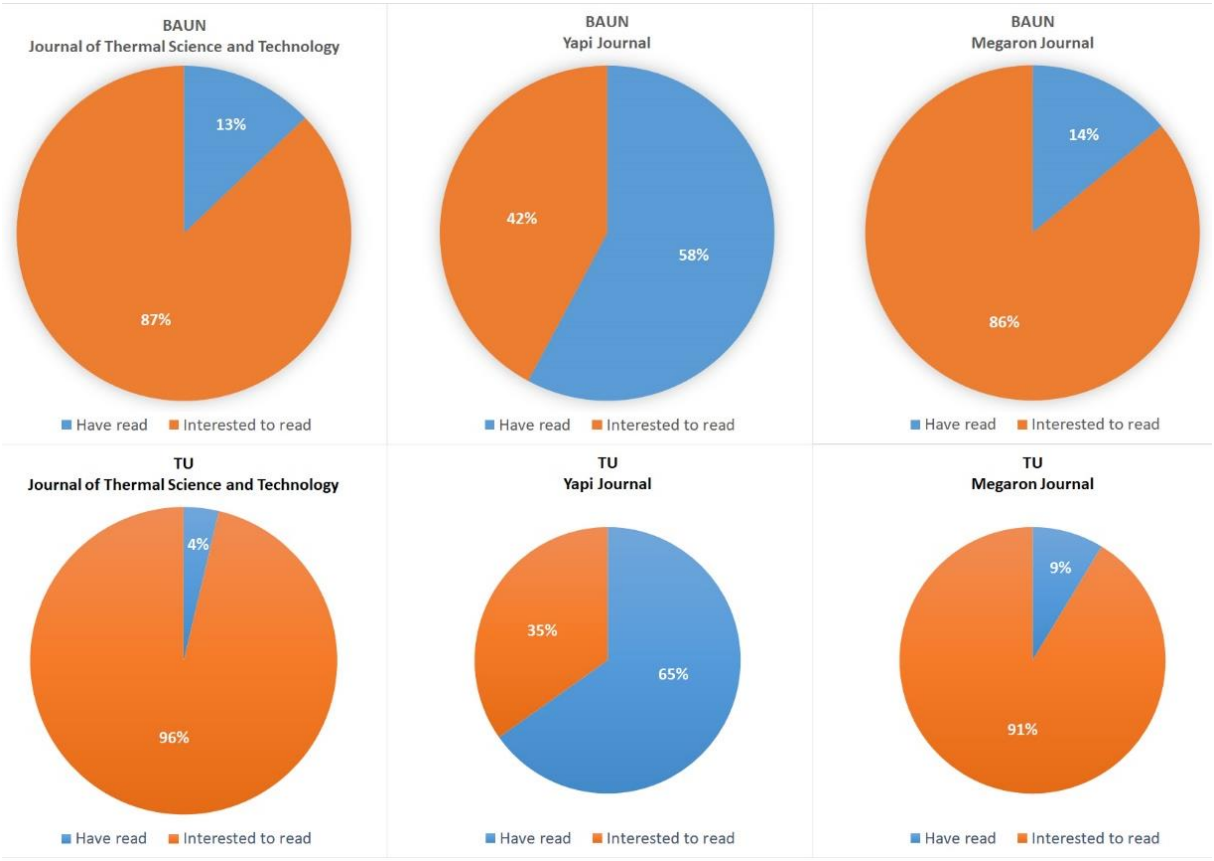

Figure 2. *Reading percentages of related journals*

Table 2. Knowledge level of the students on energy efficient design

	Second year		**Third year**		**Fourth year**	
	Balıkesir University	Trakya University	Balıkesir University	Trakya University	Balıkesir University	Trakya University
None	8.2	11.3	4.7	4.7	5.2	0
Very little	55.4	42.3	34.5	24.7	33	20
Little	36.4	40.8	58.6	64.7	51.4	65
Much	0	5.6	1.1	4.7	6.7	15
Too much	0	0	1.1	1.2	0.7	0

The familiarity of technical terms can be associated with knowledge level at the same time. For that reason, 16 terms commonly used in energy efficient buildings determined from the literature was asked to the students to select the most familiar. The results were listed from most familiar to least in Figure 3. In Balıkesir University, 'Solar shading', 'Insulation' and 'Thermal comfort' were selected by over 200 students. Also, these terms are major issues for energy efficient buildings. Among the 16 terms 'Trombe wall', 'Sun space' and 'Photo Voltaic (PV)' were marked as little-known terms by approximately 75 students. An interesting result is that 'PV' was among the least familiar terms, although it is a common tool to produce electricity from the sun. The majority of architectural students in Trakya University selected 'Insulation', 'Heat gain from the sun' and 'Solar shading' as the most familiar terms. The least rated terms 'Sun space' 'Airtightness' and 'Heat pump' were marked by the students. It is clear that there are minor changes in ranking of terms between universities. This may be due to differences in course content.

