

Research Paper

Investigating the Effects of Exposure to Natural Blue Elements on the Psychological Restoration of University Students

F. Amirbeiki¹, A. Khaki Ghasr^{2*}

¹ PhD Candidate, Department of History of Art, Architecture and Landscape, University of Groningen, Groningen, Netherland

² Assistant Professor, Department of Architecture, Faculty of Architecture and Urban Planning, Shahid Beheshti University, Tehran, Iran

Received: June 2019, Revised: February 2020, Accepted: March 2020

Abstract

Even though the positive influences of nature on human health have been known for many decades, few studies have been carried out exclusively about the psychological benefits of exposure to water and sky as natural blue elements in built environments. Hence, close-ended questionnaire along with structured interviews (with open-ended questions) are applied to investigate the main question of this study: what are the effects of blue elements' exposure on psychological restoration of university students? 81 students of architecture, urban design, and painting with graduate and post graduate degrees are considered as the participants and the main central courtyards of two traditional dwellings, which currently are used as educational environments, are selected as the case studies in the hot-arid climate of Yazd, Iran. The results of the close-ended questionnaire show that among natural elements, water has the most significant influence on fascination and being away (two components contributing to restoration). Besides, although in comparison to water, the sky has less effective influence on fascination and being away in the studied environments, it is as important as green elements in fostering fascination and being away. Through content analysis of structured interviews, it is revealed that not only is water the most preferred and important natural element of both courtyards but also students' pleasantness, refreshment, and relaxation from stress are mainly due to water exposure. In conclusion, the study tries to highlight that in addition to green elements, it is essential to consider blue elements. Besides, some design strategies based on their exposure in educational environments have been recommended in order to foster the psychological restoration of university students.

Keywords: Natural blue elements, natural green elements, central courtyards of educational environments, psychological restoration, yazd.

1. INTRODUCTION

Although university students are known as the privileged population, the number and severity of psychological disorders are increasing among them. It is reported that students' sufferings and disabilities associated with psychological illnesses may cause negative effects on their academic success, productivity and social relationships [1]. However, the characteristics and physical features of educational environments can bring positive impacts on the psychological health of their occupants [2]. It is proved that nature exposure is one of the effective features which can intensively support the psychological

restoration in the built environments [3-5]. According to "attention restoration theory", restoration, which refers to a situation that attention goes without effort to interesting, pleasant aspects of the environment while it involves the renewal of depleted psychological resources, can be achieved by exposure to nature [6].

Many researchers have focused on the positive influences of green elements on physical, social and psychological health, especially in urban areas [7-12] and some specific types of buildings such as health care spaces [13-16], workplaces [17-19], which their occupants are under a lot of pressure and stress, and residential buildings [20 - 21], which people spend the majority of their lives there. Considering the specific psychological restoration, some studies showed that perceived stress would be

*Corresponding author: a_khakhghasr@sbu.ac.ir

decreased significantly by more visits and more time spent per week in green spaces [22 - 23]. Ulrich, who is one of the pioneers in debates of healing environments, revealed that after watching a stressor video, watching a 10 minutes video of nature view can recover participants from stress significantly within 4-7 minutes [24]. Another study showed that the presence of indoor plants in underground buildings, which people have mainly negative feelings towards them, can increase the positive perceptions [25]. Considering educational environments, a study conducted in sunken courtyards, as a type of underground buildings, confirmed that the strong link between nature and these environments can bring positive impacts on psychological perceptions of occupants [26]. Furthermore, it is reported that the existence of green spaces with specific features in the university campuses can bring health benefits for both staff and students [27] and positively affect students' learning process [28].

In addition to natural green elements, the introduction of the term "blue" (as a new color, literally and metaphorically, to the debates about environmental health and therapeutic spaces [29]) revealed that water and sky are the two major natural blue elements with significant influences on human health. Although some research contained water as an element of green spaces, these days, few experts have focused exclusively on the relation between water and health [30-36]. There is some evidence that people who live near canals of water experienced aesthetic value, engaged more in social activities, and possessed emotional bonding to the water [37]. Furthermore, it is reported that both natural and built environments providing views to water were associated with higher preferences, greater positive effects, and

higher perceived restorativeness than those without water [38].

