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Research Paper

The Relationship between Felder-Silverman Learning Styles and Students' Performance in Theoretical and Architectural Design Courses

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ABSTRACT

This study investigates the relationship between learning styles and students' performance in theoretical courses and architectural design workshops based on one of the theories related to the learning style that belongs to "Felder and Silverman". The theoretical base on Felder-Silverman's theory is based on the dual processing structure of the brain that consists of two left and right hemispheres. They have used a dichotomy five-dimension scale that embraces perception (sensing-intuitive), processing (active-reflective), input (visual-verbal), organization (inductive-deductive), and understanding (sequential-global) dimensions. Two types of tests are considered to examine the relationship between performance and learning styles the first one classifies students in learning styles based on the Felder-Soloman questionnaire, and the second one examines and compares students' performance in architectural design workshops and theoretical courses. Participants are chosen among juniors (first-year students) and seniors (fourth or last-year students). This study showed that the number of seniors has significantly exceeded the number of juniors in intuitive, visual, and global styles. According to the appraisal of students' performance, juniors had the best performance in Architectural Design Basics 1 based on the reflective and visual styles, and seniors had the best performance in the Architectural Design 4 course based on global, visual, and reflective styles. Moreover, juniors showed the best performance in the Construction Materials course-that is mainly textual and pamphlet-based- based on the verbal and reflective styles, and seniors showed the best performance in the Introduction to Islamic Architecture 2 course-that is descriptive and PowerPoint presentation-based- with visual and sensing style.

Keywords: Architectural Design Teaching, Theoretical Courses Teaching, Felder-Silverman Learning Styles, Students' Performance.

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1. INTRODUCTION

Learning is one of the most fundamental topics in the new studies on education and pedagogy. In educational environments, the teaching and characteristics of learners are indeed more important than the environment and education and their relevant features. In many new studies and theories, priority has been given to the learner and identification of their talents and abilities defining education as a process for "creating situations in which individuals can learn" (Brown and Atkins 1991). Therefore, the learning styles of learners have been studied on many academic platforms by researchers to make the learning topic more academic. Architectural Engineering is one of the majors in which, both theoretical and practical knowledge must be acquired simultaneously, and also specific skills are required in the field of building design. Since individual abilities and characteristics of students are highly important in solving various problems, investigation of students' learning styles can contribute to education and achieving goals of this major, and using it to discover talents who deserve to enter this field (Soliman et al. 2019). Because this study aims to examine the relationship between learning styles and students' performance in theoretical courses and architectural design, this paper tends to find a connection between mentioned factors and dichotomy learning styles of Felder-Silverman, such as sensing-intuitive, active-reflective, global-sequential, and visual-verbal styles.

2. LEARNING STYLES

The concept of learning has been defined in different ways: the ability to know, various habits, different skills, and the ability to create solutions for a problem. Learning indeed occurs when it can create considerable changes in individuals' behaviors (Seif 2010, 30). Socrates and Plato tried to define learning and show what it was through philosophy in ancient Greece. However, the hypotheses about learning and its differences among various individuals occurred when Herbert Thelan introduced the term "learning styles" in 1954 (Emamipour and Shams Esfandabad 2018, 3). There are many studies on learning styles at the higher education level but most of them focus on the western leaners, not all learners worldwide. Most studies on learning styles are conducted in the USA and Europe (Green and Deel 2023). Learning styles have been defined in different ways, including definitions as follows (Hosseini Lergani and Seif 2010): "various individual techniques for knowledge acquisition and learning new topics," "different learning techniques among various individuals that make knowledge acquisition different under the classroom conditions." An orientation in learning style initiates a sensitivity that can become a preparedness (talent) for a specific kind of behavior. According to the definition of learning styles proposed by Keefe, these are relatively constant and stable characteristics of the acquisition method and different interactions between students and with learning environment (Samadi 2018). Also, Kolb defines learning styles as individuals' methods in selecting some learning talents compared to other talents (Grigorenko and Sternberg 1995), and Sternberg believes that learning style is the technique preferred by individuals to use cognitive talents. Famous researchers have presented various classifications for learning styles, including Keefe who introduces five groups of learning styles, Curry who presents three groups, Desmedet & Valcke who divide these styles based on the documentation analysis method (quotation), and finally, Sternberg and Grigorenko who divide cognitive styles into three general categories (Emamipour and Shams Esfandabad 2018, 12-20): A) cognition-centered, B) personality-centered, and C) activity-centered. Cognition-centered styles are mainly about cognition, not personality. Some of these styles consist of active-reflective styles, classification styles, and context-dependent and context-independent styles (Ibid). However, personality-centered styles are about personality, not cognition. Some of these styles include Gregorek and Myers-Briggs's personality styles, and finally, the activity-centered styles that mainly have a practical orientation and are about some activities such as education and learning. The most important of these styles are introduced by Dunn and Kolb (Ibid). Another popular method in the field of activity-centered approach (considered in this study) is introduced by Dunn and Prashnig that is designed based on a famous and sophisticated model introduced by Ken and Rita Dunn (Dunn and Dunn 1978) in St. John's University, New York who divided learning styles into five main factors in their first work: environmental, emotional, social, physiological, and psychological factors. Their model (LSI[1]) follows two different theories Cognitive Style Theory and Brain Lateralization Theory. The model by Dunn and Prashnig (LSA[2]) evaluates the biophysical nature and several other parts of individuals' learning styles around six categories: brain processing, sensory conditions, somatic needs, environmental preferences and interests, social approaches, and aspects. Cognitive Styles Analysis Test (CSA) by Riding (1991) and "Myers-Briggs Type Indicator" (MBTI) (1975) are two other models that have received great attention. CSA assesses individual interests and preferences within two dichotomy dimensions based on some ratios of different reactions in various situations. Visual-verbal style is how, a person tends to evaluate his/her information through mental images or words, and global-analytical style is a way through which, persons tend to classify information in general or details. However, most studies on learning styles have used the styles introduced by Kolb, Felder-Silverman, and Vark, and the Felder-Silverman style has been more used for learning styles among students