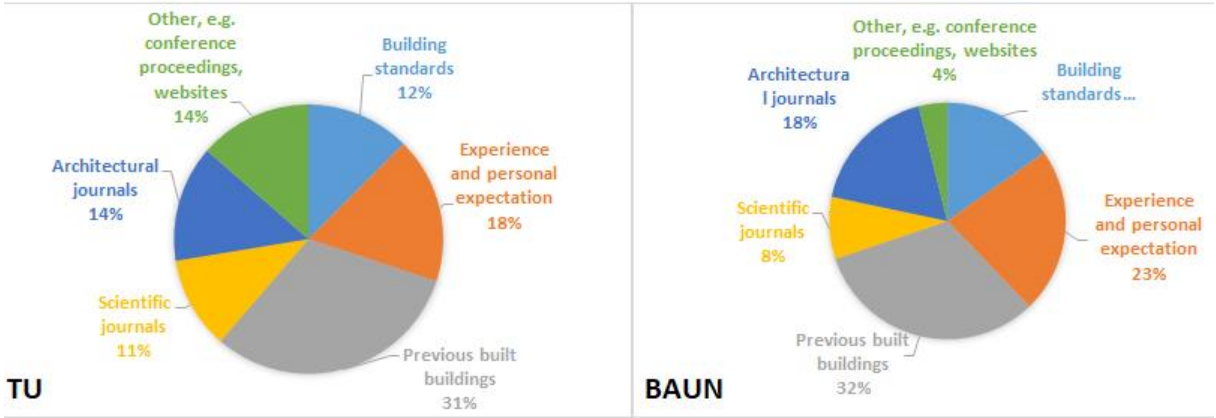

Figure 3. *Reading percentages of related journals*

Moreover, familiarity of terms was also investigated based on education years. The results (Table 3) shows that familiarity for terms has mostly increased in the fourth year compared to the second year. This finding is understandable as students are more likely to encounter these terms over time.

The next two questions deal with information sources and advice from the experts on energy efficient buildings. Thus, the participants were asked to select, from a variety of options, their preferred type of sources with reasons. Options related to sources are the journal papers, standards, previously built buildings and others. All responses were demonstrated in the pie chart (Figure 4).

Table 3. Percentage of voted terms related to energy efficient buildings based on education years

Terms	Second year		Third year		Fourth year	
	Balıkesir University	Trakya University	Balıkesir University	Trakya University	Balıkesir University	Trakya University
Thermal comfort	52.3	60.6	69	94.1	85	95
Heating/cooling load	31.4	40.8	36.9	65.9	54.9	70
Thermal bridge	40.7	18.3	27.4	91.8	39.1	80
Heat gain from sun	60.5	73.2	52.4	95.3	74.4	95
Wind chimney	16.3	43.7	44	64.7	45.9	60
Trombe wall	8.1	11.3	21.4	88.2	19.5	90
Solar shading	91.9	85.9	84.5	92.9	96.2	95
PV	15.1	21.1	33.3	69.4	36.1	80
Heat pump	46.5	23.9	36.9	45.9	58.6	55
Heat transfer coefficient	36	42.3	36.9	84.7	70.7	75
Thermal mass	26.7	40.8	32.1	90.6	53.4	90
Heat transfer	51.2	66.2	52.4	91.8	80.5	85
Insulation	91.9	90.1	81	95.3	91.7	100
Sunspace	15.1	21.1	33.3	42.4	33.1	55
Airtightness	29.1	26.8	23.8	41.2	41.4	70
Smart glass	51.2	66.2	64.3	74.1	74.4	80
Solar chimney	12.8	39.4	40.5	69.4	36.8	75

