Design and Technology Education: An International Journal
24.1

The Evaluation of the Relationship between the Use of Multi-Software and the Students' Attitude towards Computers and Technology in Undergraduate Architectural Design Studio Education

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Abstract

Different computer programs used in the architectural design process serve different purposes. However, the number of computer programs used is increasing at a rate that designers find it difficult to adapt to. Accordingly, the possibility arises to use more than one computer program during the architectural design process, and it is important to make the correct choice of which ones are most appropriate to use. This is also true for undergraduate students of architecture, and hence a pilot study was made, which focused on the use of multi-software within the scope of the architectural design studio. The relationship between the students' use of multi-software and their attitude toward computer and technology was evaluated statistically, by means of Pearson product moment correlations. The results showed that the attitude of the students toward computers and technology influences how they use multi-software.

Keywords

use of multi-software, architectural education, architectural design studio, computer attitude.

Introduction

Every passing day, new computer software emerges in the field of architecture, each of which serves different purposes. According to common usage purposes, it is possible to categorize such new computer software as Building Information Modeling (BIM), programs for free-form 3D modeling, programs for sustainable building design simulations and programs for making presentations. In addition, there are a number of programs for more specific purposes (such as acoustics, structural analysis, optimizations). BIM programs (Revit, Archicad, Allplan) are mostly used for the construction of projects, while programs such as Rhino, Grasshopper, Dynamo and Maya are mostly used for free-form 3D modeling experiments. Programs such as Ecotect, Velux Daylight Visualizer, EnergyPlus, eQuest, Daysim, Dialux and Grasshopper add-ons, for example Honeybee, Ladybug are also programs that are used for sustainable building design. Programs such as Photoshop, Illustrator and Indesign are mostly used for presentations. Programs such as 3d max, Maya, Lumion, and After Effects are also used for presentations, but are especially preferred for rendering and creating video. Examples of programs used for specific purposes are Grasshopper add-ons. For example, among Grasshopper add-ons, *Pachyderm* is used for acoustic simulation, *Karamba* is used for structural analysis, and *Octopus* is used for multi-objective optimization. Therefore, more than one kind of software is emerging for use in design education (Senyapili & Bozdag, 2012).

It is inevitable that computers are used in every modern undergraduate design programme, and from now into the future, the strategic use of computers will be essential, and this brings in the use of multiple software packages. The aim of the present study was to evaluate any relationship between the use of multi-software and the attitude of the student toward using computers, and therefore, a case study was made which focused on the use of multi-software within the architectural design studio course, as taken by students of the department of architecture. The students were directed to those computer programs that were considered to be most appropriate in the architectural design studio course, according to their particular design requirements. Thus, having experienced the use of many different programs simultaneously, the students were able to achieve appropriate results. At the end of the study, a questionnaire was conducted among the student group, to test the hypothesis that their positive attitude towards computer related technology encourages them to use multi-software.

Literature review

Many studies have been made to investigate the attitude of students towards using computers in the field of education. These studies have typically involved a search for a relationship between the attitude of the students toward using computers and factors such as anxiety over mathematical aspects, their prior experience with computers, cognitive ability, the influence of their teacher(s), personal characteristics and gender differences (Dambrot, Watkins-Malek, Silling, Marshall, & Garver, 1985; Smith, 1986; Miura, 1987; Levin & Gordon, 1989; Sigurdsson, 1991; Arthur & Olson, 1991; Gattiker & Hlavka, 1992; Shashaani, 1993; Francis, 1993; Jones & Clark, 1994; Robertson, Calder, Fung, Jones, & O'Shea, 1995; Shashaani, 1997; Mitra, Lenzmeier, Steffensmeier, Avon, Qu, & Hazen, 2000; Ames, 2003). Specific studies of possible connections between the students' attitude towards the use of computers in the design process, and teacher influence, and gender difference have been made (Hanna & Barber, 2001; Basa & Senyapili, 2005; Pektas & Erkip, 2006). A variety of studies have also been carried out on the computational approach in design education (Oxman, 1999; Cuff, 2001; Knight & Stiny, 2001; Ozkar, 2007; Oxman, 2008; Aish & Hanna, 2017; Oxman, 2017).