Sky is the most neglected natural element in debates related to human health. One study showed that in low-rise apartments, occupants, who frequently watched the sky from their windows, reported more effective functioning [39]. Another exception is the research done by Masoudinejad and Hartig [40 - 41] who stated that view through windows to sky brings about significant restorative influences for occupants in a populated city.

The main objective of this study is to investigate the effects of natural blue elements (compared to green ones) on the psychological restoration of university students, as a group who experience many psychological disorders, in educational environments. Noticing the aforementioned studies, although some studies assessed the psychological health of people associated with their perception of the totality of blue and green spaces, the psychological benefits of particular blue elements (especially in regions with harsh climates) are not considered precisely. Hence, the main central courtyards of two traditional dwellings, which currently are used as educational environments and provide exposure to blue and green elements, are considered as case studies in the hot-arid climate of Yazd, Iran (Figure 1).

The paper will be continued by presenting the features of the studied courtyards in Section 2. In Section 3, the methodology, which is applied to analyze the case studies, is explained. The results and conclusion are presented in Section 4 and 5 respectively. Section 6 describes the limitations of the present study and suggests some opinions for future research.



Fig 1. Studied courtyards: Mortaz courtyard (left), Rasoolian courtyard (right) (Source authors)

2. FIELD INVESTIGATION

Based on the Köppen climate classification, there exist four climatic zones in Iran: hot–humid, hot–arid, mildly humid, and cold [42]. In this paper, the main central courtyards of two traditional dwellings named Rasoolian and Mortaz, which are located in the hot-arid climate of Yazd with high temperature and intense solar radiation, were selected. These courtyards have been used as open spaces of the art and architectural faculty of Yazd University for more than 25 years. The Rasoolian courtyard possesses older plants and trees such as four cedar trees (each one located in a corner of the courtyard), a tall pomegranate tree, and few flowers. However, the

Mortaz courtyard provides more spaciousness because of less number of plants and trees (with lower height). It contains a fig tree, a tall palm tree, a ten-year-old orange tree as well as few rose bushes.

Both courtyards’ water pools were colored by Persian blue while Rasoolian’s water pool has a higher width and depth than Mortaz’s water pool. These water pools are located in the center of the courtyards.

Figure 2 shows the studied courtyards and their plans. Figure 3 presents the perspectives of the main central courtyards.

Besides, some information regarding the dimensions of courtyards is presented in order to have more detailed analysis (Table 1).

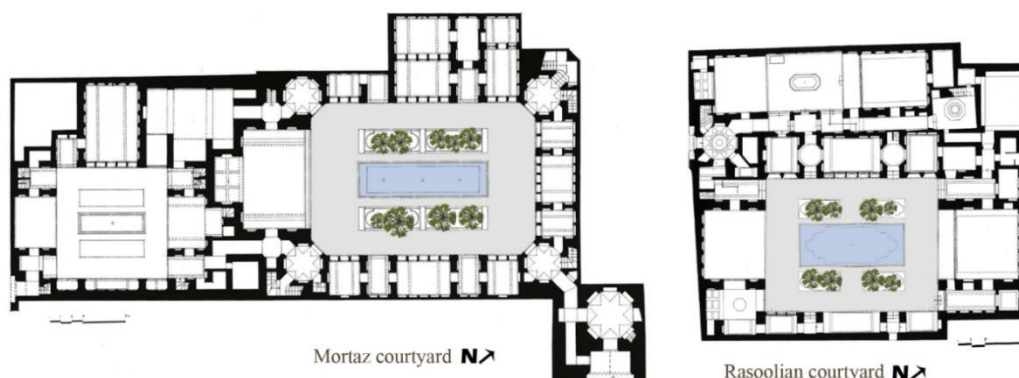


Fig 2. Plans of studied courtyards [65]