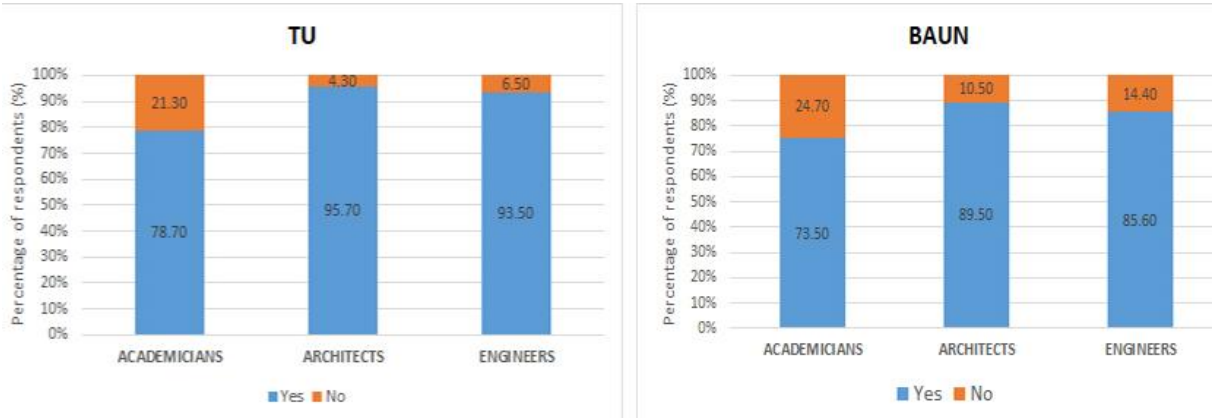

Figure 4. *The preference for particular types of resource for energy efficient building design*

Most of the participants (31% and 32%) selected the existing building as a reference and example for energy efficient building design. The potential reason of this preference may be the fact that current buildings can provide evidence-based information for design of energy efficient building. Another most preferred option with 18% (TU) and 23% (BAUN) is experience and personal expectation as information source. Maybe the students consider the experience as a helpful tool to gain practical knowledge and to develop key skills on a specific subject. Almost 18% of the participants from Balikesir University preferred the Architectural Journal whereas the ratio in Trakya University was 14%. These journals can serve as an archive of information in fields of several subjects. Another information resource is building standard. They cover a wide range of rules from design to construction. The

preference ratio of building standard was 15% (BAUN) and 12% (TU). Articles in scientific journals were preferred by a small number of the participants where the ratio was %8 - %11. Perhaps scientific journals are read generally by scientists and are mostly the final output of academic studies. There was a distinct difference between votes given by BAUN and TU students for conference, proceedings and website preferences. The ratio at Balikesir University was 4% while it was 14% at Trakya University. This can be associated with several issues such as the number of organizations in these universities, distance to various organizations based on the location of two universities and access to conference papers. Trakya University is closer to Istanbul compared to Balıkesir University. It is known that many conferences and different activities are organized in Istanbul. Moreover, International Sinan Symposium is organized every two years by the Faculty of Architecture in Trakya University. More research is necessary to able to obtain accurate reasons for this difference.

The survey also investigated experts preferred for consultation during the design of energy efficient building. As can be seen in Figure 5, 89.5% of Balıkesir University participants evaluate their colleagues as a source of information. In Trakya University, almost all students (95.7%) voted architects. It shows that architectural students accept architects as expert and the most reliable knowledge source when designing an energy efficient building. Engineers were voted in the second order as a consultant, the ratio is 93. 5% (TU) and 85.6% (BAUN). The students think that close relationships between architects and engineers are essential to provide information for energy efficient buildings. Only the mean 77% of the students from two universities admits academicians as a knowledge source for energy efficient buildings. According the general reasons expressed by students who voted academicians; they have more theoretical information and little practical skills and experience in the field of a subject. This means that academics need to improve their knowledge on practical topics.