There have been many studies made on the methodology used for architectural design studio education, among which, Kolb's (1984) experimental learning model is widely used. Kolb's (1984) model is also used in various design disciplines (Kvan & Jia, 2005; Demirkan & Demirbas, 2008; Yavuzcan & Sahin, 2017). In this model, which is used in most of the architectural design studio courses, the approach of 'learning by doing' is in the foreground. Kolb (1984) describes the learning process as a cycle, in which four dimensions (concrete experience, abstract conceptualization, active experimentation, reflective observation) are defined (Fry, Ketteridge, & Marshall, 2009). Also, in this 'learning by doing' process, students refine and revise their ideas by means of sketches (Graves, 1977; Schon, 1983; Goel, 1992; Schon & Wiggins, 1992; Garner, 1992; Goel, 1995; Suwa & Tversky, 1996; Do, Gross, Neiman & Zimring, 2001; Do, 2002).

Methodology

This work was carried out within the scope of the architectural design studio course (in the second semester of the second year) given by the author in the department of architecture of the university where this study was conducted. The course was one semester long (14 weeks/ two days in a week). The tutor met with students on an individual basis and feedback was given to them about their work. In addition to this critique, the students were provided with information related to the computer programs that they used, or might use according to how their projects had progressed.

In the present study, a methodology was followed based on Kolb's (1984) experimental learning model, and in addition, the tutor's redirection on the use of the computer program was included as an input. With this methodology, the main effort of the student concerns the use of the computer program, which he/she uses in cooperation with the tutor in the design process (again with the 'learning by doing' principle). Due to the fact that there are many commercial computer programs available, it was necessary to limit the time taken to choose the particular computer program that the students will choose for their work, thus, achieving good time management. However, the likelihood that the student will discover alternative new computer programs as a result of their own research is accordingly reduced.

Before taking this architectural design studio course, the students had already learned the rules for architectural technical drawing, and experienced designing a single building size residence (or a similar design), independently from its periphery in the two architectural design studio courses and other compulsory courses. The students were asked to make a contextual design within the context of the architectural design studio used in this study, which involved first analysing the area they were provided with, followed by determining the deficiencies of this area, according to which they made suggestions of the building(s) that are appropriate for the area. While analysing the region, students were expected to make various site analyses, which may involve an analysis of the storey heights of the buildings, functional features, building materials, façades, historical buildings and special buildings (Caniggia & Maffei, 2001), green areas, parks and squares (Sitte, 1889), urban nodes (Lynch, 1960), topographic perspectives, solids-voids (Trancik, 1986), road patterns, transportation aspects, accessibility details, urban pattern (Koskof, 1991; Moudon, 1997; Panerai, Castex, Depaule, & Samuels. 2004), historical urban pattern formation (Petruccioli, 2007), social and cultural aspects, soundscape (Schafer, 1994; Ge & Hokao, 2005; Irvine, Devine-Wright, Payne, Fuller, Painter & Gaston 2009; Leus, 2011) and smellscape (Henshaw, 2014). Having done this, the students were expected to determine the site of their proposed buildings based on the particular features that they had defined. An appropriate choice of buildings, which collectively provide many different functions (such as library, public education centre, outpatient clinic, school, kindergarten, sports hall, exhibition centre, museum, youth centre) and the establishment of a good relationship between them are also expected. Ideally, all of the buildings should cover an area of 1000-1500 m2.

Since the content of compulsory computer-aided design courses that students have taken in the past years varies, the software that they know and use also varies. However, practically all students, who took the courses, are familiar with Photoshop, Sketchup and Rhino. In the architectural design studio in the content of this study, the instructor encouraged the students to use different computer programs for particular purposes. In the end of the studio course, many products have been produced with the use of different software. In this paper, an evaluation was made of the projects of 3 students who had been given grades above 80/100, along with the software that they used.

A questionnaire study was conducted with 13 students who took the course, in order to test the hypothesis that the students' attitude toward to computer and technology encourages the use of multi-software (Table 1). The questionnaire was completed online in the final lesson of the course semester, in order to prevent any communication between the students, who were also given sufficient time and advance information to complete the questionnaire; they were further informed that their identity would be kept anonymous, with the intention to obtain more realistic responses. The students answered all the questions thoroughly.