of technical and engineering majors also the basic sciences (Tahmasabi, Fatuhi, and Esmaili 2017).

2.1. Felder-Silverman Learning Styles

Felder and Silverman have used a dichotomy five-dimension scale that embraces the dimension or understanding (sequential-global), organization dimension (inductive-deductive), input dimension (visual-verbal), and finally the perception dimension (sensing-intuitive) (Maya, Luesia, and Pérez-Padilla 2021; Emamipour and Shams Esfandabad 2018, 59-60). Among these five dimensions, two dimensions are adopted from the models proposed by Kolb and Myers-Briggs. The active-reflective dimension is adopted from the Kolb model, and the sensing-intuitive dimension is obtained from the perception dimension in the models presented by Kolb and Myers-Briggs (Emamipour and Shams Esfandabad 2018, 59-60). The model learning styles introduced by Felder-Silverman are different from other learning styles by providing five dimensions and a wider classification of learning styles (Sihombing, Laksitowening, and Darwiyanto 2020). Beyond the other models, extra learning dimensions such as listening or seeing and processing are considered by Felder and Silverman. According to this model, the learning preferences of students reflect the ways through which they listen to, see, and process specific information. Therefore, it can be argued that the design of this model provides a practical and advanced educational approach for instructors (Almarwani and Elshatarat 2022).

Table 1. Felder and Silverman's Learning Styles

Dimensions	Styles (Methods for Information Acquisition)	
Perception	Sensing Senses, facts, and observations They like to learn about realities. They are willing towards clear and defined methods and procedures with certain frameworks and are not interested in complexity	Intuitive Symbols and interpretations They mainly like to understand the relationships between elements. They prefer innovation and creativity and are not interested in repetitive issues.
Input	Visual Diagrams, images, and manual illustrations They remember visual topics such as films, diagrams, images, and tables in a better way. These individuals remember and learn images by listing visual keywords and placing them in specific places.	Verbal Words and sentences They remember data as words in both forms of text and verbal. These individuals summarize the data. Also, they are interested in teamwork.
Organization	Inductive Facts and observations	Deductive General principles and rules
Processing	Active Action and teamwork These learners are interested in teamwork and can perceive data through practical action and doing work in a better way.	Reflective Inner processing and independent task (individual) They like to understand relations and possibilities. They are interested in innovation and creativity and hate repetitive tasks.
Understanding	Sequential Linear relationships and small connective pieces They are interested in understanding issues linearly and regularly. They mainly like to solve a problem step by step and go forward through a logical process. They link the issues and concepts to the previous learnings in their minds.	Global General relationships and images They like to review details before receiving them. These individuals have a holistic view and when facing complex or hard problems understand the generalities at first and then solve the problem.