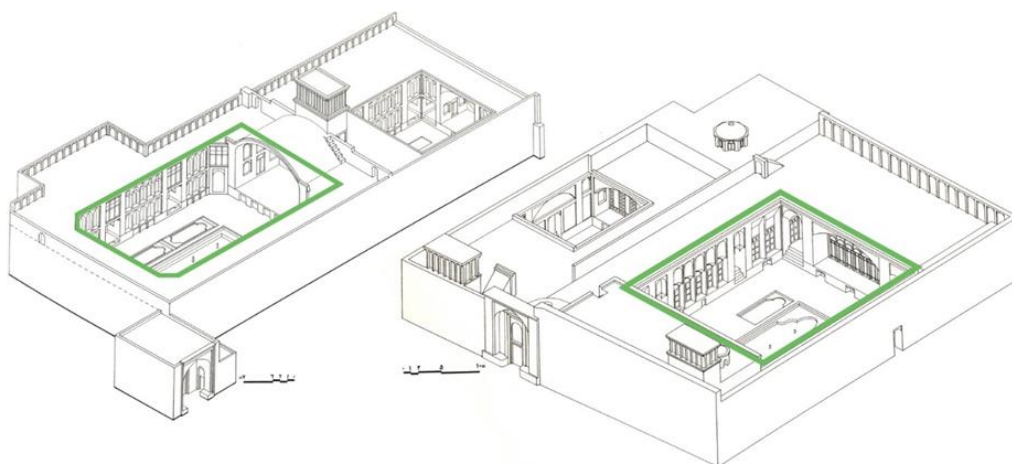


Fig 3. Perspectives of courtyards: Mortaz courtyard (left), Rasoolian courtyard (right) [65]

Table 1. Features of studied courtyards (Source authors)

Courtyard	Dimension of courtyard (m ²)	Dimension of each garden (Green elements) (m ²)	Dimension of water pool (Blue element) (m ²)	Dimension of the frame to the sky (Blue element) (m ²)
Rasoolian	20.30*15.80=320.8	5.20*2.40=12.48 4 Gardens =4*12.48=49.9	12.00*4.60=55.2	20.30*15.80=320.8
Mortaz	25.60*17.20=440.3	6.80*2.80=19.04 4 Gardens= 4*19.04=76.2	14.80*4.40=65.1	25.60*17.20=440.3
courtyard	Ratio of gardens to the courtyard	Ratio of water pool to the courtyard	Height	Ratio of height to the width of courtyard
Rasoolian	15.5%	17.2%	6.00m	0.37
Mortaz	17.3%	14.7%	7.30m	0.42

3. METHODOLOGY

Two types of questionnaires (close and open-ended) have been used to analyze the psychological health of occupants in the studied courtyards. Close-ended questionnaire was distributed among 81 participants including students of architecture, urban design, and painting in April of 2019 while via structured interviews, the open-ended questions were asked by the researchers from the same participants in May of 2019. The participants were selected based on few points as follows:

They spend at least three years in the studied environments

Both graduate and post graduate students are considered. Duo to the few doctoral students and the limited hours they spend at university; they are not considered.

The participants consist of those who are originally based in Yazd as well as other cities in order to make a balance between the students who completely know the climate of Yazd and those who are not familiar with this climatic condition.

Demographic information was assessed by questions concerning age, sex, year of study, length of visiting courtyards. The number of female and male participants in this study was 62.96% and 37.04% respectively and their age ranged from 20 to 31 years old. The percentage of participants who visited the courtyards for less than 1 hour, was 32.09%. 38.27% of them spent between 2 to 3 hours and the rest of them, about 29.64% of students, were more than 3 hours in the studied environments.

For the close-ended questionnaire, the psychological variables were identified according to the “attention restoration theory”. Fascination (effortless engagement by objects in the environment), being away (gaining psychological distance from day-to-day routine mental

contents and demands on directed attention), extent (scope and coherence of the environment engaged with) and compatibility (match between what a person can do, wants to do and must do in the environment) are four components contributing to this theory, while in this step, there is a focus on fascination and being away [43 - 44]. Hence, the close-ended questionnaire consists of six questions that try to investigate natural blue elements (compared to green ones) on fostering fascination and being away.