A 5-point Likert scale was used for the questionnaire. The answer option for each question in the survey was as following: Strongly disagree = 1, Disagree = 2, Undecided = 3, Agree = 4 and Strongly agree = 5. The questionnaire was categorized into "Students' attitude towards computer & technology" and "Students' attitude towards multi-software use" and covers 6 questions in total. The questions in the category of "Students attitude towards computer & technology" are as follows: "I want to learn more computer programs", "I find computers and technology exciting", and "I'm learning computers and technology just because I have to learn". It is planned to measure the degree of interest of students in computer and technology from the answers given to these questions. The questions in the category of "Students attitude towards multi-software use" are as follows: "I frequently make the transition between programs in design studio projects", "I have difficulties making transition between computer programs", and "Instead of using a program very well, I think that it is a better way to choose the program to be used, which is oriented to the purpose". In the responses given to these questions, it is planned to measure whether the student uses more than one program, if any problems are encountered in making the transition between the programs, and the choice of the computer program made for the particular purpose.

To measure the relationship between variables in the above two categories, Pearson product moment correlations (test of significance: two-tailed) were performed, using the SPSS statistical software. Then, according to the values obtained as a result of this correlation, the evaluation was made. However, it should be noted that the questionnaire was conducted with only 13 students, so the results obtained from this case study are somewhat limited. For more accurate results and larger generalizations, it is necessary to conduct surveys with a greater number students, and as taken from different universities.

Students' attitude towards computer & technology	I want to learn more computer programs I find computers and technology exciting I'm learning computers and technology just because I have to learn.
Students' attitude toward multi-software use	I frequently make the transition between programs in design studio projects. I have difficulties making transition between computer programs. Instead of using a program very well, I think that it is a better way to choose the program to be used, which is oriented to the purpose.

Table 1. The questions of the questionnaire

Results of the questionnaire

It turned out that all of the students wanted to learn more computer programs, since they found computers and technology exciting. However, some of them seem to show some reluctance according to an attitude of "I'm learning computers and technology just because I have to learn". Moreover, the result is that all students use more than one type of software in their project and thus made transitions between them. It turned out that the majority of students also think that it is better to choose a program for a particular purpose than to learn how to use a given program in great detail. However, it is seen that some students have difficulty in making transitions between the programs (Table 2)

There is a significant correlation between "I want to learn more computer programs" and "Instead of using a program very well, I think that it is a better way to choose the program to be used, which is oriented to the purpose”. There is also a significant correlation between “I find computers and technology exciting” and “Instead of using a program very well, I think that it is a better way to choose the program to be used, which is oriented to the purpose”. In addition, there is a significant correlation between “I'm learning computers and technology just because I have to learn” and “I have difficulties making transition between computer programs” (Table 3). That is, the hypothesis: students are interested in computer and technology encourages the use of multi-software is correct. In addition, the viewpoint of the student about the use of computers becomes effective in overcoming the difficulties of using multi software.

	Strongly disagree (number of persons / per cent)	Disagree	Undecided	Agree	Strongly agree
I want to learn more computer programs	-	-	-	1 (7.7%)	12 (92.3%)
I find computers and technology exciting	-	-	-	6 (46.2%)	7 (53.8%)
I'm learning computers and technology just because I have to learn.	6 (46.2%)	5 (38.5%)	2 (15.4%)	-	-
I frequently make the transition between programs in design studio projects.	-	-	-	1 (7.7%)	12 (92.3%)
I have difficulties making transition between computer programs.	2 (15.4%)	4 (30.8%)	4 (30.8%)	3 (23.1%)	-
Instead of using a program very well, I think that it is a better way to choose the program to be used, which is oriented to the purpose.	-	1(7.7%)	1 (7.7%)	5 (38.5%)	6 (46.2%)

Table 2. Percentage of the results of questionnaire study

		I want to learn more computer programs	I find computers and technology exciting	I'm learning computers and technology just because I have to learn.
I frequently make the transition between programs in design studio projects.	Pearson Correlation	-0.083	0.312	0.277
	Sig. (2-tailed)	0.787	0.300	0.360
I have difficulties making transition between computer programs.	Pearson Correlation	0.177	0.414	.687**
	Sig. (2-tailed)	0.563	0.159	0.010
Instead of using a program very well, I think that it is a better way to choose the program to be used, which is oriented to the purpose.	Pearson Correlation	.723**	.587*	0.350
	Sig. (2-tailed)	0.005	0.035	0.241