(Montgomery and Groat 1998)

3. BACKGROUND

There are few papers and studies that provide reliable and authentic empirical themes for large samples. Meanwhile, most major tools have been even criticized not only due to lack of empirical validity but also due to their poor theoretical basics and contradictory approaches. Some conflicting hypotheses on learning have confirmed the common ideas about learning and popular models for learning styles (Coffield et al. 2004). Some studies have been done on the learning styles of Felder-Silverman in architectural design in European countries (Kaba and Abdou 2022). Felder and Silverman (1988) used the Felder & Soloman questionnaire for architecture and chemistry engineering students and concluded that students of chemistry engineering majors are more sequential, sensing, active, and verbal rather than architecture students. Moreover, a comparison

between information from various educational levels of architecture students showed that seniors are more global, visual, and reflective than juniors. The percentage of intuitive students was higher than the whole student population. Moreover, it is more probable that the learning styles of architecture juniors are similar to architecture professors (Emamipour and Shams Esfandabad 2018, 62). Montgomery and Groat have shown that female students in engineering majors are more matched with the active learning model rather than the male students of this major. They also found that students of architecture majors have such a tendency even at a higher level. Van Zwanenberg and Wilkinson studied the relationship between the academic achievement of students and Felder-Soloman learning styles and concluded that no relationship exists between academic achievement and learning styles. Halime Demirkan and Osman Demirbas studied the effect of learning styles and gender on academic performance in interior architectural design. They employed the Felder and Silverman learning styles model, which is a four-scale model, and concluded that students use active-reflective and intuitive-sensing styles almost equally to achieve optimal academic performance (Demirkan and Demirbas 2010). In another research work, Demirbas and Demirkan examined the relationship between the architectural design process and learning styles (Demirbas and Demirkan 2003). They have used Kolb's model that introduces accommodating, converging, diverging, and assimilating styles for analysis of the architectural design process. They concluded that learners with assimilating skills have had the most achievement and accommodating learners have shown the least achievement in the architecture design process. In another study conducted by Cha et al. that used the Felder and Silverman Model in the smart education environment, learning styles are matched with a smart educational environment (in an architectural design workshop), and positive results are obtained (Cha and Kim 2006). Andrew Roberts et al. used Riding Cognitive Styles and concluded that, unlike some theories, global architecture students do not outperform analytic students, and analytic juniors have shown better achievement (Roberts 2006). In another study, Pask found that students' learning techniques for a certain task can determine which approach is used in a learning situation of a new problem-solving case. However, approaches are changing and oscillating depending on the tasks; most students are not able to be flexible enough when facing new problems, which implies learning shortcomings that limit the application of strategies.

In Iran, Mehrdad Karimi Mashavar has studied the relationship between students' performance in architectural design workshops and learning styles based on Kolb's model and concluded that assimilating students have been the most successful students in the field of sketch, while students with converging styles showed weakest performance and students with diverging style had the best performance (Karimi Mashavar 2011). In another study titled "Learning Styles and Analogical Thinking Method during the Design Process of Architecture," a suitable structure was designed for the analogical teaching method in preliminary courses of architectural design, and then the relationship between different scales and students' learning styles in design basics was examined. The results of this study showed that reflective individuals are more successful in doing symbolic analogies, active individuals are more successful in creating direct analogies, sensing individuals are successful in personal analogies, and students with intuitive style are more successful than those with abstract analogies. Also, learners with intuitive styles have performed better in selecting suitable resources, and individuals with visual and sequential styles have been successful in transferring resources to the analogy objective (Bastani and Mahmoodi 2019). Abasali Izadi investigated the student selection for studying architecture major based on the theory of Yong and Myers-Briggs considering the psychological differences between students. He concludes that the type of entrance exam for architecture should be changed. A study titled "Investigating the relationship between player types and learning styles in gamification design" examined the relationship between dimensions of the Fleder and Silverman learning style model and the type of player based on the Hexa-scale model. After the findings were assessed and analyzed using the Pearson Shi-Square test and contingency table, five hypotheses out of ten hypotheses were confirmed and the relationship between player type and some learning style dimensions was confirmed (Abdullah Zadeh and Jafari 2017).

4. METHOD

This study has been conducted based on the correlational method with a descriptive survey type. The descriptive study focuses on the analysis of the relationship between unmanipulated variables and the generalization of results. The Felder-Soloman learning styles questionnaire has been used to determine the type of students' learning styles.

