STUDENTS' PRODUCT PERCEPTION: A CROSS-SECTIONAL ANALYSIS

Işıl OYGÜR[1] **and Selen Devrim ÜLKEBAŞ**[2]
[1]Özyeğin University
[2]Kadir Has University

ABSTRACT

This paper reports a study that was conducted to analyze the differences in product design students' perception of products. While product perception is reported as one of the competencies of product design students, our knowledge on the development of this competence via design education is limited. In order to address this gap, students studying at different levels of design education at a 4-year product design programme were asked to participate in a keyword assignment study. Students were distributed a pen to analyze and asked to assign keywords that they associate to this product. The analysis of the keyword preferences across years indicates an increase in the use of keywords related to instrumental function of products. While students prefer using fact/description based keywords in the early years of design education, they rely more on opinion-based keywords in the later years. Most of these opinion-based keywords are associated with the instrumental dimension. Thus, the data from this case indicates more focus on instrumentality in the contemporary product design education.

Keywords: Product perception, education, product design

1   INTRODUCTION

Product design students are expected to develop a range of knowledge, skills, and capabilities throughout the four years of their undergraduate education. Product perception/language is reported as one of these competencies [1], [2]. The design of products involves development of messages [3], [4]. These messages aid in user-product interaction and address practical, aesthetic and symbolic issues related to products [5]. Because of their significant role in user-product interaction and therefore in product design profession, product design education includes theoretical courses as well as studio courses to advance student's knowledge on product perception/language. However, to our best knowledge, there is no study reporting on the development of industrial design students' perception of products throughout the four years of their undergraduate education. The study reported in this paper tries to address this gap with the preliminary findings of a larger research project covering the topic.

2   PERCEPTION OF ARTIFACTS

Products are used for serving certain purposes in human lives. While meeting these purposes, our interactions with products define the basis for the product experiences. According to Crilly, Moultrie, and Clarkson [6], product experience is the interpretation process of the user. This approach to product-user interaction considers the process of design and the outcome of this process within a communication framework [6], [7]. In other words, products transmit a message about their intended purposes and usage to the user. The design of these messages is a significant part of the product design process and profession as the correct usage of the products depend on them. For this reason, there are various studies focusing on aspects of product perception/language.

Some of the earlier studies focus more on the issues related to the usability of products. For example, Gibson [8] and Norman [9] work with the notion of "affordance" and focus on artefact's purpose of communicating user its usage, how it operates. The Offenbach theory of product language takes a broader perspective and considers products based on practical function (e.g., ergonomic, economical, and ecological aspects) and product language (communicative aspects such as aesthetics and associations) [10]. Product semantics looks further into product's associations and emphasizes that, in addition to physical and physiological functions, the designer has to consider symbolic environment

(psychological, social and cultural context) [7]. With this perspective, Krippendorff [11] defines the levels of product experience based on five adjectives: objective/measurable, evaluative/aesthetic, social status and positions, emotional, and interface quality.

Crilly et al. [2] defines the dimensions of products as aesthetic impression (the sensation that results from the perception of attractiveness/unattractiveness in products), semantic interpretation (what a product is seen to say about its function, mode-of-use, and qualities) and symbolic association (the perception of what a product says about its owner/user). Desmet and Hekkert [12] define the levels of product experience as aesthetic experience, experience of meaning, and emotional experience. Heufler [10] proposes yet another but similar classification. In explaining artefacts from the consumers' perspective, he defined three experiences in relation to three functions: practical function (physical experience as on the user level), aesthetic function (sensory experience on the observer level), and symbolic function (social experience by the owner level).

Similar to Heufler, Rafaeli and Vilnai-Yavetz [13] define three dimensions related to artefacts: instrumental, aesthetic and symbolic dimensions. Their focus is more on emotions and people's reaction to artefacts, especially within organizational contexts. Instrumental dimension of an artefact refers to artefact's capability to accomplish intended goals. This dimension assesses the product from the perspective of functionality and usability considering ergonomics, economical issues, and ecological concerns. Aesthetic dimension is about the form and the sensual experience of the artefact. Thus, aesthetics covers both the qualities in relation to form (e.g. shape, colour and material) and the user experience resulting from the sensorial interaction with the product. The last dimension, symbolism refers to the meanings or associations that are evoked by the artefact. This dimension is based on individuals' interpretations. It is defined by associations, values, and meaning that are evoked by the artefact.

