THE EFFECT OF THREE DIMENSIONAL VISUALIZATION ABILITY ON BASIC DESIGN EDUCATION: AN EMPIRICAL STUDY IN A TURKISH PLANNING SCHOOL

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Abstract

Basic design education is an essential component in most of the design education programs around the world and the importance of basic design education should not be undervalued in planning schools. The themes needed to be discussed during a basic design course includes two dimensional geometry (point, line, plane, and plan) and three dimensional volumes (space, volume, perspective). Among these themes, three dimensional visualization ability constitutes an important part as a planner is assumed to imagine and design the city in three dimensions (Gunay, 2007). Although there is a general agreement on the positive effect of three dimensional visualization ability on students' success in basic design education, no study has attempted to test this relation. This study aimed to develop a methodology to test students' three dimensional visualization ability and analyze the relation between three dimensional visualization ability and success in basic design education. Students studying in city and regional planning department at Dokuz Eylul University participated in the study. Results showed a significant relation between three dimensional visualization ability and success in basic design education. However, it should be noted that this study focused on basic design education. Whether students need three dimensional visualization abilities to be successful in planning and design practice needs to be further investigated. A useful extension of this study may also examine the relation between two components of basic design education; three dimensional visualization ability and creativity.

Keywords: three dimensional visualization ability, basic design education, success in design schools, planning education, creativity.

Introduction

Basic design education is a fundamental component in most of the design education programs around the world. Boucharenc (2006) conducted a survey in 198 design and architecture schools located in 22 countries, including France, Japan, Great Britain, United States, Germany, and Belgium, to determine the status of basic design education in the world. Teachers of basic design and project design (teaching the design courses in the academic years following the basic design studio), participated in the study. In general, results showed that design instructors, whether teaching basic design or project design, perceive basic design exercises as an essential component of four or five year design education.

Boucharenc's (2006) survey collected information on the actual and desired duration of basic design courses in the world. Results showed that in most of the surveyed schools teaching of basic design takes at least one year (about 79 %) or integrated over the whole academic program (about 15 %). Only in about six percent of the surveyed schools, teaching of basic design takes a period of less than one year. When teachers were asked about ideal duration of time allocated to the teaching of basic design, most of the basic design and project design teachers were in the view that basic design should be taught for at least one year (about 50 % of the participants) or should be integrated over the full length of academic program (about 45 %). Only about five percent of the teachers surveyed thought that it should take less than one year. This finding on actual and ideal duration of basic design education may indicate the importance of basic design education in various design education programs.

Although design programs in Turkey were not represented in Boucher's study, it is plausible to assume that his findings are partially applicable to Turkish planning schools. In most of the Turkish planning schools, basic design takes about one year. Informal conversations with basic design and project design teachers showed a desire to discuss basic design concepts in the academic years following the basic design studio. Acknowledging the fact that basic design is a fundamental component of design education, this study focuses on the essential themes of exercises in basic design.

Boucharenc (2006) investigated the essential themes needed to be discussed during a basic design course. He gave an extended list of themes including point, line, plane, plan, space, volume, perspective, structure, proportion, deformation, ergonomics, light, color, materials, rhythm and others. When the proportion of the themes to be discussed was investigated, the author found two dimensional geometry (point, line, plane, and plan) and three dimensional volumes (space, volume, perspective) constitutes about %50 (about %25 each) of the curriculum. In other words, students' ability to comprehend and shape the third dimension constitutes an important part of basic design education. The importance of three-dimensional visualization ability in Turkish planning schools is no exception. In fact, Gunay (2007), who is teaching basic design in city and regional planning department at a Turkish design school for many years, argued that:

"First year basic design studio interrogates the concepts of balance, solid-void, frame of reference, scale, proportion, order (structure, network, model), in terms of one dimensional lines, two dimensional areas and three dimensional volumes."

Given the fact that three dimensional visualization ability is a fundamental theme in basic design education, this study focuses on teaching of visualization techniques. In general, basic design teachers attempt to develop student's three dimensional visualization ability by teaching visualization techniques such as axonometric, isometric, sketches, models, and three dimensional software. Boucharenc (2006) found that basic design teachers tend to use four traditional approaches (axonometric, isometric, sketches, and models). They rarely use three dimensional software. On the other hand, project teachers put more emphasis to sketches and models and put about equal importance onto axonometric, isometric, and three dimensional software. We argue that, although basic design and project design teachers disagree on which technique is more beneficial for the development of three dimensional visualization skills, it is generally accepted that a student who is better equipped with these skills would be more successful throughout the basic design course and produce more creative designs for tasks that require three dimensional visualization ability. Yet, there is no empirical study that tests the relation between three dimensional visualization ability and success in basic design. Thus, this study attempted to investigate the relation between these factors.