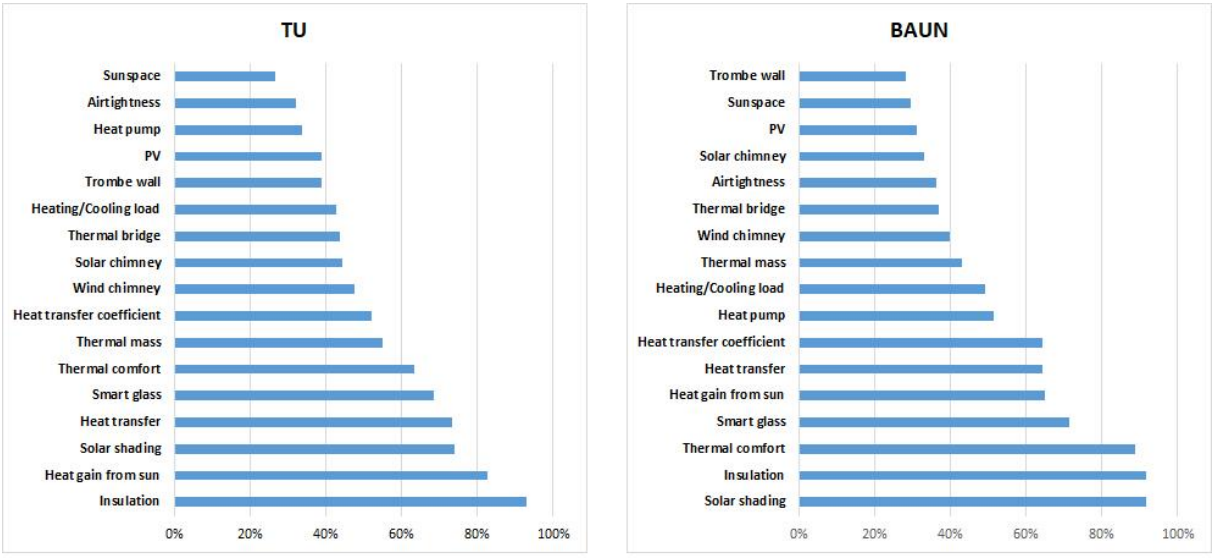

Figure 5. *Percentage of architectural students who want to get advice from experts*

Other questions focus on the understanding of willingness of the architectural students to design energy efficient buildings. A high percentage, 88.1% of the participants from Balikesir University seemed assertive in designing energy efficient buildings whereas a small part of them were reluctant. The rate of willingness for energy efficient building design is very high with 96.6% in Trakya University. The major reason for the negative respondents expressed by participants was similar and they mostly concentrated on high construction expenditure and lack of demand for energy efficient buildings. A complementary question for design of energy efficient building was about the expected building stock in the future; would you like to see more energy efficient buildings in the next 5-10 years. Almost all of the participants (95.7%-BAUN and 98.9%-TU) want to see more energy efficient buildings in the building stock. Very few students have opposite opinions. These are also consistent with the previous results.

Keskin and Erbay [32] stated that architecture discipline has an important responsibility for building sustainability and construction of environmentally friendly buildings. The authors consider that architects should believe that energy needs of buildings can be reduced with energy efficient architectural strategies and they have an important role to save energy in buildings. For this reason and to support previous questions related to energy efficient building design, a new one was prepared. It examined students' perceptions about whether it is possible to reduce the energy consumption of buildings with architectural strategies. While the vast majority (82.8%) of Balıkesir University participants agree that energy saving is possible with architectural solutions, 17.2% of students think that this is not possible. In Trakya University 91% of the students believed architectural solutions could be helpful to reduce energy demand in buildings. One of the reasons behind the negative belief is as follows; architects do not have sufficient knowledge; another is that the contractors are the main determinants of the construction and decision process. In addition, the lack of energy efficient building samples is also stated as a negative situation.

Regulations, standards and codes can contain mandatory instructions that affect the architectural design process. Thus, the following question focuses on the rules on energy efficiency in these documents that limit the architectural design process and creativity of architects. 67.7% of the participants in Balıkesir University think that designing a building with rules as energy efficient does not affect the freedom and creativity of the architects and process. However, 32.3% of the students disagree. According to the results of the survey from Trakya University, 75.8%, of students consider that the criteria does not limit the design and architects but 20% of them believe that it can restrict architects and the design process. The general reason explained by the students is that the rules can make the design process more complicated. This may also be accepted as a barrier for increasing the number of energy efficient buildings. To clarify this situation, the nine potential barriers listed in the

questionnaire were asked to the participants. The results revealed that the five greatest perceived barriers were the same for Balıkesir and Trakya Universities (Figure 6). They are unknown importance of subject adequately, increasing construction costs, lack of demand, no legal obligation and insufficient architectural expertise. They were found as major barriers and adversely affect the increase in the number of energy efficient buildings. These concerns can be mitigated by explaining the energy saving potential of energy efficient buildings and their financial and environmental benefits. In other words, all gains from the energy efficient buildings could be used as the main argument by policy makers and all stakeholders to eliminate hesitation or anxiety. On the other hand, lack of resources/knowledge and lack of Turkish resources/knowledge on the subject are the least rated obstacles.