While each of these scholars uses different terms, they all have similar conclusions. Products are multi-dimensional and designers should consider instrumental, aesthetic and symbolic issues in design. These issues are also a concern for product design education [14], [15]. Design students are expected to develop competence on instrumental, aesthetic and symbolic dimensions of products. This involves the critical analysis of the products based on these dimensions and the design of new products addressing them. Thus, design education is expected to generate in-depth knowledge on product perception/language through its 4-year curriculum.

3 METHODOLOGY

In order to analyze the impact of product design education on students, we designed a study focusing on the product perception of students studying at different levels of product design education. Three research questions guided this study:

1) Is there a difference between product perceptions of students studying at different levels of product design undergraduate education?
2) If there is a difference, what are the characteristics?
3) What can these characteristics tell about the product design education?

With the aim to find answers to these questions, we designed a cross sectional study assessing students' keyword assignment to a given product. A cross sectional study was needed to assess if there are differences on students' perception of products based on their education level.

The research reported in this paper is a preliminary study of a larger research agenda on students' expertise development through product design education. As a first step, we needed to check our assumptions, develop a comprehensive list of product associations, get data from a larger number of students, and test the validity of the selected theoretical framework for the study of students' product perception. With these goals, we designed a simple paper-and-pencil study taking 5 minutes.

The study asked students to assign 5 keywords to a product that they were introduced to. This is a version of free listing, a standard data collection tool used in anthropology. According to Bernard, Wutich, and Ryan (2016, p. 170) free lists "produce very interesting data that can be analyzed in their own right." Weller and Romney (1988, p. 16) recommend "free listing as the first step in all research involving the definition of new domains." This is also one of the reasons why we selected this method. However, rather than making it open ended, we limited the required keywords with 5. This is because of the fact that we wanted to learn about the first keywords that students associate the product with.

Students enrolled to studio courses at a university from Turkey were asked to participate in the study. All the students were majoring in product design and ranged between 17 and 25 years old.

At the first day of the fall semester, students were distributed an object and a piece of paper (to note their keywords). The object was a pen. The pen in Figure 1 was specifically selected because of being an anonymous design object that everyone has familiarity with. With the selection and distribution of the product, students are expected to capture real time sensory experiences as well as being reminded about their previous practical, aesthetic, and symbolic associations with the product.

Figure 1. The pen that was used in the study

The participation to the study was voluntary. No financial or other reward system was adopted. All the written responses were transferred to Excel. Keywords with morphological derivatives (e.g., mass production and mass-production), synonyms (e.g., mass production and quantity production) and words with the same meaning (e.g. easy to use and user-friendly) were combined during this process. The frequencies and descriptive statistics were calculated with SPSS version 20.

The analysis reported in this paper is descriptive. Keywords are grouped based on two theoretical frameworks. First we classified the keywords being either opinion based (what we think of someone or something) or fact/descriptive based (what someone or something really is). Second, we utilized Rafaeli and Vilnai-Yavetz's [13] three-dimensional classification scheme and grouped keywords into instrumental, aesthetic and symbolic dimensions. Our selection of Rafaeli and Vilnai-Yavetz's [13] classification scheme over others is based on the fact that this scheme has been tested by other scholars (e.g., [16], [17]) and found useful for the analysis of artefacts.

3.1 Limitations of the study

The current study uses only a single object, a pen, for analysis. Even though the object was purposefully selected, the findings might have been different (especially, in reference to higher assignment of keywords related to instrumental dimension) with another object. Therefore, it is necessary to replicate the same exercise with other products.

This study utilizes a cross sectional analysis to study the change in students' perception of products throughout the years of industrial design education. While it provided valuable insights on the topic, there might be latent issues (e.g., socio-economic characteristics, previous exposure to design) affecting the product perception of different cohorts. Therefore, it might be needed to conduct longitudinal studies with the repeated application of the questionnaire with different products as students go through the four years of the design education. Furthermore, it is necessary to conduct the same study with students from other disciplines to learn if the findings are specific to product design students.

4 FINDINGS

We collected 120 usable responses from students studying at different levels of the 4-year undergraduate product design programme. This number represents 77% of the students enrolled in the programme. 87 of these students are female (72.5%) and 33 are male (27.5%). 33 of these students are from first year, 29 from second, 32 from third, and 26 from fourth year. The participation to the study is the lowest for the first year students with the return rate of 69%.

