SUSTAINABILITY AND INDUSTRIAL DESIGN EDUCATION: THE CASE OF THE DEPARTMENT OF INDUSTRIAL DESIGN AT METU, TURKEY

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ABSTRACT

SUSTAINABILITY AND INDUSTRIAL DESIGN EDUCATION:
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Problems that the earth has faced with such as the depletion of natural resources, contamination of water, air and land, extension of species, and the global warming have brought up the sustainable development to the agenda. This state of affairs has elicited the undeniable role of industrial design activity on the sustainable development; sustainability has become an important concern of industrial design education. The purpose of this study is to determine the state of sustainable design education in the undergraduate industrial design programs in Turkey – especially in the Department of Industrial Design at Middle East Technical University (METU) – by exploring the relation between industrial design education and the concept of sustainability with regard to the examples from all around the world. With reference to the arguments collected by the literature review study and findings of the field study about the opinions of industrial design students and educators, suggestions will be made on how sustainability can be integrated in the curricula of the undergraduate industrial design programs in Turkey.

Keywords: industrial design education, sustainability, sustainable design

ÖZ

SÜRDÜRÜLEBİLİRLİK VE ENDÜSTRİ ÜRÜNLERİ TASARIMI EĞİTİMİ:
ODTÜ ENDÜSTRİ ÜRÜNLERİ TASARIMI BÖLÜMÜ ÜZERİNE BİR ÇALIŞMA

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Yüksek Lisans, Endüstri Ürünleri Tasarımı Bölümü

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Dünyanın, doğal kaynakların tükenmesi, çevre kirliliği, türlerin yok olması, ve küresel ısınma gibi problemlerle karşı karşıya kalması sürdürülebilir kalkınma konusunu gündeme getirmiştir. Bu durum, endüstriyel tasarım etkinliğinin sürdürülebilir kalkınmadaki önemli rolünü ortaya çıkarmış, sürdürülebilirlik kavramı endüstri ürünleri tasarımı eğitiminin önemli bir ilgi konusu haline gelmiştir. Bu tezin amacı, endüstri ürünleri tasarımı eğitimi ve sürdürülebilirlik arasındaki son yıllarda ön plana çıkan söz konusu ilgiyi inceleyerek, dünyadaki örnekler ışığında Türkiye'deki endüstri ürünleri tasarımı lisans programlarında – özellikle ODTÜ Endüstri Ürünleri Tasarımı Bölümünde – sürdürülebilir tasarım eğitiminin durumunun belirlenmesidir. Bu çalışma sonucunda, konu üzerine literatürden derlenen görüşler ile öğrenci ve eğitmenlerle yapılan anket ve görüşmelerden oluşan alan çalışmasının bulguları ışığında sürdürülebilirlik kavramının Türkiye'deki endüstri ürünleri tasarımı eğitimi programlarına nasıl dahil edilebileceğine dair önerilerde bulunulacaktır.

Anahtar Kelimeler: endüstri ürünleri tasarımı eğitimi, sürdürülebilirlik, sürdürülebilir tasarım

To My Little Brother

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

1.1 Problem Definition

> The major difference between a thing that might go wrong and a thing that cannot possibly go wrong is that when a thing that cannot possibly go wrong goes wrong it usually turns out to be impossible to get at or repair.
>
> Douglas Adams, 2002, p.720

Are there any other planets that are safe for human to live on in our solar system? At present, the Planet Earth seems as it is the only choice for us to live on. Although one might think it is huge, compared to the infinite size of the universe it is just like a micro-organism that has been sustaining for thousands of years. In 1966, which was not so long ago, the first photographic images of our planet from outer space were delivered to the world by National Aeronautics and Space Administration (NASA), and more importantly, this was the first time in the history that people perceived Earth as a holistic and self-supporting organism that is peacefully suspended in the silent and dark outer space (Chapman, 2005).

Sustainability of the earth is getting questionable due to the unsustainable patterns of the present society and the economy. When the first photographic image of Earth from outer space is compared with today's, it is not so difficult to find seven differences at one glance. Eighty percent of the planet's natural forests are destroyed; in the past three decades, one-third of the planet's natural resources have been consumed; more than one billion people (in other words, approximately one in six people on earth) lack access to improved water supplies; and over the past 50 years, the average global temperature has increased at the fastest rate in the recorded history. What has caused those? Many practitioners claim that destructive and unsustainable squandering of Earth's resources is due to an overgrowing

human population because more people need more things to survive. However, the facts are not supporting this view. Although over the last 50 years the world's population has increased by 50 percent; our resource utilization has increased by 1000 percent for the same period (Chapman, 2005). Therefore, some other factors should be presented in addition to population growth. Chapman (2005) believes that "the mess we are in today is more likely to be a result of unsustainable development in the way we design, manufacture and consume objects in the modern world" (p.3).

After the Industrial Revolution, inconsiderate pattern of industry affected not only the environment but also both social and economical life of societies. The balance of the world economy at those times depended on the industrialization of civilizations. This industrialization pattern permanently affected the nature's balance. Since then, overall energy use, carbon dioxide emissions, water pollution levels, and the number of threatened species continue to increase (UNEP, 2006).