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

Table 3. Results of Pearson product moment correlations between "Students' attitude towards computer & technology" and "Students' attitude toward multi-software use" categories

The use of multi-sofware in architectural design studio

In this section, first, the best 3 student projects which had scored a grade above 80/100 were chosen for evaluation by the author. Various criteria for grading in the content of the architectural design studio course are as follows; development of designs within contextual design framework, having a strong concept of design, preliminary research / analysis, correct technical drawing, space organization of the created building designs, modification of the projects to overcome various obstacles encountered in the design process.

Case 1: Sports Centre Project

The student primarily conducted field research. At this stage, the municipal maps of the area prepared in AutoCad environment were transformed into a Photoshop environment and converted into analysis boards, which displayed the current situation in the region. The field research made it possible to visualize the missing qualities in the region, which therefore helped the student to determine the particular function to be proposed. Later, the student, proposed to build a sport complex by bringing an additional function to the stadium in the land next to it. To start the design, the student first began to make 3D sketches using the SketchUp program for the specific area that he had selected in the region. At this stage, the student actually entered the process of rediscovering with digital sketches, while simultaneously beginning to produce the site model. The student began to produce triangular shaped masses, starting from the form of the land and the concept of linking nodes in the surrounding field. The student had foreseen that after the design had reached a certain level, he would continue to design in Revit on the basis that this program could be used most easily to make sections, elevations and plans for anticipated triangular forms. The student brought these triangular forms into the Revit environment as mass and began to detail these mass models in the Revit environment (Figure 1), where the design process continued over an appreciable time. Once the design had been brought to a certain level in the Revit environment, the instructor recommended the student to also make energy simulations in Revit. Later, the student transformed the 3D model from the Revit to the Lumion environment, where he took renders and made an animation of the project, finally using the Photoshop environment for his presentation. This involved collecting into Photoshop the renderings in Lumion, plans, sections, elevation and perspectives obtained in Revit environment and map drawings in AutoCad, and finally creating the boards in Photoshop environment.

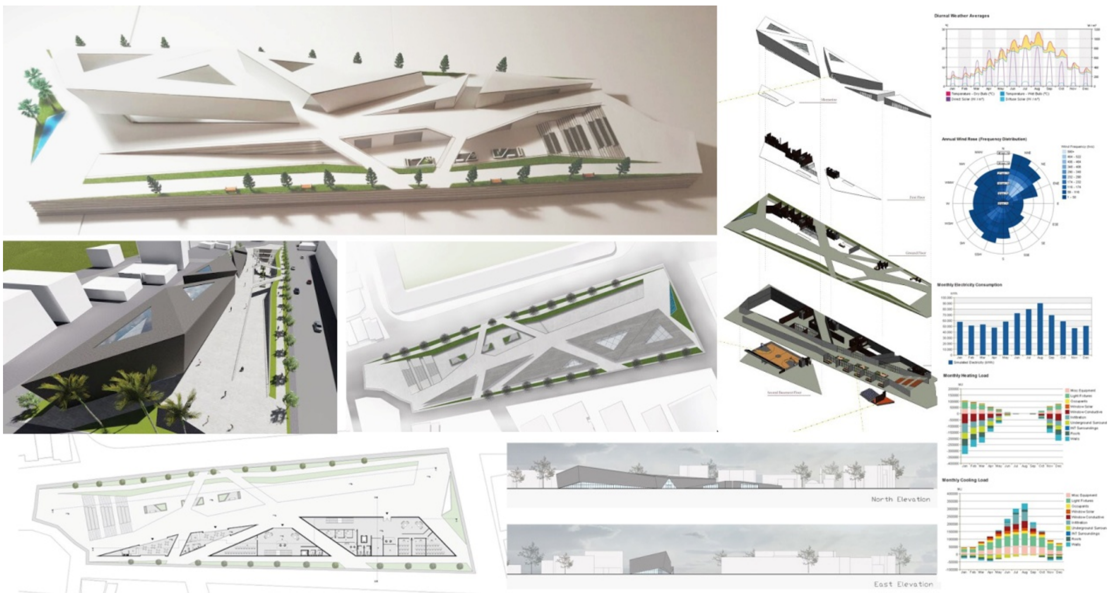

Figure 1. Sports centre study of a student

Case 2: Cultural Hub Project

The student primarily conducted field research, for which Photoshop and AutoCad programs were used. By considering the multiculturalism of the area, the student proposed a combined complex for young people, where many activities can co-exist.