In previous similar studies, juniors and seniors in architectural design courses have been employed for better comparison between the learning styles of these two categories of students and examine their performances as a statistical society to achieve a better conclusion. To evaluate the effect of course type and teaching method on the performance of students with different preferential styles, the theoretical courses proposed with architectural design courses simultaneously in one academic semester were also added. Accordingly, the first design course (that is Architectural Design Basics 1) was chosen for juniors

and the main design course (Architectural Design 4) was selected for seniors. In terms of the theoretical courses presented in the same semester, the choice criterion was the type of course and the presence of a specific teaching technique for these courses in different ways to achieve a better appraisal of the performance of students with different preferential styles. Hence, the course Construction Materials teaching method is verbal and pamphlet-based and was provided for juniors and Introduction to Islamic Architecture 2 is taught visually based on the descriptive discussions and PowerPoint was selected for seniors.

Ultimately, student appraisal by skilled professors in courses Architectural Design Basics 1 and Architectural Design 4 is done to determine students' performance. The scores for Construction Materials and Introduction to Islamic Architecture 2 were also extracted from the student's records.

4.1. Participants

This study has been conducted on 44 BSc students in architecture major of Islamic Azad University Sanandaj Branch. The participants are selected from juniors (23 students) (two courses of Architectural Design Basics 1 and Construction Materials) and 21 seniors (two courses of Architectural Design 4 and Introduction to Islamic Architecture 2).

4.2. Data Collection Tool

The Felder-Soloman Learning Styles Index Questionnaire is used as a research tool to determine the learning styles of students. This instrument has been designed based on the Felder-Silverman learning styles (Emamipour, and Shams Esfandabad 2018, 116-117). This questionnaire consists of 44 questions. The questions do not have cultural dependence and can measure four dimensions of learning (eight learning styles). Eleven questions are used to assess each dimension. Regarding the dichotomies for each question, two learning styles on two sides of a contrasting spectrum are examined. Many individuals such as Zwanenberg, Livesay, Zywno, and Litzinger, Lee, Wise & Felder have tested the validity and reliability of the original questionnaire (in the English language) based on the Cronbach's alpha coefficient and achieved satisfying results (Samadi 2018). Persian version of this questionnaire has been tested then its validity and reliability have been confirmed by Shams Esfandabad (2003), Sarvqad and Dayant (2009), Samadi (2011), Rahmani and Azali (2012).

Each learning style is scored between 0 and 11, and these scores are classified into five categories: completely preferred, preferred, flexible, not preferred, and not completely preferred. Hence, students' willingness for each learning style is determined within these five categories (Fig.s 1 & 2). Students' performance appraisal tool is indeed a board of skilled judges, including three faculty members and two instructors of the architecture department of the university two members of which, directly participated in the design process and problem-solving by students throughout the semester. Judgment metrics for Architectural Design 4 included platform and design of open space, concept, performance, form, creativity, and presentation. These metrics included concept, performance, form, creativity, details, and presentation for the course Architectural Design Basics 1.

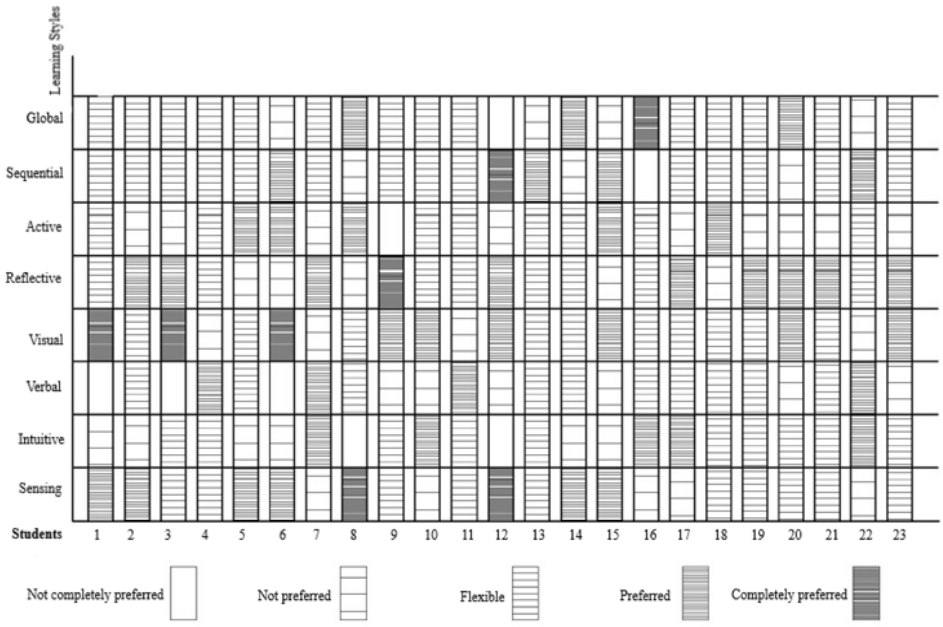

Fig. 1. Determining Learning Styles and Their Rates among Juniors based on the Felder-Soloman Questionnaire