First, more explanation about questions was given to the students and then all the respondents were asked to rate each question on a Likert scale from 1 (completely disagree) to 7 (completely agree). The questions are presented in table 2.

Repeated measure ANOVA was conducted to analyze the responses and to compare the effects of natural elements on fascination and being away. The null hypothesis (H_0) is that there is no significant difference between the mean scores of the factors. The alternative hypothesis (H_1) assumes that there is a significant difference between at least two factors.

The second questionnaire consists of open-ended questions which most of them were derived from validated and existing questionnaires [34, 44 - 45]. These questions were asked via structured interviews which were fully controlled by the researcher and gave the participants less room to be flexible and casual [46]. According to a schedule, each participant was asked to come to the courtyards and answer the questions with the same order. Indeed, these interviews were formulated to cover the gaps and help to deeply understand the association between psychological restoration and exposure to natural elements. It should be noted that all the interviews were recorded. The questions of this part are presented in Table 3.

Table 2. Close-ended questionnaire

- To what extent sky in this courtyard, foster your fascination and your attention is drawn to it (Fascination)?
- To what extent water in this courtyard, foster your fascination and your attention is drawn to it (Fascination)?
- To what extent green elements in this courtyard, foster your fascination and your attention is drawn to them (Fascination)?
- To what extent visiting sky in this courtyard, distract you from day-to-day routine (Being away)?
- To what extent visiting water in this courtyard, distract you from day-to-day routine (Being away)?
- To what extent visiting trees and plants in this courtyard, distract you from day-to-day routine (Being away)?

Table 3. Open-ended questions

- Are you keen on spending your leisure time in this central courtyard?
- What natural element reminds you this central courtyard?
- What is the most important natural element of this environment?
- What is the most preferred natural element in this courtyard?
- Please describe every natural green and blue elements of this courtyard.
- What are your feelings associated with visiting each natural element?
- What makes this environment different from other places?
- How many hours are you in this place during a day? Less than 1 hour Between 2 to 3 hours More than 3 hours

Structured interviews were analyzed through content analysis. In this regard, first, the recorded responses were entered into MS Excel spreadsheet, giving every participant a specific code (first capital letter of the case studied courtyard, then a number, e.g. R7 = Rasoolian, participant no.7). For the next step, the core statements of responses were determined and the related core statements were categorized in the key themes. The results were categorized in the themes as perception, preference, promoting positive emotions, and relieving negative feelings. Noted that the key themes are identified after repeatedly reading the responses and reducing them to the core statements [47]. Specifying the frequency of each theme (Table 4 and 5) made it possible to investigate the differences between the influences of blue and green elements on psychological restoration.

Table 4. Results of structured interviews (Source authors)

		Studied environments	
		n	%
		81	100
Pleasantness	Totality of environment	6	7.4
	Sky	10	12.3
	Water	31	38.2
	Green elements	19	23.4
Promoting positive emotions	Totality of environment	11	13.5
	Sky	6	7.4
	Water	38	46.9
	Green elements	20	24.6
Excitement	Totality of environment	1	1.2
	Sky	7	8.6
	Water	11	13.5
	Green elements	2	2.4
Stress	Totality of environment	3	3.7
	Sky	30	37.03
	Water	51	62.96
	Green elements	13	16.04
Relieving negative feelings	Totality of environment	3	3.7
	Sky	8	9.8
	Water	21	25.9
	Green elements	6	7.4

Table 5. Results of structured interviews (Source authors)

		Studied environments		
		n	%	
		81	100	
Perception	Reminder element	Sky	14	17.2
		Water	60	74.04
		Green elements	9	11.1
	Important element	Sky	23	28.3
		Water	58	71.6
		Green elements	17	20.9
Preference	Preferred element	Sky	33	40.7
		Water	54	66.6
	Green elements	37	45.6	

4. RESULTS

First, the validity and reliability of the close-ended questionnaire were tested. The content validity indicates the extent that the questions are relevant and representative to measure the psychological restoration of the students. In this study, the content validity of the questionnaire was confirmed by the experts in this field. The reliability of the questionnaire indicates the internal consistency of the questions. In this study, the Cronbach's alpha was 0.751, which indicated a high level of internal consistency of the scales.