The sketches were started in a 3D design environment and then most of the design time was spent in the Rhino environment, while simultaneously making the model/maquette studies (4). In addition, the student started to compete for creating differences on building facades after making decisions about the general mass. For this, he proposed a solid-void ratio that varies on the facade. To achieve this, a script was developed by using the Grasshopper program, which works as a plug-in to the Rhino program. Given the student's interest in kinetic structures, and to reflect this on the facade, he suggested the possibility of making kinetic sun breakers, for which Arduino and Firefly (Grasshopper add-on) programs were used. At this stage, ready-made codes in the internet environment proved beneficial (Figure 2). For the presentation, he collected his model, drawings and various analyses in boards, by means of Photoshop.

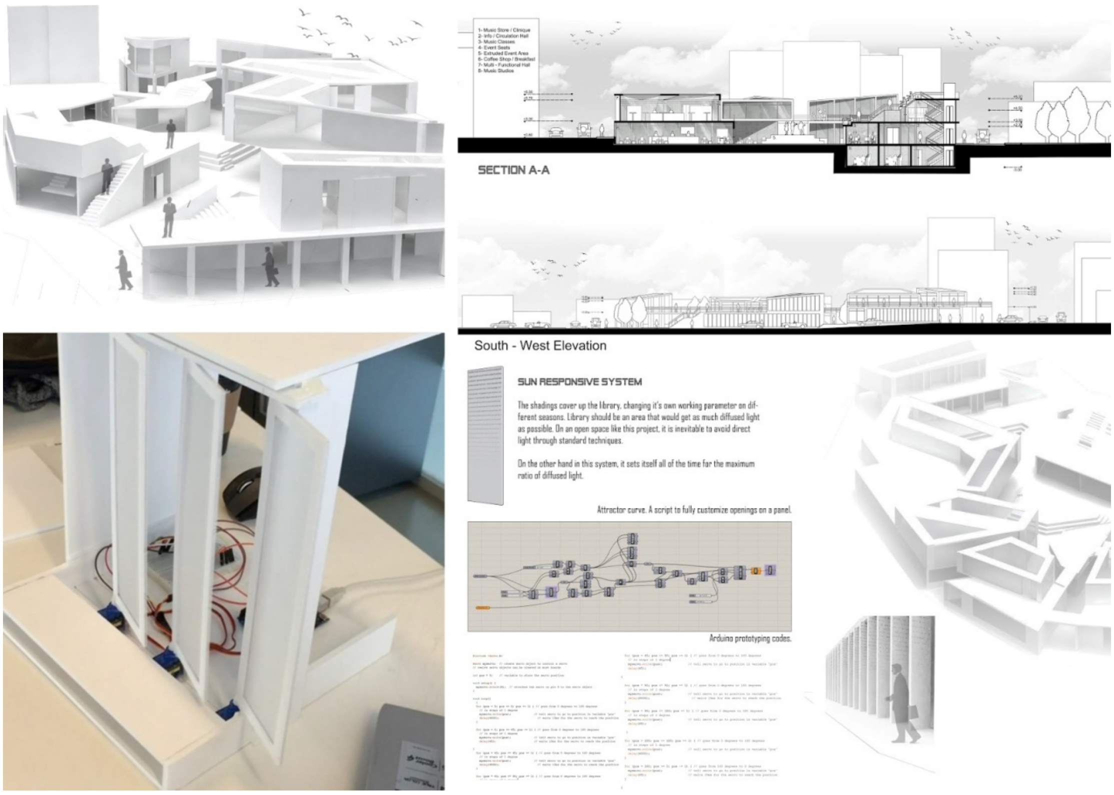

Figure 2. Cultural hub study of a student

Case 3: Public Library Project

The student focused on street pattern while making site analyses, for which a visibility graph of the region was obtained by means of the space syntax method, using the DepthmapX program. Based on this analysis, a specific area was selected for the public library proposal. The SketchUp program was used while creating a design mass model; however, the student simultaneously continued to draw plans in the AutoCAD program and made models/maquettes. Meanwhile, she also made transformations from AutoCad to SketchUp. After the building design had reached a certain degree, the student wanted to create a difference on the facade of the building in order to change its overall simplicity, for which the instructor recommended the use of the Grasshopper program. Since Grasshopper works as a plug-in to the Rhino program, the student transferred the 3D model that had been created in SketchUp to Rhino, by which means various facade trials became visible (created in Grasshopper with Voronoi geometry) on the 3D model in Rhino. In order to establish harmony between the roof of the building and the created facade on a form basis, various