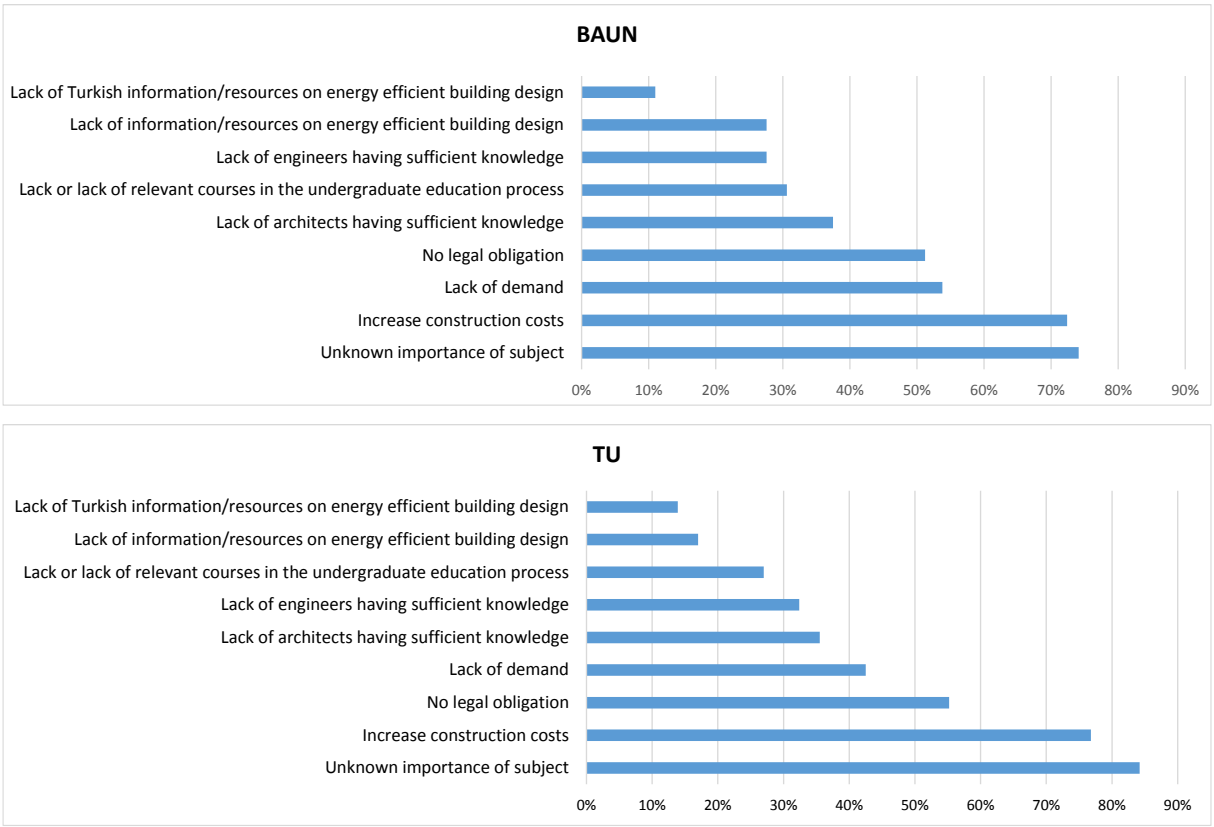

Figure 6. *Potential barriers to increasing the number of energy efficient buildings*

The last question deals with participation in activities such as seminars, conferences and/or lectures about the subject. This question was formulated in this way; "Have you been involved in any activity on energy efficient buildings?". 61.4% of the students in Balıkesir University joined activities but this rate was only 48.5% in Trakya University. It can be related to the number of activities organized by the universities. When the results are examined based on the educational year, it is clear that participation rate increases towards upper classes (Table 4). It means that interest, awareness and actions for energy efficient buildings increases over time.

Table 4. Percentage of the students joining to the activities related to energy efficient buildings

	Second year		Third year		Fourth year	
	Balıkesir University	Trakya University	Balıkesir University	Trakya University	Balıkesir University	Trakya University
Yes	52.3	29.6	57.1	44	69.9	80
No	47.7	70.4	42.9	56	30.1	20

3.2 Content and format of information resources

It is not possible to learn everything about a subject through the courses. Paper based documents can be helpful for the learning process. Generally, scientific papers consist of mostly theoretical information, technical terms and mathematical equations. They can be easily understood by academicians, but it can be unfamiliar to audience from other disciplines having professional qualification such as architects. This type of resources may prevent the application of study findings during the design process. For these reasons, the last part of the questionnaire deals with information resources in terms of different aspects such as preferred styles and formats. Initially, we investigated whether available resources about energy efficient buildings were adequate for students. Only 16.2% of the respondents in Balikesir University believed existing resources were enough. This rate is surprisingly higher at 30.3% for Trakya University. This result indicates that there is not a consensus among students from Trakya and Balıkesir University. The rest of participants consider that there is not enough resource about the subject. The possible reason of this can be related to lack of Turkish resources in literature and difficulties in access to information resources.