To have detailed information about the effects of natural green and blue elements on occupants' psychological restoration in terms of fascination and being away, repeated measure ANOVA with Greenhouse-Geisser correction was conducted. The results of this step are presented as error bar charts in Figure 4.

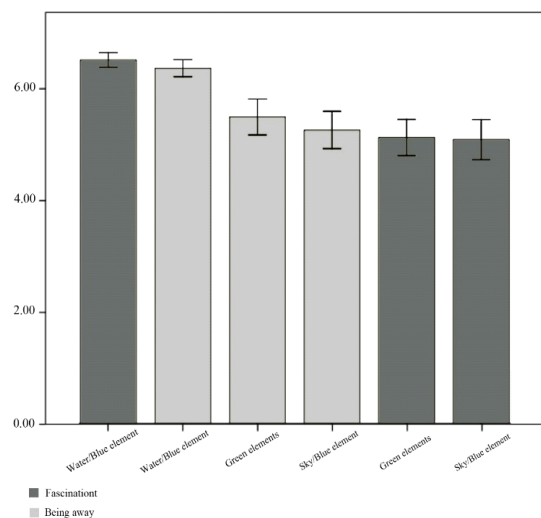


Fig 4. The results of repeated measure ANOVA test (Source authors)

In Figure 4, the responses are ranked from higher to lower influences of natural elements. The overlap between the standard deviation bars can be used to determine whether or not a difference is significant. Note that the standard deviation is a measure of variability rather than being a statistical test. Hence, to have a valid conclusion, the results of the statistical test should be considered.

The results show that the mean psychological restoration level differs statistically significantly between various elements' exposure in central courtyards ($F(2, 226.062) = 26.784, P=0.00$). Post hoc using Bonferroni correction indicates that the mean score for the question related to the influence of water exposure on fascination ($M=6.53, SD=0.59, P=0.00$) is significantly higher than the four questions' mean score. However, water influence on being away ($M=6.38, SD=0.69, P=0.95$) is the factor which its mean score does not significantly differ from this factor. In general, these results suggest that water exposure has the most significant influence on fostering fascination and being away in the studied courtyards. Another finding of this step is that although in comparison to water, the sky has less effective influence on fascination and being away, there is no significant difference between sky and green elements' influences. It reveals that as the most neglected natural element in debates related to human health, the sky is as important as green elements in fostering psychological restoration in terms of fascination and being away.

The results of structured interviews, presented in Table 4 and 5, reveals more detailed information about the influence of natural elements on the psychological restoration of university students. Although any assigned code and the percentage of responses are indicated, the most striking points contributing to a better understanding are presented as follows. It should be noted that in addition to the natural elements, few responses were related to the totality of the environment.

Findings of structured interviews showed that among positive emotions, pleasantness and refreshment of occupants are strongly associated with visiting water in the studied courtyards. Many students mentioned that although visiting sky and green elements in the courtyards can positively affect their emotions, the presence of water has the most significant effects on their psychological restoration in terms of promoting pleasant mood and refreshment. "Watching the waves and the ever-changing appearance of water" and "visiting the reflection of the built environment, sky and trees in the water" were mentioned several times by respondents as the reasons beyond their pleasant mood. "Everything reflection, especially traditional doors, in water creates an imaginary and extraordinary scene" (R36) and "I enjoy watching waves and sun glitter in this mirror which only shows beauty" (M12). Indeed, moving and flickering profiles are capable to stimulate viewers' eyes [48] as well as bringing about faster and more emotional reactions [49]. Hence, as the water was mostly illuminated by the sun during this study, its' appearance changed constantly and quickly [50] by light reflections and waves which could more easily attract the attention of occupants and foster their

pleasantness more strongly compared to sky and green elements. Interestingly, some students appreciated the pleasantness of trees and especially sky through their reflection in the water pool: "water pool is a small sky on the ground" (R3) and "it keeps the vast beauty of sky" (R18) and "the vitality of the trees in a small area" (R19). Although sky and trees provide diversity in terms of perception, for example, the sky during different hours of the day with ever-changing colors and passing clouds and green elements during different seasons with various flora and fauna, compared to water, they were perceived less effective on the pleasantness of students.