trails related to the roof were continued in the Rhino environment. Again, the student preferred to take a render in the Rhino environment. Facades (created in the 3D environment) were transferred to AutoCAD in order to reflect them in the elevations. Plan, section and elevations, which were prepared in AutoCad environment, were transferred to Illustrator environment to adjust the line thicknesses and these were transferred to the Photoshop environment in order to colour drawings. The last boards were prepared in the Photoshop environment (Figure 3).

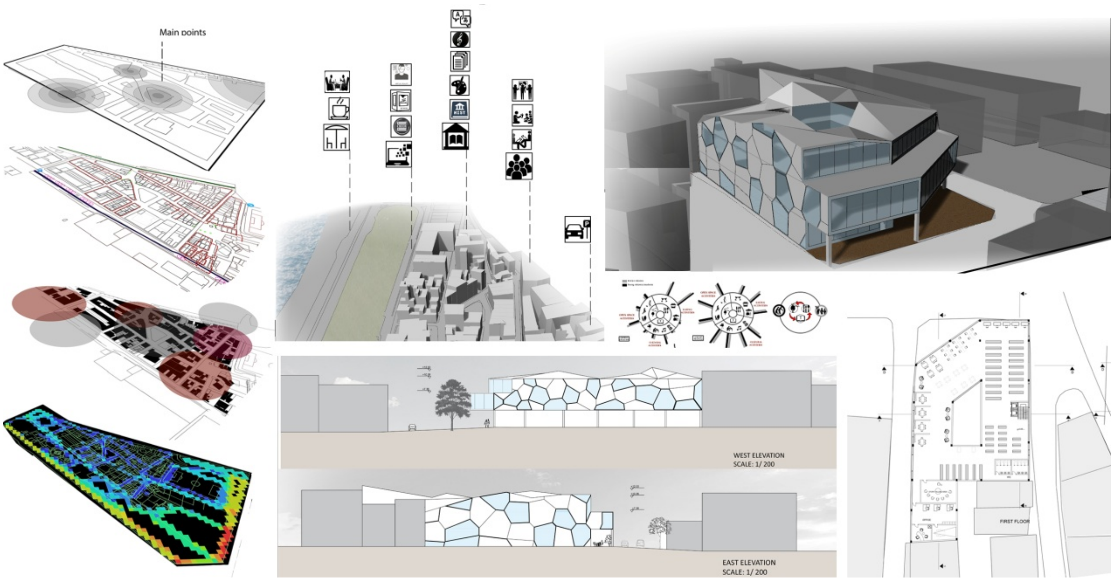

Figure 3. Public library study of a student

Discussion

It is possible to categorise the design process of 3 student projects as the 'site analyses' stage in which the region is examined, the 'early design process' stage in which sketches are made, the 'design process' stage in which 3D models are done and, plans, sections, elevations are drawn, and the ‘presentation’ stage in which renders and boards are prepared. During 14 weeks, students used some programs at different time periods (at different stages) and also used some programs simultaneously to produce projects.

From the students’ projects, it can be seen that different kinds of software are used at each stage including site analysis, early design process, design process and presentation. Therefore, during the transitions between these stages, transitions between various software programs were also experienced. In Case 1, for instance, Photoshop and AutoCad were used in the site analysis stage; SketchUp was used in the early design process; Revit was used in the design process stage; and Lumion was used in the presentation stage. In Case 2, the following programs were used as the project progressed: Photoshop and AutoCad in the site analysis stage; Rhino in the early design process stage; Grasshopper, Firefly and Arduino in the design process stage. In Case 3, the uses of the programs were: AutoCad, and DepthMapX in the site analysis stage; SketchUp in the early design process stage; Rhino and Grasshopper in the design process stage; Illustrator in the presentation stage (Table 4).

