A STUDY ON EFFECTS OF STUDENT ADMISSION METHODS ON STUDENTS' DESIGN PRACTICES

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ABSTRACT

In this research we investigated the relationship between student admission process to design programs and design processes of students in the product design studio in two distinctively different product design undergraduate programs in Istanbul. Mimar Sinan Fine Arts University Industrial Design Program accepts students based on drawing exams where students' visual perception and expression skills are tested, whereas Istanbul Technical University Industrial Design Program accepts students based on a national math and science exam. Thus, students entering the industrial design programs through artistic examinations or national examinations have different backgrounds regarding their studies prior to their university educations.

It was hypothesized that students coming from different backgrounds may have different approaches to problem solving in stages of product design process. To understand the difference in the design processes in the product design studio we investigated the changing roles of "skill" versus "rationale" based on interviews with selected students and studio instructors.

Keywords: design education, studio, skill development, problem based learning

1- BACKGROUND OF THE STUDY

Four major industrial design departments which have a history of more than 20 years accept students based on a national math-based exam or aptitude tests. Because the student acceptance criteria are different in those departments, students' educations and studies prior to industrial design undergraduate program also differ. Since some educational psychologists suggest that thinking habits affect problem solving skills (Resnick 2001, D'Zurilla et.al.), this paper aims to investigate whether the industrial design processes of students of these universities differ.

1-1 INDUSTRIAL DESIGN DEPARTMENTS IN TURKEY

Industrial design education is dated back to 1971 in Turkey. The first four industrial design departments were founded in Mimar Sinan Fine Arts University (MSFAU) in 1971 (URL-1), Middle East Technical University (METU) in 1979 (URL 2), Marmara University (MU) in 1985 (URL-3) and in İstanbul Technical University (ITU) in 1993 (URL-4).

Today these four universities also represent the two distinct student acceptance procedures for industrial design education. METU and ITU accept students according to their scores on national LYS (undergraduate placement examination). MSFAU and MU elect their students with a combined score of LYS, secondary school achievement scores (calculated by the average of student's high school grades), university's general aptitude test and department's aptitude test; the final score is majorly affected by department's aptitude test score.

Since the acceptance procedures are dissimilar, students' preparation before acceptance to the program also differ. Students who want to be elected for MSFAU and MU mostly concentrate on their drawing and artistic skills, while the potential students of METU and ITU mostly prepare themselves for LYS through solving problems on subjects like mathematics, physics, chemistry, etc. Also, their high school education may also be diverse; students' of METU and ITU mostly come from "Anatolian high schools"' or "science high schools"' science divisions, while a significant amount of students of MSFAU and MU come from "fine arts high schools".

1-2 BACKGROUND'S AFFECT ON STUDENTS' UNDERGRADUATE EDUCATION

In the related literature, artistic problem solving and mathematical problem solving are defined as having different characteristics.

A study by Ho and Eastman (2006) hints that 2D and 3D spatial abilities are inter-dependent but are independent from mathematical abilities, supporting the idea that mathematical thinking and visual capabilities may require different problem solving habits. Scholars of mathematical and artistic thinking also stress different aspects about students who are familiar with those dissimilar problem solving methods.

Also some educational psychologists suggest that thinking habits affect problem solving skills. D'Zurilla and Goldfried (1971) hint that problem solving can also be described as a learning process and successful problem solvers tend to adopt unknown terms into subjects they are accustomed to. Also Resnick (2001) supports the idea that intelligence can be thought and previous mental practices affect one's approach to a problem, as *"...,one's intelligence is sum of one's habits of mind"* (Resnick 2001).

Schoenfeld (1992) argues that learning mathematics is empowering; mathematically empowered students easily understand, gather and analyze quantitative data to make balanced judgements. He also claims that mathematical thinking maybe used in practical applications such as proportional reasoning for scale models. Mathematically empowered students are claimed to be flexible thinkers that can deal with novel problems and situations; *"They are analytical, both in thinking issues through themselves and in examining the arguments put forth by others"* (Schoenfeld 1992).

Visual arts students, however, differ from science division students in term of problem formulating and solving practices. Caves (2000) claims that artists' problem solving practices resemble scientific research as both seek a new discovery to create values and a strategy to

realize it; but visual artists formulate problems and solutions internally. Therefore the problem is not precise. Hence, visual arts students are separated from other students as *"...being serious and introspective, socially reserved, relatively indifferent to accepted standards of behavior and morality, imaginative and unconventional in outlook, intensely subjective and highly self-sufficient"* (Caves 2000). It is also explained in some studies that one of the common problems for visual arts students is the transition from problem solving to problem finding. When students draw compositions or choreographies within a given problem by their teacher, they need to find a solution to a given problem, however in order to success in a creative thinking process they also need to formulate the problem that is to be solved (Gibbons 2007).