Type or format of information resources can directly change its intelligibility. Thus, its style is very important and should be determined based on the audience. To examine existing resources' type in literature from the perspective of students, it was asked whether their design format is suitable for use and understood by architects or not. Almost half of the students (46.2% -BAUN, 46.8% -TU) think it is appropriate, while the rest think it is not. The answers from two questions show that the architectural students need resource in a suitable format. Content for information resource is another significant issue. It was asked if a design guide is prepared for architects and which of the 13 topics should be included in this guide. Figure 7 summarizes the responses according to the topics. The results showed that 'Renewable energy sources', 'Natural ventilation', 'Natural daylight', 'Principles of energy efficient building design' and 'Insulation' were the most desired topics included in the design guide for students of both universities. 'Photovoltaics (PV)', 'Heat pump', 'Passive strategies for building design' were the least desired topics in the design guide.

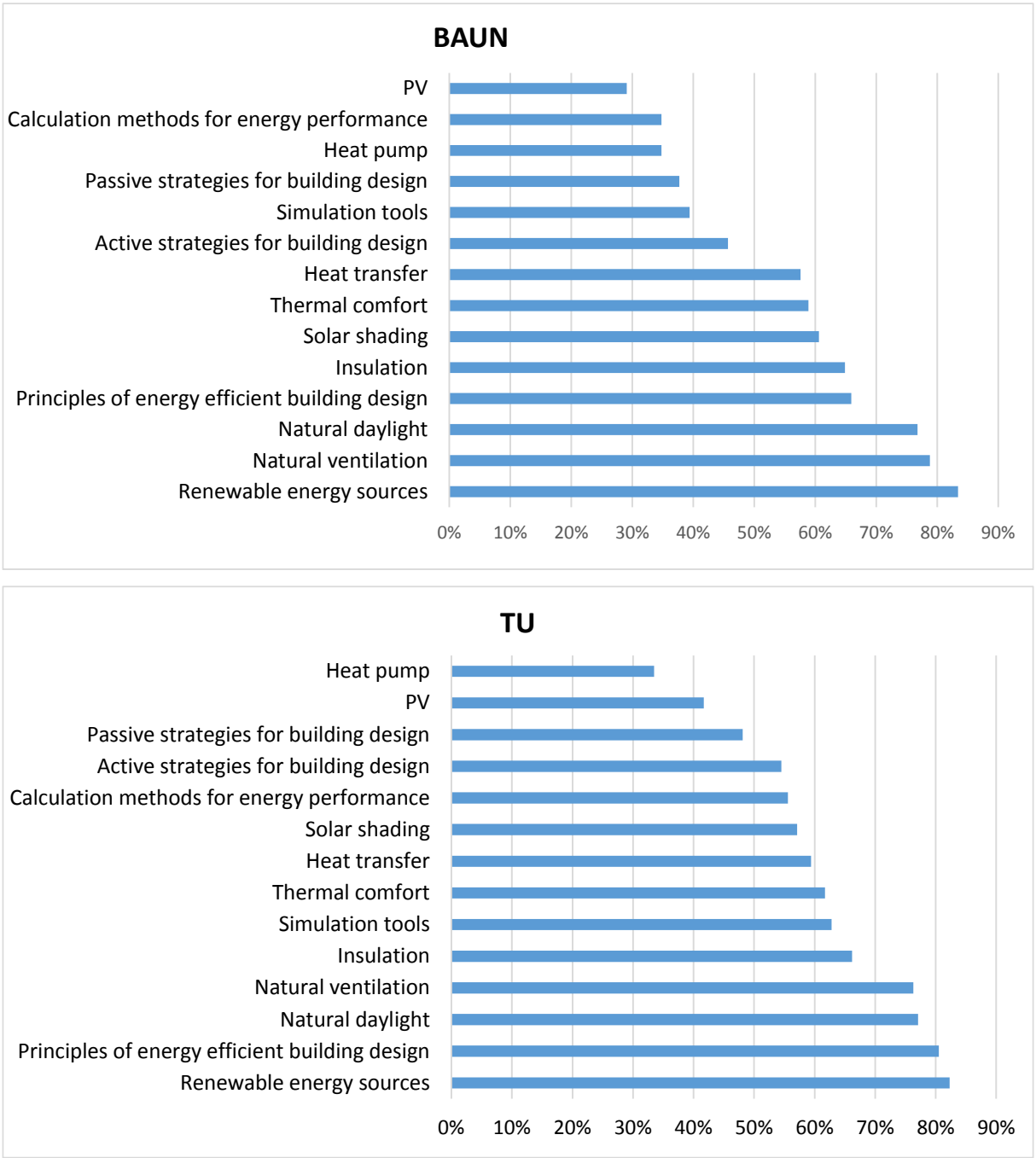

Figure 7. *Preferred topics in the design guide*

Once the topics have been decided, the next question has been prepared regarding the style and format of the design guide, because they are as important as the topics in the design guide. We inquired in our questionnaire which presentation style is better. Survey findings in Figure 8 indicated that the greatest preference by students (90%) was diagrams, pictures and descriptions for design guide. This is generally valid for all architects because, as is known, architects have the ability to reflect their design and comments visually [33]. It was also seen that almost 50% in BAUN and 60% in TU of the students prefer a design guide consisting of mathematical equations and calculation examples. This is an

important result because a significant part of the students believes the necessity of mathematical equations. In our opinion, students are interested in usage of mathematical equations and calculation examples, but as an architect candidate still mostly prefer a design guide consisting predominantly of visual materials. It is clear that there is no one certain style for design guide. As a result, a design guide should be a combination of one or more styles desired by the architectural students.