Additionally, in the 3 students' projects, it is clear that more than one type of software can be used simultaneously at each stage. Therefore, there are continuous transitions taking place between the software used in each stage. For example, in case 1 and case 2, transitions were made between Photoshop and AutoCad programs during the site analysis stage. In case 3, a transition occurred between AutoCad and SketchUp programs in the early design process. In Case 2, Rhino, Grasshopper, Firefly, and Arduino were used together in the design process stage (Table 4).

When we look at the 3 different studies, it can be seen that the programs used by the students in the stage of site analysis are very similar, which are Photoshop and AutoCad. Again, in the presentation stage, it can be seem that the Photoshop is used by all 3 students. However, the programs used in the early design process and design process stages vary between the 3 students (Table 4).

According to how students want to improve their projects, the program proposal brought by the instructor can slow down the process to some extent, if the student is unfamiliar with its use. However, this did not prevent the design process and solutions to the various problems were solved by working with the instructor.

	Site Analyses	Early Design Process (sketches)	Design Process (modelling, plans, sections, elevations)	Presentation (renders, boards)
Photoshop	Case 1, Case 2, Case 3			Case 1, Case 2, Case 3
AutoCad	Case 1, Case 2, Case 3	Case 1, Case 3	Case 3	
Rhino		Case 2	Case 2, Case 3	Case 2, Case 3
Grasshopper			Case 2, Case 3	
Firefly			Case 2	
Arduino			Case 2	
Revit			Case 1	
SketchUp		Case 1, Case 3	Case 3	
Lumion				Case 1
DepthMapX	Case 3			
Illustrator				Case 3
Model (maquette)		Case 1, Case 2, Case 3	Case 1, Case 2, Case 3	Case 1, Case 2, Case 3
Site Model (maquette)	Case 1, Case 2, Case 3			Case 1, Case 2, Case 3

Case 1
Case 2
Case 3

Table 4. Computer programs used by 3 students for different purposes throughout the design stages of the architectural design studio course

Conclusion

Although this study is specifically concerned with the use of computer-aided design tools within the architectural design studio, its inferences are related to all other design disciplines because, the use of computer technology is increasing rapidly in all areas of design. Since different computer-aided design programs serve different purposes, the use of multi-software concerns all areas of design. The studies, which will be carried out on the use of multi-software in design education, are thought to contribute to the development of those methodologies that will be followed by educators in universities. In addition, such studies are thought to be of interest to computer programmers in terms of interface design development and transition between programs.

In today's architectural design studio education, it is inevitable for students to use more than one program and to make transitions between the programs. The studio supervisor(s) should therefore be sufficiently knowledgeable about the many different types of programs, which are important for developing the student's project, so that they can pass on information about which programs the student should be directed to and how the transition between these programs might be.

However, according to the statistical evaluation of the questionnaire, it seems that if a student is interested in computer and technology this encourages their use of multi-software. In other words, as the student becomes interested in computers and technology, the difficulties of using multi software are more easily overcome, their use of the technology increases.

Some students may find the interface of some programs more complex than others, because the working principles behind them differ. For example, while the AutoCad program works the same way as drawing on paper, the Revit program works with object-based modelling, and the Grasshopper program works with coding principles. However, if a student is interested in computers and related technology, they may be encouraged toward the use programs of differing complexity with greater confidence, creativity and competence.

The use of computer programs by architecture students related to the purposes of their study makes them more enquiring in this area. Students, starting from an early stage of architectural education, can get into the habit of acquiring information regarding the best purposes for which different computer programs can be used (especially various plug-ins).

Seeing the purposes and diversity of the programs and knowing how to transition between them also helps the student to find the environment in which they are more comfortable, because, every student experiences the design process differently in terms of their varying knowledge and past experiences. As an example, some students prefer to start in a 2D environment for their designs, while others prefer to start in a 3D environment.

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