Therefore it may be hypothesized that students coming from different backgrounds may have different approaches to problem solving in stages of product design process. The different approaches of students in these schools have also been observed by the authors, who have been working in these schools as instructors.

1-3 PROBLEM SOLVING IN INDUSTRIAL DESIGN

There are several studies on problem solving in industrial design, some of which support the idea that problem solving in design has a complex structure and it requires several problem solving skills.

Cross (1990 2001) argues that characteristics of problem solving in design involve dealing with uncertainty. This idea is also compatible with the statements that design deals with "wicked problems" by nature that are hard to define (Rittel and Weber 1973, Buchanan 1992, Dorst 2011). Cross (1990) also claimed that designers can (1) provide novel and unusual solutions, (2) work with incomplete information (3) deal with uncertainty, (4) use their imagination for solving practical problems (5) use drawings and other modelling media for problem solving. Also, in his study it was also emphasized that designers mostly apply a solution-focused strategy, while scientists have a problem-focused strategy (Cross 1990, Norman 1990). In another study, he supported this idea by stating that "*...successful design behaviour is based not on extensive problem analysis, but on adequate 'problem-scoping'"*; later he claimed that problem and solution should be explored together (Cross,, 2004).

Dorst (2003) provided a more structure based approach on problem solving in design. He claimed that design processes are gradual deals with "determined", "underdetermined" and "undetermined" problems. Determined problems include *"...'hard' (unalterable) needs, requirements and intentions"* that should be discovered and analyzed by designer, and they can be solved by rational problem solving, whereas underdetermined problems are defined by *"...interpretation of design problems and the creation and selection of possible suitable solutions"* which can only be done during the design process through exposition of problems and possible solutions together (Dorst, 2003). Finally, Dorst (2003) declared that undetermined problems are mostly freely solved by designers' own skills, tastes, style and abilities.

Dorst's categorization forms the coding scheme of students' reports in this study. By looking at the definition of three categories as "determined", "underdetermined" and "undetermined", it can be assumed that determined problems will require more mathematical problem solving skills as they deal with more objective criteria, while undetermined problems should require more artistic skills. Underdetermined problems should stand somewhere in between as they both require reasoning an interpretation, and they may differ in each design process.

2- RESEARCH

In this section, first interpretations for the survey and their evaluations methods are explained. Later results will be declared to be discussed further in conclusion.

In our research we made a survey between 31 ITU and 31 MSFAU students in order to understand their weaknesses and strengths in design process. Students were chosen between fifth semester (third year, first semester) students to final semester students, as it was aimed to survey students who has completed at least two successful projects. Therefore, purposive sampling was used in this study (Robson 2002).

Three open ended questions were asked to students in order to get a better understanding about students' tendencies. These questions were: (1) "What are the aspects that makes you struggle more in your design projects?" (2) "How do you make your research for your project?" (3) "What criteria do you use when you create your project's final form?" Since students' approach to problem solving was investigated Questions 2 and 3 were used to gather information about methods used by students during design process. Question 1 was used to gather data on students' self-assessment on their weaknesses about design process. This question shows how confident students feel about their skills. It also compliments the other two questions by indicating the nature of the weaknesses of the students besides strengths.

After collecting written reports from 31 students from each university, thematic coding was used (Braun and Clarke 2006). The questions about design stages were coded into three categories mentioned above; "determined", "underdetermined" and "undetermined". Answers that are coded into these three groups are listed for each question.

Each question were made mandatory to answer.

2-1 CODING SCHEME: STAGES OF DESIGN PROCESS

Design process in educational projects were divided into seven stages by writers' own experiences with students, supported with scholars' ideas about design process (Ulrich and Eppinger 2008, Stoll 1999). These stages were named as "setting the aim", "research for the aim", "setting the concept", "developing alternative solutions", "developing the chosen alternative", "detail solving of the chosen alternative" and "finishing the chosen alternative for prototyping".

Most of the time, students are provided with a broad problem field to be narrowed down by themselves through design project process. Examples for project titles may be as general as

"human powered vehicles" or "professional kitchen appliances". So, the first step for the students is to *set an aim* to be focused. This step may be regarded as "underdetermined" as there is not much clue about which problem area to choose. However, there are some objective data that can be used by students for deciding which problem area is more suitable for a favorable project. Students decide which direction to take through the process, which also suits to underdetermined problem definition.

	Determined	Underdetermined	Undetermined
setting the aim		x	
research for the aim	x		
setting the concept	x		
developing alternative solutions		x	
developing the chosen alternative		x	
detail solving of the chosen alternative	x		
finishing of the chosen alternative			x

Table 1. Coding scheme for the design process phases

At *research for the aim* step, students are expected to collect data about the problem area they selected, and analyze them to make some conclusions that can be used in their design process.This stage may be evaluated as "determined" problem solving, as research methods and data are mostly objective. At this stage students mostly inspect criteria such as the areas that product will be used, potential user, legal constraints and sometimes academic researches that may lead them.