While the students were asked to assign 5 keywords, some students used more or less than this number. 4 students assigned only 3 keywords, 6 assigned 4 keywords and 7 assigned 6 keywords. This yielded to 592 keywords from all 120 participants. This 592-keyword list included 174 different keywords. Thus, students came up with 174 words/phrases associated with the product.

The variety in keyword selection is similar in all four years with a range of 10 keywords (71, 76, 67, 66, number of keywords in respect order). When we analyzed all four years together, "blue" is the

most assigned keyword (F: 41, 6.9%). This keyword is followed by "cheap" (F: 32, 5.4%) and "simple" (F: 29, 4.9%).

In order to analyze the differences among 4 years, we further looked into keywords that were assigned at least by the 2% of the same cohort (Table 1). Most of the keyword selections match among 4 years with some points to highlight. The term ergonomics enter to students' vocabulary in the second year (in reference to lower frequency of keywords related to human factors, e.g., ergonomics and usable, in the first year). Sophomores also start to consider the economical aspect of the product as well (in reference to the keyword "cheap"). The issues related to manufacturing (in reference to the keyword "mass production") become more of a concern in senior year.

Table 1. Keyword assignments among 4-years

First year		Freq.	%
1)	blue	16	9,8
2)	ink	11	6,7
3)	pen	11	6,7
4)	plastic	10	6,1
5)	ball-point	6	3,7
6)	transparent	6	3,7
7)	functional	5	3,0
8)	simple	5	3,0
9)	writing (verb)	5	3,0
10)	Faber-Castell	4	2,4
11)	cap	4	2,4
12)	stiff	4	2,4
13)	writing (noun)	4	2,4

Second year		Freq.	%
1)	blue	10	7,0
2)	ink	9	6,3
3)	transparent	9	6,3
4)	writing (noun)	6	4,2
5)	ball-point	5	3,5
6)	cheap	5	3,5
7)	light	5	3,5
8)	plain	4	2,8
9)	plastic	4	2,8
10)	ergonomic	3	2,1
11)	simple	3	2,1
12)	writing (verb)	3	2,1

Third year		Freq.	%
1)	simple	15	9,3
2)	cheap	13	8,1
3)	blue	7	4,3
4)	usable	7	4,3
5)	uncomfortable	6	3,7
6)	common	5	3,1
7)	plain	5	3,1
8)	stiff	5	3,1
9)	transparent	5	3,1
10)	geometric	4	2,5
11)	light	4	2,5
12)	long lasting	4	2,5
13)	plastic	4	2,5
14)	standard	4	2,5

Fourth year		Freq.	%
1)	cheap	13	10,4
2)	blue	8	6,4
3)	simple	6	4,8
4)	mass production	5	4,0
5)	ball-point	4	3,2
6)	economic	4	3,2
7)	light	4	3,2
8)	transparent	4	3,2
9)	cap	3	2,4
10)	classic	3	2,4
11)	common	3	2,4
12)	functional	3	2,4
13)	stiff	3	2,4

Opinion
Fact/description

Freshmen mostly use words related to the physical qualities of the product (e.g., ink, pen, plastic). These words verbalize the parts and materials of the product. They mostly refer to a fact or description of a product. This situation is almost the same for sophomores. However, a significant change is observed from second year to third year. Juniors and seniors selected keywords stating opinions more than keywords stating a fact/description. These opinions are mostly in the form of adjectives and they reflect an experience with the product. This might be interpreted as these groups' better focus on and understanding of the usage and user experience of the product.

When the keywords were grouped based on the three-dimensional framework (instrumentality, aesthetics, and symbolism) provided by Rafaeli and Vilnai-Yavetz [13], we realized that students vocabulary is broadest in issues related to instrumental and symbolic dimensions. There are 71 different keywords for the symbolic and 72 for the instrumental dimensions. There are only 31 keywords associated with the aesthetic dimension.

The relative significance of instrumental, aesthetic and symbolic dimensions show a different distrubution when the frequency of the keywords are considered. This distribution indicates the relative significance of instrumentality over other dimensions. While the keywords related to instrumental dimension makes up 43.9% of the database, keywords for symbolic dimension corresponds to 33.1% and aesthetic dimension to 23%. In addition to their lower frequency, there is also another issue related to the keywords associated with the aesthetic dimension. Aesthetic dimension covers qualities in relation to form, shape, colour and materials as well as the associations gained by the user's sensorial interaction with the product. However, students' keywords related to aesthetics are almost limited to the qualities such as the product's colour, form and material; and rarely involve experience based associations.