"Hearing the sound of water", "feeling the coolness and pleasant weather created by it" and "smelling its' fragrance" were mentioned repeatedly by students which help them to get refreshed. Water plays a significant role in creating refreshments and thermal comfort of the occupants especially in hot-arid zones [51-53]. Hence, while the case studies are located in the harsh climate of Yazd, the occupants' perception of water influence on refreshment was intensified: "Breathing the cool weather associated with water helps me to get refreshed" (R9); "I like sitting near the water pool and enjoy the fresh weather and smell of water, especially during hot days" (R37). In addition to water, few students considered an important role for the "birds' flight in the sky" and "their sound through the trees" in creating refreshment. "Sitting in this courtyard and listening to the songs of birds hidden among trees" (M1) and "watching their dance in the blue scene create joyful and refreshing moments" (M4).

Like the positive emotions, it is water which significantly relieves negative feelings of students. It was reported repeatedly that relaxation from stress is strongly dependent on the rich variety and the long-lasting attraction of water in the studied environments: "spending few minutes near the water pool helps me to get relaxed and calm" (R30); "This water pool is pure calmness [...] it invites me to live at the moment and forget all my worries" (M10). The responses showed that the sky is the second natural element that has a strong association with relaxation from stress. In contrary to other categories, which there is no big difference between the influence of sky and green elements, for relaxation from stress, the sky plays more significant role than green elements. "Sky as the mother of the courtyard seems very close to the earth" (M11) and "the vast expanse of it creates feelings of openness, freedom and great calmness" (M22). It is proved by other researchers that the vastness and amount of sky scenes can provide opportunities for restoration likelihood and make strong link to a specific place [34, 41, 54 - 55].

Not only is water perceived the most important and reminder element of the studied environments, but also among the natural elements, it is the most preferred one. Many responses revealed when students try to remember the environment, water is the first natural element which comes to their minds and they considered a great role for it as they stated "water defines the center and the meaning of this environment" (R19) and "I could not imagine removing water from this courtyard [...] this place would be absurd without water" (M3). Also, occupants placed a

premium on sky and green elements, but water remains as the basic and essential natural element of studied courtyards.

The results of this step completely support the data collected by the close-ended questionnaire. In general, water plays the most significant role in fostering the psychological restoration of university students in the studied environments. Also as the same as natural green elements, the sky, which is the most neglected natural element in debates related to human health, is capable to restore psychological problems. Hence, in addition to green elements, it is essential to consider blue elements and design strategies based on their exposure in educational environments.

5. DISCUSSION

Health benefits associated with nature exposure through open spaces have been investigated at various scales such as forests in the cities, parks in the neighborhoods as well as houses' yards [24, 56-58]. Besides, some researchers focused inclusively on nature exposure influences on students through open spaces of educational environments [59-63]. Generally, it is reported that to reduce stress and promote positive emotions in various types of environments, it is essential to regularly make the connection with natural elements especially green areas and water. Compared to the mentioned research, although there are many similarities, it seems that the only feature of this study leading to different perceptions towards natural elements is the hot-arid region of Yazd as the location of case studies. In fact, in addition to the blue color of the water pool in case studies during all seasons, the blue color of the sky, which can be seen during the majority of days in this region, significantly supports the restoration of depleted psychological resources of students in studied environments. Besides, according to the responses of students to open-ended questions, they perceived water and sky as blue elements reminding the concept of infinity and creating a sense of openness and freedom. Indeed, students' perception went beyond the mere physical features of the environment and highlighted the spiritual aspects. While in the regions that sky is mainly grey during many days of the year, there is less possibility for experiencing these feelings as well as the perception of spiritual aspects.

Another important point is that students enjoyed being in the studied central courtyards and having interaction with natural elements while the physical pleasure intensified their positive emotions. This notion is supported by a research focused on Isfahan University students, which proved that there is a direct relationship between students' positive emotions and their physical pleasure [64]. Among various spots of the university, students put a priority on being in the central courtyards because they enjoyed being there and having connection with natural elements. Hence, exposure to natural elements not only decreases their psychological problems but also increases their positive emotions as well as reminding spiritual aspects of environments.