Authorities were aware of the human impact on the environment during the 1800s; however, it is only recently that the environment is considered to be linked to society and economy. This brings a wider and new concept beside eco-design, green design and environmental friendly design. The term of sustainability has emerged with the necessity to change the world's existing condition. Last decade of the 20th century, authorities agreed on the need for a 'development' that "meets the needs of the present without compromising the ability of future generations to meet their own needs" (Brundtland, 1987, unpaged). In the literature, sustainability is generally defined on behalf of concepts, actions, strategies and processes to maintain sustainable development. However, sustainability is an evolving concept and although it is widely comprehended, it is still ambiguous.

Even though definitions of sustainability show diversity, people reached to a consensus that there is a need for sustainable development. However, how this development can be achieved is a challenging question. Education is one of the key elements to achieve sustainable development. Since it is the initial and an essential step of transformation

towards sustainable development, it provides scientific and technical skills, as well as motivation, justification, and social support for valuing those skills to transform society (UNESCO, 2005).

As the many other professionals, industrial designers would play a crucial role on how sustainability can be achieved, because what people use, consume and dispose are all the decisions of designers. In his book titled Design for the Real World, Victor Papanek (1971) criticizes industrial design as being one of the most harmful professions. However, one can argue that industrial designers can also create solutions to these problems; and therefore, the industrial design process should be considered as a whole from the beginning to the end in regards to its impact on environmental, social and economical issues. Designers link the consumers and the world of production and they have the potential to be important actors in the product development process (Vezzoli, 2003).

The need for environmentally, socially and economically skilled and capable industrial designers emphasizes the role of industrial design education in the development of sustainability. Fortunately, the educational authorities are aware of this issue and they are trying to integrate the subject of sustainability in industrial design education. For instance, in 1996, when the question “which/what subjects, regarding the future developments in the field, should be included in curriculum?” was asked, educators from different universities around the world mentioned mostly the concepts of “green design” and “sustainable design” as the important subjects for the profession of industrial design to tackle with the future developments (Ünlü, 2001).

The importance of sustainability concept within the designer’s responsibilities is recognized by many associations and councils endorsing industrial design profession and education. Cumulus (International Association of Universities and Colleges of Art, Design and Media), ICSID (International Council of Societies of Industrial Design), BEDA (the Bureau of European Design Association), and EIDD - Design for All Europe are among those associations. Most recently, in 2008, The Kyoto Design Declaration was signed by the Executive Board of Cumulus with the endorsement of ICSID, Icograda, BEDA, AIGA and EIDD. They approved

the principles of designers' global responsibility for building sustainable, human-centered, creative societies documented in the Declaration. Moreover, all of them referred to the term of sustainability in their statements, reports and other documents.

This worldwide attitude towards sustainability of the international associations and councils is assimilated by the educational institutions. Many universities in the world began to integrate subject of sustainability in their programs' curricula. For instance in Australia, many design departments in the universities are supporting sustainability by their educational programs (Ramirez, 2004). As an example from Europe, Delft University of Technology in the Netherlands has a particular program on Design for Sustainability (DfS) which is also providing a research platform for sustainability in industrial design. There are many other examples of these kinds of educational institutions valuing sustainability from all around the world.

When the curricula of industrial design programs in Turkey are scrutinized, there seems to be a gap between teaching sustainability and industrial design education. As it is seen in the following chapters, although, there are some statements like "meeting the needs of future" and "caring for environmental and social issues" mentioned by some industrial design departments as the educational aims of their undergraduate programs, only few of them offer courses about sustainability. Considering the worldwide developments on the integration of sustainability to the industrial design education, in Turkey, sustainability will be an unavoidable aspect to incorporate into the industrial design. Understanding why sustainability is essential for industrial design is derived from the urge of realizing the effects of design on the environment, society and business. Today's educational institutions are educating future industrial designers that will deal with major problems like climate changes, disasters, depletion of natural sources and so on. Therefore, it is necessary to analyze the importance of sustainability in industrial design in order to build a proper and comprehensive content for design education in the national context.

1.2 Scope of the Study

The purpose of this study is to determine the state of sustainable design education in the undergraduate industrial design program in Turkey, especially in the Department of Industrial Design at Middle East Technical University (METU), by exploring the rising relationship between industrial design education and sustainability with regard to examples from all around the world. Suggestions will be made on how sustainability can be integrated in the curriculum of the undergraduate programs of industrial design in Turkey with regard to the findings of literature and field studies about opinions of industrial design students and educators.

The research questions to be addressed in the literature survey are:

- Why and how 'sustainability' did become such an important global concern?
- What is the role of education in sustainable development?
- What is the role of industrial design profession in sustainable development?
- How industrial design educational institutions in the world support sustainable design with their programs?

The research questions to be adressed in the field study are:

- What is the current state of sustainable design education in the undergraduate industrial design program in the Department of Industrial Design at the Middle East Technical University?
- What are the perceptions of students and educators about sustainability in the Department of Industrial Design at the Middle East Technical University?
- What are the opinions of students and educators on integration of sustainability in the Department of Industrial Design at the Middle East Technical University?