The distribution of keywords for instrumental, aesthetic and symbolic dimensions across four years brings further insight into the difference of students' product perception (Table 2). We see a change in the relative percentage of each dimension from first year to fourth year. While the keywords related to instrumental dimension correpond to 39% in the first year, this number is 52% for the fourth year. Similarly, as seen in Table 2, while there are 5 instrumental keywords for the first year, the same dimension includes 8 keywords in the last year's list. Furthermore, from first year to last year, keywords related to instrumental dimension move towards the top of the frequncy tables.

Table 2. Distribution of keywords based on instrumental, aesthetic, and symbolic functions

First year

		Freq.	%
1)	blue	16	9,8
2)	ink	11	6,7
3)	pen	11	6,7
4)	plastic	10	6,1
5)	ball-point	6	3,7
6)	transparent	6	3,7
7)	functional	5	3,0
8)	simple	5	3,0
9)	writing (verb)	5	3,0
10)	Faber-Castell	4	2,4
11)	cap	4	2,4
12)	stiff	4	2,4
13)	writing (noun)	4	2,4

Second year

		Freq.	%
1)	blue	10	7,0
2)	ink	9	6,3
3)	transparent	9	6,3
4)	writing (noun)	6	4,2
5)	ball-point	5	3,5
6)	cheap	5	3,5
7)	light	5	3,5
8)	plain	4	2,8
9)	plastic	4	2,8
10)	ergonomic	3	2,1
11)	simple	3	2,1
12)	writing (verb)	3	2,1

Third year

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1)	simple	15	9,3
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4)	usable	7	4,3
5)	uncomfortable	6	3,7
6)	common	5	3,1
7)	plain	5	3,1
8)	stiff	5	3,1
9)	transparent	5	3,1
10)	geometric	4	2,5
11)	light	4	2,5
12)	long lasting	4	2,5
13)	plastic	4	2,5
14)	standard	4	2,5

Fourth year

		Freq.	%
1)	cheap	13	10,4
2)	blue	8	6,4
3)	simple	6	4,8
4)	mass production	5	4,0
5)	ball-point	4	3,2
6)	economic	4	3,2
7)	light	4	3,2
8)	transparent	4	3,2
9)	cap	3	2,4
10)	classic	3	2,4
11)	common	3	2,4
12)	functional	3	2,4
13)	stiff	3	2,4

Aesthetic
Instrumentality
Symbolic

From first year to fourth year, there is also a decrease in the percentage of keywords related to aesthetic dimension. While the keywords related to aesthetic dimension make up 27.4% of the first years' list, it drops to 18.4% in the fourth year. There is also a slight decrease in symbolic dimension, from 33.6% to 29.6%.

It is also important to analyze the character of the keywords assigned for each dimension across years (Table 3). Keywords associated with instrumental dimension mostly state facts about the product in the first year. Students tend to describe physical qualities related to product's functions and parts by using fact based verbalizations. They prefer using opinion based verbalization for describing the experience using the product. This opinion based verbalizations for the same dimension appears to correpond to terms with broad meanings such as functional and stiff. A similar pattern exists for the other two dimensions as well. Students again prefer to use factual qualities of the product for the aesthetic (e.g., colour, form, material) and symbolic (e.g. pen, ink, writing) dimensions. These dimension rarely involve experience based associations.

Table 3. Keyword type in relation to instrumental, aesthetic, and symbolic dimensions

First year

		Dimension	Keyword type
1)	blue	Aesthetic	Fact/description
2)	ink	Symbolic	Fact/description
3)	pen	Symbolic	Fact/description
4)	plastic	Aesthetic	Fact/description
5)	ball-point	Instrumentality	Fact/description
6)	transparent	Aesthetic	Fact/description
7)	functional	Instrumentality	Opinion
8)	simple	Symbolic	Opinion
9)	writing (verb)	Instrumentality	Fact/description
10)	Faber-Castell	Symbolic	Fact/description
11)	cap	Instrumentality	Fact/description
12)	stiff	Instrumentality	Opinion
13)	writing (noun)	Symbolic	Fact/description