After finishing their research, students make some decisions to *set up a design concept.* Setting the concept may be defined as a "determined" problem solving, as students deal with mostly objective data that are mentioned in previous stage. They reason a concept for their scope based on criteria they set during their research. Studies show that even when form-based design studies are done, there can be a research phase to determine the goals for the specific project.

Most of the instructors ask students to *develop alternative solutions* to elaborate a design concepts towards an industrial product, in order to let students choose the most favourable solution that they can develop in a limited time. At this stage, students have to come up with different solutions to the problems they defined in the concept development stage. They have some objective criteria that can lead them, however they have many potential paths. So there is an ambiguity about which path to consider, which hint that this stage may be evaluated as an "underdetermined" problem solving stage.

After student and instructor(s) select a concept among various concepts, students *develop the chosen alternative.*

At this stage students try different basic mechanical principles, materials, scales, etc. to try various solution scenarios in the same problem space. However, they may also consider more subjective criteria such as trends, aesthetics and else, so it may be said that this stage has also an "underdetermined" problem character. *Detail solving of the chosen alternative* is mostly based on objective aspects such as mechanical details, production constraints, standard equipments, etc. Therefore this stage may also be regarded as a "determined" problem stage.

At the end of the process, students *finish the chosen alternative for prototyping*. When making final decisions about form, texture and interface students may choose to work with a blend of inputs from ergonomics, ease of production to aesthetics or trends. Therefore some of the students tend to interpret this stage as "determined" problem, as others may tend perceive this stage as "undetermined" problem.

2-3 RESULTS OF THE RESEARCH

In the first question the students were asked "What are the aspects that makes you struggle more in your design projects?"

For MSFAU and ITU, most of the students mentioned seven product design phases described above. Those phases were coded as explained. As the problem is mainly about the process uncertainty, it was coded as an underdetermined problem. For example, a student mentioned that he/she couldn't foresee if his/her concept has potency to become a product. Another student mentioned having too much freedom at the beginning of the project as a problem, and this was coded as an undetermined problem as it indicated a problem about lack of objectivity.

Among 31 MSFAU students, 19 mentioned determined aspects as major difficulties. 14 mentioned underdetermined problem areas and only 2 mentioned undetermined problem areas. The top mentioned issue was "research stage" as it was mentioned by 10 students. The second most mentioned issue was "stating the aim" as it was mentioned 9 times.

When answers of ITU students were analyzed, it was seen that 12 students mentioned having problems about determined problem solving, 20 students mentioned problems about underdetermined aspects and 8 students mentioned having problems about undetermined stages. The most mentioned problem was *setting the aim* with 12 students; one of the students mentioned having too much freedom to choose among many possible targets as a problem.

Q1. What are the aspects that makes you struggle more in your design projects?			
	Determined	Underdetermined	Undetermined
MSFAU	19	14	2
ITU	12	20	8

Table 1. Frequency for Question 1: What are the aspects that makes you struggle more in your design projects?

Question 2 was "How do you make your research for your project?".Mentioning objective data collecting tools in student reports were coded as "determined" problem solving. This category included looking at previously designed products, interviewing users, using the product, classifying data, defining problems, technology research, interview with producers and sellers, literature review. Design methods that included interpretation were coded as "underdetermined" and among them there were defining improvable aspects of the products, looking for innovation areas, defining a keyword, defining needs and opportunities and looking for clues for emotional design. Starting from own experiences was coded as "undetermined", as it is subjective.

From 31 MSFAU students, all of them mentioned at least one determined problem solving method. 6 also mentioned underdetermined research tools and only 2 mentioned undetermined data collecting method.

As with ITU students, all of the 31 students mentioned determined problem solving methods and none of them mentioned underdetermined or undetermined problem areas.

Q2. How do you make your research for your project?			
	Determined	Underdetermined	Undetermined
MSFAU	31	6	2
ITU	31	0	0

Table 2. Frequency for Question 2: How do you make your research for your project?

The last open ended question about design stages was "What criteria do you use when you create your project's final form?"

Subjective issues were coded as undetermined and this category included aesthetics, visual harmony with environment, a differentiated look, applying own style, general product identity. Objective inputs were coded as determined, among which there were production constraints, ergonomics, functionality and existing user habits.

From 31 MSFAU students, 23 mentioned undetermined and 15 mentioned using determined problem solving methods.

However, in ITU, 23 out of 31 students mentioned determined problem solving methods and 11 mentioned undetermined issues.