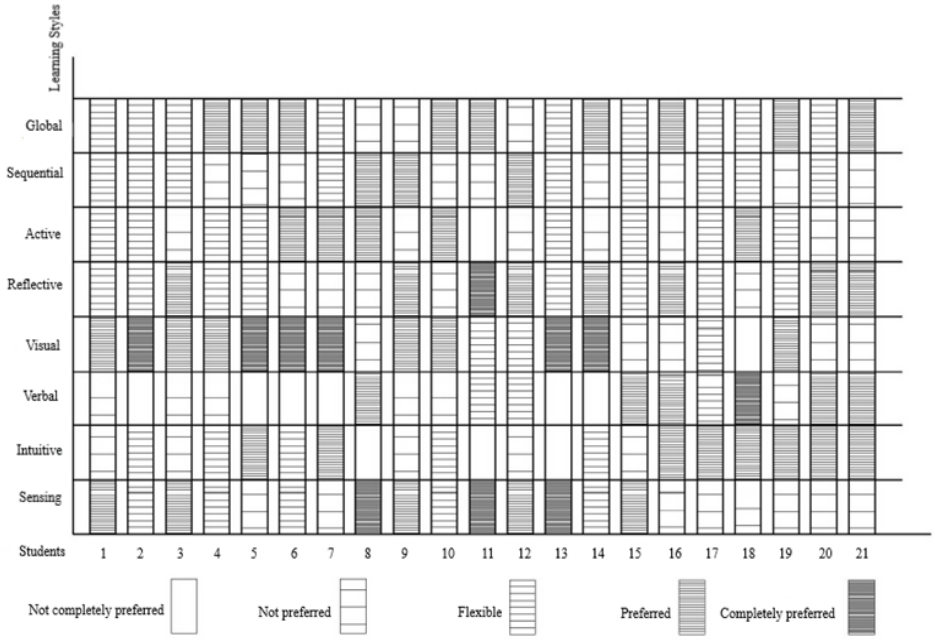

Fig. 2. Determining Learning Styles and Their Rates among Seniors based on the Felder-Soloman Questionnaire

4.3. Curriculum of Basics and Architectural Design Courses

The curriculum of Architectural Design 4 is about the study and design of an 80-bed hospital in Sanandaj City. In this classroom, students were responsible for studying and examining project needs and demands for a maximum of one month, and then each student was responsible for implementing a design process based on his/her method. Four one-day sketch turns each about designing one of the wards of the hospital were held during the design process to measure the performance of students over the design process and judge their creativity rates in dealing with the topic and solving the problem over the design process. At the end of the semester, they presented the design in frame of plans, façades, sections, external and internal perspectives, and one replica in 1.300 scale. The curriculum of Architectural Design Basics 1 consists of five different practices that can measure the student's performance in design workshops. The duration of each practice was different depending on the type and load of the task, which started from simple practice and led to more difficult practices at the end of the semester.

5. DISCUSSION AND DATA ANALYSIS

The results obtained from examined statistics of students' distribution in different Felder-Silverman learning styles are depicted in Figs 3 and 4. These graphs show the mean scores that juniors and seniors obtained in each learning style. The highest score of juniors belongs to the visual style followed by the reflective style, and the highest score among seniors belongs to the visual style followed by general and reflective styles. Moreover, the lowest score of both juniors and seniors is related to the verbal style.