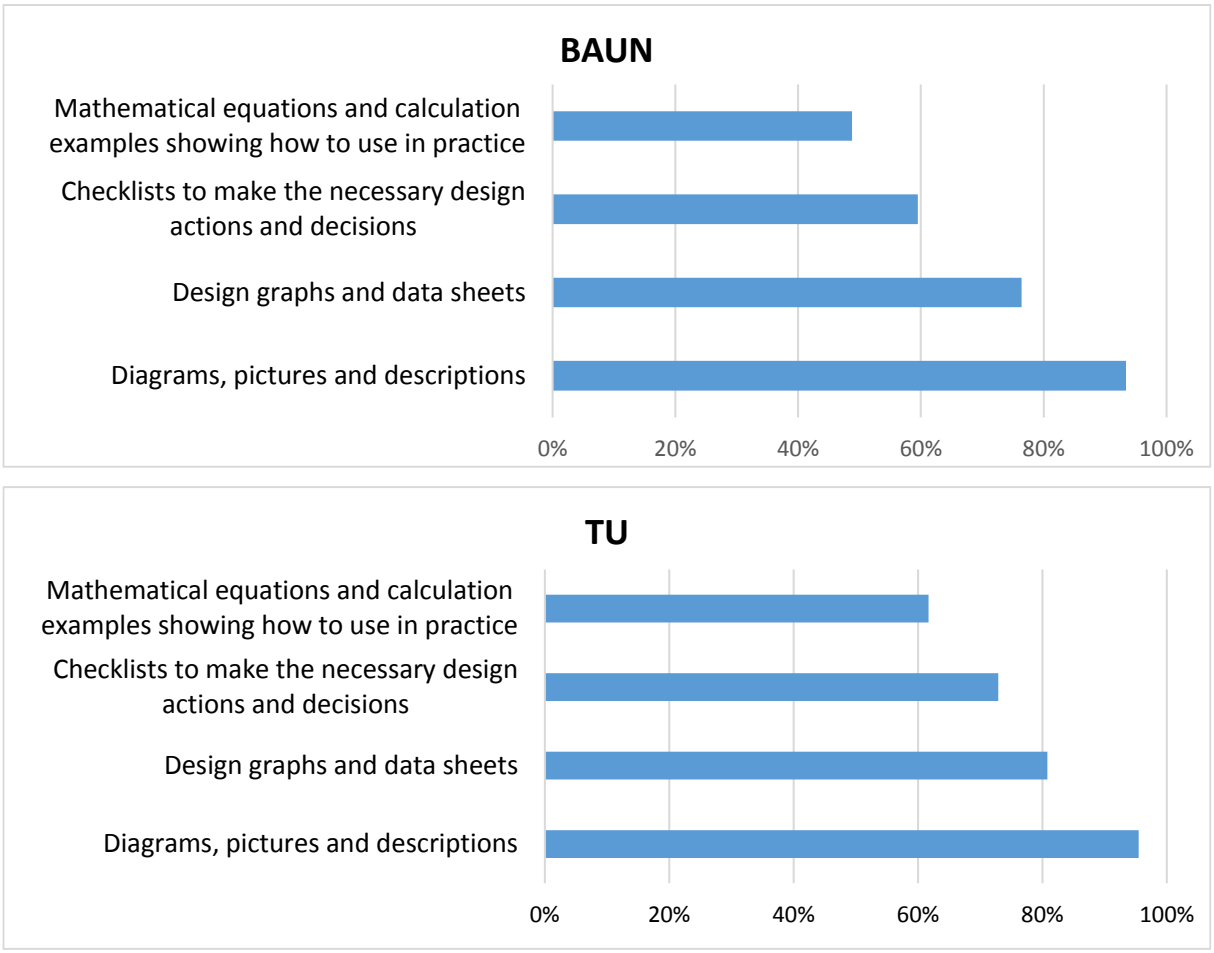

Figure 8. *Preferred presentation styles*

The survey results also showed preferred level of detail for a design guide. A short and concise guide for energy efficient building design was scored as 63.7% (BAUN) and 50.2% (TU). The participants emphasized the importance of shortness and clarity for the design guide. Several participants expressed the main reasons behind their choices as follow;

- Short guide can be more easily understood.
- Avoiding confusion is good.
- Details can make it boring.

By contrast, the rest of the students wanted a comprehensive guide including detailed instructions and arguments on energy efficient buildings. They commented that:

- Even if we know nothing, we can learn something.
- If we learn more, we can use it more effectively.
- Designing will be easier when all the details are learned.
- More information can lead to more accurate results.
- A detailed guide is required.

Finally, the participants were asked where the design guide should be published. The findings showed that over 80% of participants in two universities preferred the internet to publish the design guide. More than 50% of the students would prefer a design guide to be published as journal articles and books.

4. CONCLUSION

This study was conducted to investigate future architects' requirements, current knowledge level, perception, and awareness regarding the energy efficient buildings on a group of architectural students from Balıkesir and Trakya Universities. The findings of the survey were examined to give idea and raise awareness about energy efficient buildings through the architectural students. When the participants are considered as an architect in the future, their vision is more important for academicians and professionals.

The main results of survey conducted in two universities were summarized as follows:

- There is no dominant distinction between answers of students in Balıkesir and Trakya Universities.
- The respondents seem generally very optimistic towards reading publications about energy efficient buildings.
- Familiarities of the terms show students' good awareness on energy efficient buildings. Terms generally took similar vote rates in Balıkesir and Trakya Universities. By using the most preferred terms, academicians can determine course content to meet the needs and expectations of architectural students.
- According to students, unknown importance of subject, construction costs, lack of demand and lack of legal obligation are the most important barriers for increasing the number of energy efficient buildings. Therefore, the development of solutions for these issues should be priority.