Method

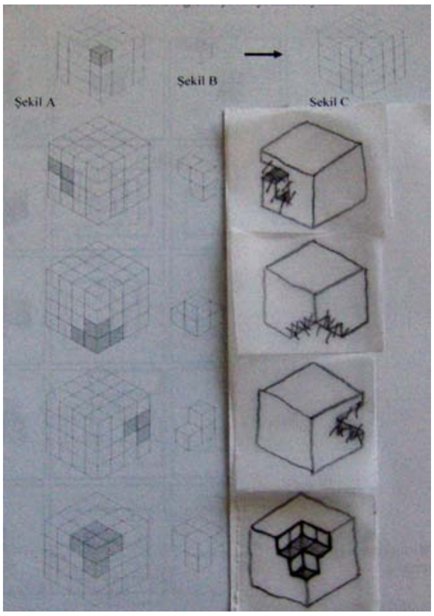
For the 2007-2008 academic year 61 students, five of whom dropped the course in the first two weeks, enrolled to the required basic design course in city and regional planning at Dokuz Eylul University. Each student's success in basic design was measured by their average grades on 62 first semester basic design studio tasks. Each task was rated by at least two basic design studio instructors who are teaching at the

Department of City and Regional Planning at Dokuz Eylul University during the 2007-2008 academic year. In general, students were able to complete each task in approximately 3 to 20 hours. The tasks aimed to develop students' technical drawing skills and abstract thinking ability to understand and represent the concepts such as balance, order, harmony, contrast, emphasis, cluster, unity, and variety via mostly two dimensional media. For each student, each task was graded from 0 to 100. Then an average score, which was based on the completed tasks rather than all tasks, was calculated for each student. The average grades vary between 46 and 78. Students who achieved a score below 60 were assigned to 'low', and students who achieved an average score above 60 were assigned to 'high' *success in basic design*.

Among 56 students who attend the basic design course for one semester, twenty nine (14 male, 15 female) volunteered to participate in three dimensional visualization tests. Volunteered students took the tests at the beginning of their first week of second semester of university attendance. To measure each student's three dimensional visualization ability, participants were asked to complete three tasks, all of which required isometric drawing skills.

For the first task, *removing cubes*, participants were given a cube formed by 64 smaller cubes (4 cubes on each of the x, y, z-axes). Then the participants were asked to remove four groups of three to five cubes from this 64 cube composition. For each cube group, the removed cubes were drawn next to the bigger cube, and the location where they were removed, were indicated with color differentiation on the bigger cube. Participants were then asked to draw four final isometric drawings showing the removed cubes in the bigger cube composition (Figure 1). The sum of the correct response for each task determines participants' success in this task. The correct response is the difference between the correct lines and incorrect or missed lines. The scores vary between 13 and 51. Students who achieved a score below 45 were assigned to 'low', and students who achieved a score above 45 were assigned to 'high' *success in removing cubes task*.

Figure 1: An example showing the survey questions and answers for removing cubes task.



For the second task, *drawing different views*, participants were asked to draw top, left, and right views for four shapes (Figure 2). The sum of the correct response for each task determines participants' success in this task. The scores vary between 2 to 12. Students who achieved a score between 2 and 6 were assigned to 'low', and students who achieved a score between 7 and 12 were assigned to 'high' *success in drawing different views task.*

For the third task, *drawing isometric perspectives*, participants were given two nine pixel compositions (3 rows X 3 columns), where the height of each pixel was indicated with numbers. Participants were then asked to draw an isometric perspective for each composition (Figure 3). The sum of the correct response for each task determined the participants' success in this task. The scores vary between 1 and 18. However, more than half of the students completed this task without error, and received a score of 18. Students completed the task without error was assigned to 'high', and others were assigned to 'low' *success in drawing isometric perspectives* task.

Figure 2: An example showing the survey questions and answers for drawing different views task.