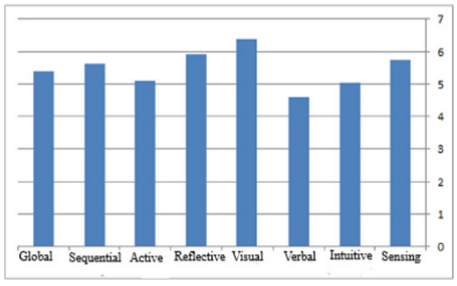

Fig. 3. Mean Scores of Learning Styles among Juniors

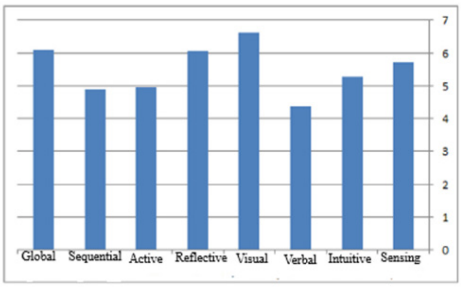

Fig. 4. Mean Scores of Learning Styles among Seniors

However, the mean score of a style is a general parameter, so the scores related to preference and complete preference of students must be measured to assess each style because these items indicate the learning style of the student. Therefore, distribution statistics of students with preference and complete preference of interest in various learning styles were measured based on Figs 1 and 2 (Table 2).

Table 2. Distribution Percentage of Students Having Preference or Complete Preference in a Learning Style

Junior		Senior	
Ratio to whole Students (%)	Learning Style (Preference and Complete Preference)	Ratio to whole Students (%)	Learning Style (Preference and Complete Preference)
35	Sensing	38	Sensing
21	Intuitive	38	Intuitive
17	Verbal	24	Verbal
39	Visual	57	Visual
43	Reflective	38	Reflective
21	Active	24	Active
21	Sequential	14	Sequential
17	Global	43	Global

According to data reported in Table 2, the maximum number of students among juniors with preference or complete preference in one style equaled 10 students in reflective style. These individuals who are interested in reflective processes of the brain do not usually do a task without considering all options but are more willing to reflect on the problem and its solutions and decide on the right time. Nevertheless, the maximum number of members with preference or complete preference in one style among seniors equaled 12 students in visual style. These students achieve the best learning by watching and need visual simulations. They prefer using images, mental maps, tables, etc. instead of words and texts. They can remember many things they see and have a high power of imagination. Hence, they use illustration and imagination to remind and understand the relevant reasonings. The number of visual students among juniors equals 9, and this style had the second rank in terms of the number of students but the second rank among seniors equals 9 members related to global style, which is required for solving larger and more complicated problems of architectural design. These students usually think rapidly and take risks; they have irregular patterns and thoughts and many times perform immediately in the decision-making process. They have to do several tasks simultaneously and ignore some details, so they must have general information about the problem and the motivation to think of it before solving the case. These individuals prefer concepts to facts and use sudden instant and endless approaches to deal with problems. Therefore, general aspects of the problem must be explained to them, then they can address the details of the design case. They may perform randomly and suddenly in their intellectual process, so the process of reaching a proper response may become longer. This style (global) among juniors has the lowest number (4 students), which implies their unfamiliarity with this kind of processing and its importance in problem-solving and design processes. However, the lowest number of seniors (3 students) is related to sequential style. These students learn step by step and pay attention to details. They are more interested in regular searches and prefer facts to concepts and encounter problems by following a sequential and step-by-step process; hence, they feel more comfortable when they do not have to take risks or adopt random solutions.

The findings of this part of the study are highly consistent with results obtained by Felder and Silverman. They concluded about architecture students that students in the final semester are more visual, global, and reflective rather than students in the early semester. According to data reported in Table 2, the number of seniors significantly exceeded the juniors in terms of intuitive, visual, and global styles, so increased visual and global styles are matched with findings obtained by Felder and Silverman, while a decline has occurred in reflective style that is not matched with their results.

Table 3. Results of Juniors and Seniors' Performance in Theoretical and Workshop Courses

		Juniors		Seniors
Architectural Design Workshop	Best performance in the workshop of Architectural Design Basics 1	1. Reflective students 2. Visual students	Best performance in the workshop of Architectural Design 4	1. Global students 2. Visual students 3. Reflective students
	Weakest performance in the workshop of Architectural Design Basics 1	1. Active students 2. Sequential students 3. Sensing students	Weakest performance in the workshop of Architectural Design 4	1. Sequential students 2. Active students 3. Verbal students
Theoretical Courses	Best performance in Construction Materials	1. Verbal students 2. Reflective students	Best performance in Islamic Architecture 2	1. Visual students 2. Sensing students
	Weakest performance in Construction Materials	Active students	Weakest performance in Islamic Architecture 2	1. Sequential students 2. Active students