Q3. What criteria do you use when you create your project's final form?		
	Determined	Undetermined

MSFAU	15	23
ITU	23	11

Table 3. Frequency for Question 3: What criteria do you use when you create your project's final form?

The questions "How do you make your research for your project?" and "What criteria do you use when you create your project's final form?" ask for students' approach to their design problem. The last quest asks for students' self-assessment of their proficiency in different stages of the design process. That is why, the last two questions were evaluated together. Table 2 and 3 indicate the tendency of problem solving style, as these questions indicate an intent to use certain types of problem solving methods.

MSFAU	Determined	Underdetermined	Undetermined
How do you make your research for your project?	31	6	2
What criteria do you use when you create your project's final form?	15	0	23
MSFAU TOTAL	46	6	25

Table 4. Frequency of MSFAU students' approach to design problems.

ITU	Determined	Underdetermined	Undetermined
How do you make your research for your project?	31	0	0
What criteria do you use when you create your project's final form?	23	0	11
ITU TOTAL	54	0	11

Table 5. Frequency of ITU students' approach to design problems.

From Table 2 and 3 above, it can be seen that MSFAU students tend to work with more ambiguous problem solving methods when compared to ITU students.

While research stage has a strong determined problem solving character, six MSFAU students mentioned underdetermined problem solving methods and 2 mentioned undetermined problem solving methods for this phase. None of the ITU students mentioned any research methods that were open to interpretation.

For creating final form, students could mention either determined or undetermined problem solving paths. For this question, ITU students mainly mentioned determined problem solving paths, while MSFAU mainly mentioned undetermined paths.

When students were asked about at what stages they struggled, the problem areas for each university were coded as follows.

What are the aspects that makes you struggle more in your design projects?	Determined	Underdetermined	Undetermined
MSFAU	19	14	2
ITU	11	20	8

Table 6. Frequency of Q3 for MSFAU and ITU students.

When compared to MSFAU, ITU students seem to be more comfortable with determined problem solving stages and less comfortable with stages that require interpretation and objective inputs. MSFAU student seem to struggle more with determined problems. As the most mentioned problem area was research stage, it can be thought that even if MSFAU students report that they apply determined research methods, they may not feel comfortable with them. On the contrary, only two ITU students declared they found research stage difficult, which indicates that ITU students have less problem applying determined problem solving methods.

3-DISCUSSION AND CONCLUSION

Results of the survey conducted among ITU and MSFAU students hint a relation between students' background and their approach to problem solving in product design projects.

Due to the limited time and limited length for this paper, research was mostly focused on students approaches to problems based only on their reports. First, it was investigated what type of problem solving methods would students choose when they had an opportunity between different paths. For this purpose students were asked what methods they mostly used to decide their projects' final form, as they might both follow a determined or undetermined path. Second, a question about research stage, which has a determined character, was asked to see if they were aware of the main characteristics of a certain design stage. Finally they were asked what did they found mostly difficult in a design stage to see if they were comfortable with the methods they choose or they have to apply.

MSFAU students have a tendency to work with undetermined problem solving methods. However, they do not completely leave out determined problem solving methods. MSFAU students report using underdetermined and undetermined problem solving activities at the research stage, while ITU students do not have any such tendency.

ITU students, which are elected for product design department via results of a science-math based exam, seem to be more comfortable working with determined problem solving

methods. Since science and math problems mostly deal with objective data, it may be suggested that their experience with analyzing and applying objective data may have an effect on their interpretation of design problems.

On the other hand, MSFAU students are accepted through a drawing examination, and they mostly draw compositions and objects given by their instructors prior to their undergraduate studies. Since they are used to create compositions within a given context, they may be more accustomed to work without objective data. Also familiarity with this type of practice might help them be more comfortable about following subjective solutions. Results of the research suggests that, MSFAU students are more comfortable working with ambiguity, and they tend to work with undetermined problem solving methods, and they feel uncomfortable with determined problem solving processes.

To sum up, our study hinted that there may be a link between students' backgrounds and their approach to design problems. However, to make this conclusion clear, the education they take should also be investigated, as the quality or content of the education they take may also affect their problem solving habits. Although the curricula both schools show no significant difference, the approach of the instructors delivering similar courses may differ.

Today, each industrial design department in Turkey accepts students with either drawing examination or a math-based LYS score. Therefore it provides a fertile ground to explore the sustained impact of student's prior training on their designing activity. Further explorations can provide knowledge about the best practice for student admission method as well as improving design education according to student needs.

For further studies, researchers intend to do in depth interviews with students and instructors about their approach to design problems. After investigating the similarities and the differences of both design programs' curricula, protocol studies may follow to investigate the relationship of students' backgrounds and their design processes at a cognitive level.

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