Second year

		Dimension	Keyword type
1)	blue	Aesthetic	Fact/description
2)	ink	Symbolic	Fact/description
3)	transparent	Aesthetic	Fact/description
4)	writing (noun)	Symbolic	Fact/description
5)	ball-point	Instrumentality	Fact/description
6)	cheap	Instrumentality	Fact/description
7)	light	Instrumentality	Opinion
8)	plain	Symbolic	Opinion
9)	plastic	Aesthetic	Fact/description
10)	ergonomic	Instrumentality	Opinion
11)	simple	Symbolic	Opinion
12)	writing (verb)	Instrumentality	Fact/description

Third year

		Dimension	Keyword type
1)	simple	Symbolic	Opinion
2)	cheap	Instrumentality	Fact/description
3)	blue	Aesthetic	Fact/description
4)	usable	Instrumentality	Opinion
5)	uncomfortable	Instrumentality	Opinion
6)	commmon	Symbolic	Opinion
7)	plain	Symbolic	Opinion
8)	stiff	Instrumentality	Opinion
9)	transparent	Aesthetic	Fact/description
10)	geometric	Aesthetic	Fact/description
11)	light	Instrumentality	Opinion
12)	long lasting	Instrumentality	Opinion
13)	plastic	Aesthetic	Fact/description
14)	standard	Symbolic	Opinion

Fourth year

		Dimension	Keyword type
1)	cheap	Instrumentality	Fact/description
2)	blue	Aesthetic	Fact/description
3)	simple	Symbolic	Opinion
4)	mass production	Instrumentality	Fact/description
5)	ball-point	Instrumentality	Fact/description
6)	economic	Instrumentality	Fact/description
7)	light	Instrumentality	Opinion
8)	transparent	Aesthetic	Fact/description
9)	cap	Instrumentality	Fact/description
10)	classic	Symbolic	Opinion
11)	common	Symbolic	Opinion
12)	functional	Instrumentality	Opinion
13)	stiff	Instrumentality	Opinion

Even though similar patterns to first year students are observed in aesthetic and symbolism dimensions, more expert-like keyword usage emerge in instrumental dimension starting from the second year. Second year students start to evaluate economic issues, ergonomic concerns, manufacturing related and experience based qualities of the product.

Students start to use more opinion based keywords for symbolic and instrumental dimensions starting from the third year. Since symbolism is defined by associations and meaning based on individual interpretations, keywords stating opinions are expected for the symbolic dimension. On the other hand, the use of opinion based keywords for the instrumental dimension is more remarkable. This can be interpreted as students tendency to develop a better understanding on the use of the product. Therefore, they prefer words expressing the experience of using the product.

5   IMPLICATIONS FOR PRODUCT DESIGN EDUCATION

While it is not possible to generalize our findings based on the descriptive analysis of the data collected from a single university, the results provide insights into product design students' perception of products throughout the years. Three of the most significant findings come from the distribution of opinion versus fact/description-based keywords and the distribution of keywords related to instrumental and aesthetic dimensions.

As students move from first to last year of their product design education, they seem to focus more on stating their opinions coming out of their experience with the product. Most of these opinions are related to the instrumental dimension of the product. In contrast to other dimensions, students broaden their vocabulary on instrumental dimension more throughout the years. This can be interpreted as more focus on instrumentality in the contemporary product design education.

We found that, in reference to the symbolic and instrumental dimensions, the attitudes of students become more expert-like from the first year to the fourth year. In addition to fact/description-based verbalizations, students start to use opinion-based verbalizations for issues related to instrumentality and symbolism in the later years. However, the keywords selected for these verbalizations are generic and broad in nature. This can be interpreted as a lack of required expertise development of students as industrial design professionals.

The most problematic finding of the analysis appears in aesthetic dimension. Aesthetic dimension rarely involves experience-based associations. Students use factual qualities of the product and they seem to lack an understanding for expressing experiences gained from sensorial interaction with the product. This might be one of the reasons for the decrease of keywords related to aesthetics in the fourth year.

In this paper, we only focused the keyword assignment of students. However, words might have different meanings depending on the context of use. For example, simple (one of the most assigned keywords) might be related with the usage or the aesthetics. Therefore, it necessary to repeat this study with additional data collection tools to consider the exact meaning of keywords assigned by students. This process can also include sharing our findings with the students and collecting additional data from the students' comments on the findings. These will be our next steps in the analysis of the development of students' product perception throughout the years of product design education.

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