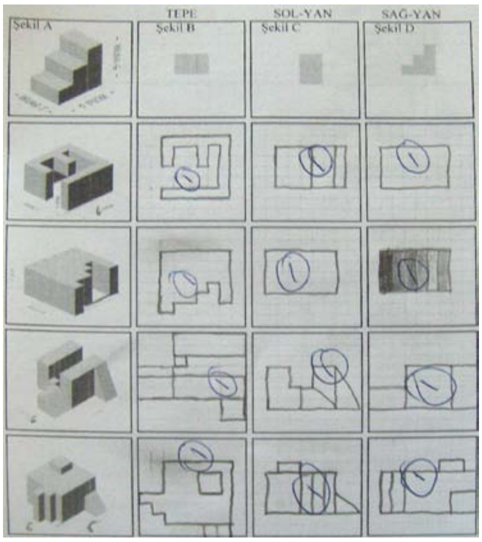
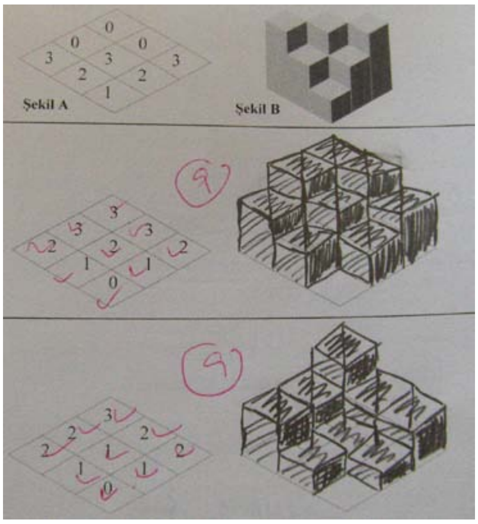


Figure 3: An example showing the survey questions and answers for drawing isometric perspectives task.



Finally, a *combined three dimensional visualization ability score* was determined for each student: Participants who received ‘high’ from at least two of three tests were assigned to *‘high three dimensional visualization ability’* and others were assigned to *‘low three dimensional visualization ability’*.

Statistical Results

Overall, results showed that three dimensional visualization ability affects success in basic design. Table 1 shows the tabulated data with respect to success in basic design and level of three dimensional visualization ability. Results showed that, students who received higher scores for basic design success were equally distributed within high and low three dimensional visualization abilities. However, students who received lower scores for basic design success tended to achieve lower scores for three dimensional visualization abilities. This difference achieved statistical significance (•2 = 3.99, df = 1, p < *0,05).*

Table 1: Distribution of number of participants by 'success in basic design' and 'level of three dimensional visualization ability'.

		Success in Basic Design		TOTAL
		High	**Low**	
Three Dimensional Visualization Ability	**High**	10	1	11
	Low	10	8	18
TOTAL		20	9	29

When the separate tests measuring three dimensional ability was analyzed, results showed a significant interaction between drawing isometric perspective and success in basic design (•2 = 7.13, df = 1, p < *0,01).* Students who received higher scores for basic design success tended to achieve higher scores and students who received lower scores for basic design success tended to achieve lower scores in drawing isometric perspective (Table 2).

Table 2: Distribution of number of participants by 'success in basic design' and 'success in drawing isometric perspective task' .

		Success in Basic Design		TOTAL
		High	**Low**	
Drawing Isometric Perspective	**High**	15	2	17
	Low	5	7	12
TOTAL		20	9	29

Although the relation between basic design success and removing cubes and the one between basic design success and drawing different views of a shape did not achieve statistical significance, the relation between these factors was in the expected direction. Students who received higher scores for basic design success tend to achieve higher scores and students who received lower scores for basic design success tend to achieve lower scores for removing cubes test (Table 3) and drawing different views test (Table 4).

Table 3: Distribution of number of participants by 'success in basic design' and 'success in removing cubes task'.

		Success in Basic Design		TOTAL
		High	**Low**	
Removing Cubes	**High**	11	4	15
	Low	9	5	14
TOTAL		20	9	29

Table 4: Distribution of number of participants by 'success in basic design' and 'success in drawing different views task'.

		Success in Basic Design		TOTAL
		High	**Low**	
Drawing different views	**High**	11	3	14
	Low	9	6	15
TOTAL		20	9	29

Conclusion

This study examined the relation between basic design education and three dimensional visualization ability. Success in basic design was measured by students' average grades on various basic design studio tasks. Students' three dimensional visualization abilities were measured by three tasks, all of which required isometric drawing skills. As expected, results showed that students who were successful in basic design received better scores in three dimensional visualization ability tests. Similarly, students who received lower scores for success in basic design showed lower three dimensional visualization abilities.