6. CONCLUSION

This article conducted the close-ended questionnaires and structured interviews (with open-ended questions) to investigate the effects of natural blue elements (compared to green ones) on boosting the psychological restoration of university students. The case studies were the main central courtyards of two traditional dwellings, which currently are used as educational environments of art and architectural faculty of Yazd University.

Through library studies, the paper showed the positive influences of green elements on the psychological health of occupants in various environments. Via close-ended questionnaire, it reported that in the hot-arid climate of Yazd, not only is the sky as important as green elements but also it is water that plays the most significant role in promoting the psychological restoration of students in the studies environments. Content analysis of structured interviews strengthens the substantial role of blue elements in promoting positive emotions and reminding the concept of infinity.

It is concluded that to design the open spaces of educational environments, both blue and green elements should be considered. On the whole, this study systematically addressed to what extent blue elements' exposure can affect the psychological restoration of university students in regions with hot-arid climate and close cultural contexts to Yazd.

Considering the results of the paper, some recommendations for designers are presented as follows:

Doing various activities in open spaces and constant attendance of students in these areas revealed that the design of open spaces is as important as the design of closed areas in educational buildings. As students face stressful issues, open spaces can provide opportunities to connect with natural green and blue elements during the breaks.

Since in harsh climates such as the hot-arid climate of Yazd, few species of trees and plants can thrive, water and sky, as the other natural elements that are capable to provide opportunities to easily contact with nature, can play an important role in promoting psychological restoration. Hence, in addition to green elements, considering water pools, water canals, and sky in open spaces of educational environments can significantly increase the positive emotions and psychological restoration of students.

7. LIMITATIONS AND FUTURE RESEARCH

While the findings of this study showed important results, it is recognized that it has some limitations. First, this research was conducted during spring while trees and plants were green and there were few clouds in the blue sky with sunny weather. How different appearances of green and blue elements during other seasons would affect the ratings and students' perceptions is an open question. Second, the case studies are located in specific geographical conditions (hot-arid climate of Yazd) and how other climatic conditions would affect the ratings and

students' perceptions is an open question. Third, although there exist some design strategies which present different views to natural elements, their influences are not considered. For example, in this study, the views to the sky, water, and green elements were perceived through the central courtyards, while various views through other design strategies would bring different effects. Hence, how different design strategies presenting various views to natural elements would affect the ratings and students' perceptions is the other open question.

Forth is the lack of validity of laboratory investigations. However, it was tried to impose some restrictions and approaches to secure reliable estimations. In this regard, for the close-ended questionnaire, the ordinal scale was used to measure fascination and being away. Following this, nominal and integral scales were used to estimate the presence or absence of stress, positive emotions as well as the amount of these feelings.

For future research, it is essential to consider case studies located in different climatic conditions of Iran. Also, future works can address some limitations of the present study with more attention to different appearances of natural elements during different seasons, more focus on weather, daylight variations, and different design strategies. Besides, it would be interesting to do a comparison between the influences of natural green and blue elements in the open spaces of traditional and modern buildings.

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AUTHOR (S) BIOSKETCHES

F. Amirbeiki, PhD Candidate in Department of History of Art, Architecture and Landscape, University of Groningen, Groningen, Netherland
Email: f.amirbeiki.tafti@rug.nl

A. Khaki Ghasr, Assistant Professor, Department of Architecture, Faculty of Architecture and Urban Planning, Shahid Beheshti University, Tehran, Iran
Email: a_Khakighasr@sbu.ac.ir

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HOW TO CITE THIS ARTICLE

Amirbeiki, F., Khaki Ghasr, A., (2020). *Investigating the Effects of Exposure to Natural Blue Elements on the Psychological Restoration of University Students*. *Int. J. Architect. Eng. Urban Plan*, 30(1): 1-10, June 2020.

URL: <http://ijaup.iust.ac.ir>