5.1. Discussion on Correlation Analysis

Statistical analysis of collected data is done through SPSS21 Software. The learning styles of students are scored based on the Felder-Soloman questionnaire (a scale of 0-11 score is used to measure each dichotomy) and students' performance is evaluated based on the interval measurement scale. Hence, the Pearson Product-Moment Correlation Coefficient is used to evaluate the relationship between learning styles and performance because both Are interval variables. The results showed no significant relationship between learning styles and students' performance in Architectural Design 4, Architectural Design Basics 1, Construction Materials, and Introduction to Islamic Architecture 2 courses (Appendix 1). The exception is related to seniors' performance in the Architectural Design 4 course in which, significant values are obtained between students' performance and visual style at the level of 0.074 with a correlation coefficient of 0.398, and with global style at the level of 0.142 with a correlation coefficient of 0.331. Moreover, students' performance in the two courses of architectural design and Islamic architecture is considerable at the level of 0.056 with a correlation coefficient of 0.423, indicating that successful students in the design course can perform successfully in the Islamic architecture course too. The findings of this study are matched with results obtained by Van Zwanenberg et al. (2000) who studied the relationship between academic achievement of students and Felder-Silverman learning styles. Their results indicated no relationship between the academic achievement of students and learning styles. On the other hand, these findings are not matched with the results obtained by Emamipour and Shams Esfandabad (2004) who found a significant relationship between academic achievement and learning styles, so that intuitive and sequential learning styles could anticipate high academic achievement.

5.2. Discussion of Juniors' Performance Appraisal

According to the appraisal of juniors' performance in the Architectural Design Basics 1 course and theoretical course of Construction Materials[3] (Fig.s 5 & 6), reflective students followed by visual students had the best performance in Architectural Design Basics 1, while students with active style followed by sequential and sensing styles had the weakest performance. In terms of the Construction Materials course, verbal students followed by reflective students had the best performance and active students showed the weakest performance. It should be noted that the Construction Materials course is presented based on a pamphlet and theoretical method by the professor over the semester.

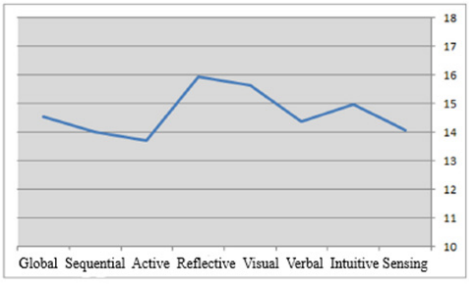

Fig. 5. Juniors' Performance in Architectural Design Basics 1

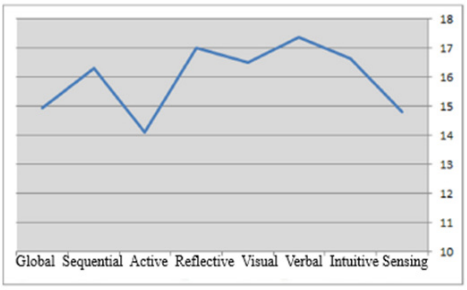

Fig. 6. Juniors' Performance in the Construction Materials Course

5.3. Discussion on Seniors' Performance Appraisal

Seniors' performance appraisal in Architectural Design 4 indicates the success of global, visual, and reflective students and the failure of sequential, active, and verbal students. Moreover, evaluation of students' performance in the course Introduction to Islamic Architecture 2 indicates that visual students followed by sensing students had the best performance but sequential and active students had the weakest performance. It is worth noting that this course is mainly presented as PowerPoint and descriptive discussions.