- Architecture students mostly prefer existing buildings as a learning tool. This presents importance and need of good practical applications for the specific subjects and they can provide proven and helpful information to architectural students.
- Visual presentation techniques instead of theoretical terms are preferred as a design guide style. A design guide should also be in a short format with intelligible and visual explanations. It can be concluded that visual representation of theoretical knowledge and clear mathematical notation are vital requirement for architectural students.

- It is essential that efforts to increase architectural students' knowledge about energy efficient buildings give a positive effect, e.g. towards increasing the number of buildings consuming low energy.
- Almost all of the students wanted accessible design guideline on the internet. This indicates that web platform is very important and an easy tool to reach the audience. An interactive design guideline on an online platform or blog can be helpful for the architectural community in the future.

To conclude, this study reveals personal views and opinions of architectural students that will contribute to the educational and professional process. The above results are expected to be useful and guiding for developing information resources for architectural students. It was also revealed that they should be prepared with attractive visual format and content for energy efficient buildings and case studies of current buildings should be a part of the architectural education in a practical manner. In view of these results, department managers can set up coherent course content and sources of information, ideally in an atmosphere that fosters interdisciplinary solution and collaboration. Indeed, well-designed courses may even constitute solutions to the problems related to energy efficient buildings that many architects are facing nowadays.

The main limitation of this study is that the survey took place in two architecture schools. Thus, the results can likely not be generalized to all architectural students. They express opinions and perception of a small sample of architectural students. Hence, future studies with much larger sample size would be required to ensure more generalization of the findings of the study. Content of study could be expanded to evaluate the effectiveness of the architectural education process in terms of the sustainable building design by reviewing curriculum in schools of architecture.

CONFLICTS OF INTEREST

No conflict of interest was declared by the authors.

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