It should be noted that three dimensional visualization ability is not the only factor that may affect success in basic design education. As Denel (1981) argued creativity is one of the most important skills that a design student should possess. However, understanding the relation between three dimensional visualization ability and creativity was beyond the scope of this study. Yet, we tested if students who had higher three dimensional visualization abilities produced better and more creative designs for compositions that require an understanding of third dimension with a follow-up test. The students who participated in this study were later asked to develop a design for an entrance of a hypothetical monument during the second semester of the basic design course. The area to be designed had a high slope. The students were allowed to work in groups of two people. The project was to be completed in ten days and the instructors helped students by giving critiques for design. Since this task was given as a part of course curriculum, rather than a part of this research, it is not possible to statistically compare the creativity of students' designs between students who received higher scores and lower scores in three dimensional visual ability tests. Despite methodological concerns, we found that the probability that a student may produce a successful or a poor design in terms of creativity was about equal for students who received high scores in three dimensional visual ability. However, students who received low scores in three dimensional visual ability were unlikely to produce a successful design in terms of creativity. Figure 4 shows an example of a design alternative produced by two students who received high scores in three dimensional visualization ability tasks, and figure 5 shows an example of a design alternative produced by two students who received low scores in three dimensional visualization ability tasks. Note however, this figure could not provide concrete empirical evidence. Thus, whether better three dimensional visualization ability leads a student to produce better and more creative design alternatives for a design problem deserves to be further investigated.

Figure 4: An example of a design alternative produced by two students who received high scores in three dimensional visualization ability tasks

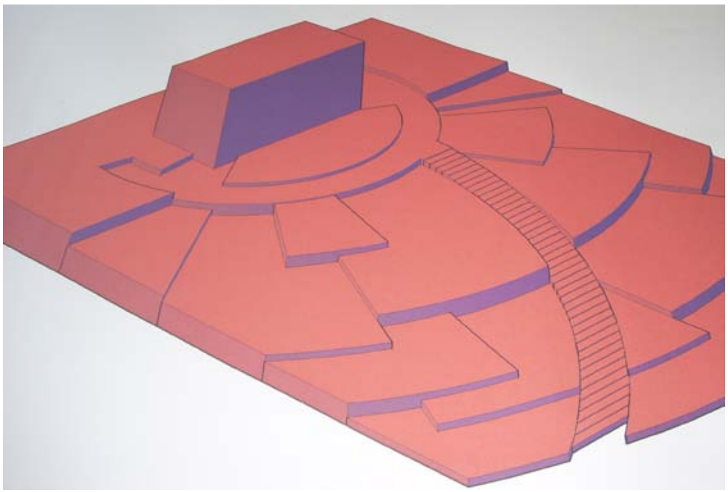
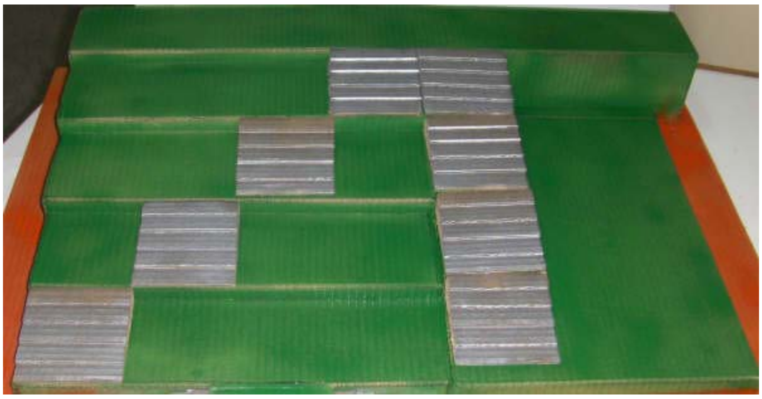


Figure 5: An example of a design alternative produced by two students who received low scores in three dimensional visualization ability tasks



Recall, this study measured three dimensional visualization ability with three tasks, all of which required isometric drawing skills. Future studies may also consider using other tests, such as mental cutting and perspective drawing, to measure three dimensional visualization ability. These tests were given in a basic design course at the end of the first semester for one group of students majoring in city and regional planning. Whether the results of the present study will apply to other design based programs such as architecture, graphic design, interior architecture remains to be seen. More work needs to be done to test the generalization of the results to various groups of students.

Moreover a useful extension of this study may test whether design education can improve a student's three dimensional visualization ability and focus on which technique (axonometric, isometric, sketches, models or three dimensional software) is more beneficial in teaching and enhancing students' three dimensional visualization abilities.

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