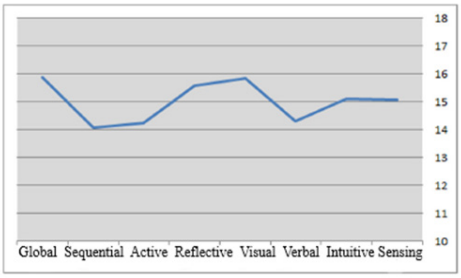

Fig. 7. Seniors' Performance in Architectural Design 4

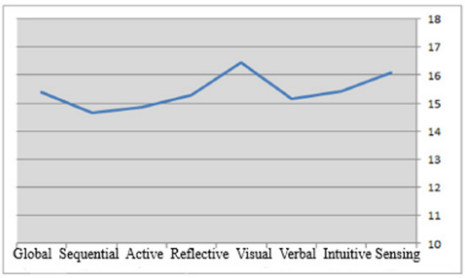

Fig. 8. Seniors' performance in Introduction to Islamic Architecture 2

5.4. Discussion on Comparison between Students' Performance in Theoretical and Architectural Design Courses

According to the comparison between graphs of juniors' performances (Fig.s 5 & 6), students with reflective and visual learning styles have performed more successfully in workshops on Architectural Design Basics, and verbal and reflective students have been successful in theoretical courses. The active, sequential, and sensing students have performed weaker in Architectural Design and active students have weaker performance in theoretical courses. However, the comparison between charts of seniors' performance (Fig.s 7 & 8) indicates that global, visual, and reflective students had the best performance in architectural design while visual and sensing students had the best performance in the theoretical course, and sequential, active and verbal students had the weakest performance in architectural design but sequential and active students performed weekly in the theoretical course. These results are matched with the results of visual and verbal styles obtained by Emamipour and Shams Esfandabad but are not consistent with the results of sequential and global styles. They concluded that architecture students had fewer verbal and global styles and more visual and sequential styles compared to students in other majors.

6. CONCLUSION

A significant increase is seen in the number of seniors having intuitive, visual, and global styles. The course of Architectural Design showed that students with visual and global styles had better performance. Also, successful students in design courses can be successful in Islamic Architecture courses. In the case of students' performance appraisal, students with reflective and visual styles had the best performance in the Architectural Design workshop. Active and sequential styles have the weakest performance and the sensing style is replaced with the verbal style. In theoretical courses, there is a relationship between the optimal performance of juniors with verbal and reflective styles in Construction Materials and with visual and sensing styles in the course Introduction to Islamic Architecture 2. These results can be used in students teaching regarding their preferred learning styles to help them achieve a better future and less frustration. These results show that consideration of the learning style type of students can be effective in optimizing their learning and presenting better courses. The novel aspect of this study highlights new techniques for the effect of learning styles on the performance of architecture students.

APPENDIX

Table 1. Pearson Product-Moment Correlation Coefficient for Juniors

Variables	Sensing	Intuitive	Verbal	Visual	Reflective	Active	Sequential	Global	Design Basics 1	Construction Materials
Sensing	1	-1**	-0.168	0.168	0.123	-0.123	0.103	-0.103	-0.131	-0.259
Intuitive		1	0.168	-0.168	-0.123	0.123	-0.103	0.103	0.131	0.259
Verbal			1	-1**	-0.090	0.090	-0.107	0.107	-0.047	-0.069
Visual				1	0.090	-0.090	0.107	-0.107	0.047	0.069
Reflective					1	-1**	-0.107	0.107	-0.230	0.175
Active						1	0.107	-0.107	0.230	-0.175
Sequential							1	-1**	-0.074	-0.092
Global								1	0.074	0.092
Design Basics 1									1	0.276
Construction Materials										1

Table 2. Pearson Product-Moment Correlation Coefficient for Seniors

Variables	Sensing	Intuitive	Verbal	Visual	Reflective	Active	Sequential	Global	Design Basics 1	Construction Materials
Sensing	1	-1**	0.105	-0.105	0.260	-0.260	-0.004	0.004	-0.020	-0.025
Intuitive		1	-0.105	0.105	-0.260	0.260	0.004	-0.004	0.020	0.025
Verbal			1	-1**	0.276	-0.276	0.040	-0.040	-0.398	-0.164
Visual				1	-0.276	0.276	-0.040	0.040	0.398	0.164
Reflective					1	-1**	-0.119	0.119	0.203	-0.112
Active						1	0.119	-0.119	-0.203	0.112
Sequential							1	-1**	-0.331	-0.147
Global								1	0.331	0.147
Design Basics 1									1	0.423
Construction Materials										1

** Correlation is significant at the level of 0.01. Because Felder-Silverman styles are defined as dichotomies, both styles belong to one dimension of assessment and have a reverse correlation with each other (correlation coefficient of -1).

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CONFLICT OF INTEREST

The authors have no conflicts of interest to declare.

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The authors commit to observe all the ethical principles of the publication of the scientific work based on the ethical principles of COPE. In case of any violation of the ethical principles, even after the publication of the article, they give the journal the right to delete the article and follow up on the matter.

PARTICIPATION PERCENTAGE

The authors state that they have directly participated in the stages of conducting research and writing the article.

ENDNOTE

1. Learning Style Inventory
2. Learning Style Analysis
3. This course is divided into one theoretical unit and one practical unit in the formal chart of the curriculum but is presented theoretically in the classroom.

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