1.3 Structure of the Thesis

The thesis structured under five chapters.

Chapter 1 gives a brief background of the study and presents the problem definition, aim and scope of the study and finally presents the research questions of the study.

Chapter 2 presents the literature review study about the emergence of environmentally-conscious approaches; definitions of sustainability and sustainable development and how they are approached from the industrial design profession's point of view; and the current situation of sustainability as a study subject in higher education. Additionally, research studies on sustainability in higher education, especially in industrial design education, are presented in the chapter. The chapter concludes with a study that was conducted in order to understand the structure of sustainability teaching in industrial design education.

Chapter 3 composed of two parts. In the first part two preliminary studies are presented which were conducted in order to prepare the base of the main research study. And then, details of the methodology followed in the main research study to explore the awareness and understanding of industrial design students and educators about sustainability and to make suggestions on how sustainability can be integrated in the curriculum of the undergraduate program of Industrial Design at Middle East Technical University (METU) are given.

Chapter 4 gives the results of study carried out with industrial design students and educators at METU.

Chapter 5 presents answers to research questions, concluding remarks of the findings, which are acquired from literature review and studies conducted, and suggestions on the integration of sustainability into industrial design education. The thesis is finalized with the implications for research and practice.

CHAPTER 2

LITERATURE REVIEW

This chapter deals with the concept of sustainability, its challenging structure and its appearance and evolution in the industrial design education. In order to have a broad perspective, the chapter is composed of four sections. The first section focuses on the emergence of environmentally conscious approach and development of this approach up today. The second section explores the sustainability concept by presenting diverse definitions of sustainability and sustainable development. The third section explores the concept of sustainability from the industrial design perspective and connects it with the responsibilities of industrial design profession. The final section presents the development of sustainability in higher education, and the approaches to sustainability in industrial design education.

Because of the density of the related literature about sustainability between 1990 and present, publications of the years between 1990-2009 were scrutinized by using certain keywords such as; sustainability, sustainable design, industrial design education, sustainability in higher education, design curricula, eco-design, environmental design in the libraries at METU and Delft University of Technology (TUDelft), in the publications by UNEP and UNESCO and in some leading databases like Blackwell Synergy, Science Direct, Sage, Emerald, Elsevier, Jstor, Eric and so on.

Moreover, especially the curricula of ICSID member industrial design educational institutions and industrial design undergraduate programs in Turkey were scrutinized as an additional study to the literature review in order to get information about current situation of teaching sustainability in industrial design education.

2.1 Emergence of Environmentally-Conscious Approaches and Beyond

Environmentalist movement emerged with different motivations during different time periods in particular societies. For instance, while the environmental movements began in 1739 in the USA with a petition written by Benjamin Franklin and other Philadelphia residents to Pennsylvania Assembly to stop waste dumping and remove tanneries from Philadelphia's commercial district; in Europe, interest to environmental issues begins with the emergence of the Industrial Revolution during the late 1800s. Many ideas about environmental consciousness have been developed till the present and still there are diverse understandings. Pezzoli (1997) defines the diversity in environmentalist thought ranging along ideological lines such as socialist, capitalist, anarchist differences as well as geographic lines such as urban focus, wilderness focus, preservation, conservation, and so on. Birkeland (2002) implies abuse of power is common among all those diverse attempts since the seeking power to obtain and maintain control over others involves acquiring and/or exploding human and natural resources. Power incompatible with social, economical and environmental wellbeing in the long term, eventually leads to social repression and conflict, or, sometimes war.

There were early movements such as The Progressive Era (1880-1920s) and Garden Cities (1920s-1930s) which attempted to express concerns about sustainability even if the exact term was not mentioned. In 1925, Alice Hamilton, an urban/industrial environmentalist, wrote the book titled “Industrial Poisons in the United States” mentioning the way how health, environment and politics intersect (Pezzoli, 1997). This intersection was not so different from the concerns of today’s sustainability related movements.

In 1949, Aldo Leopold, joint a land ethic based on the idea of nature having inherent value in his famous book titled “A Sand County Almanac,” which became a reference text for many eco-philosophers and green activists who argued that the environmental crisis as one of human characteristics.

In the 1960s, green thought focused on fundamental personal, social and institutional transformations rather than environmental considerations such as eco-efficiency, minimizing of energy resources or waste (Birkeland, 2002). During the late 1960s, environmentalists understood that the primary challenge must be to clean up the mess left by two decades of rapid and unclassified post-war growth (MacNeil et al., 1991 in Pezzoli, 1997). Impacts of the Second World War on economy and social equity alerted people to make more radical changes on the way of environmentalist thinking. Environmental concerns were perceived as contributions to development of economy and social equity.

In 1972, the Club of Rome, so called as `the invisible college', composed of researchers, industrialists, managers and scientists from all around the world, published a report, *The Limits to Growth,* arguing for the need to achieve a global equilibrium based on the limits to population growth, the economic development of less developed countries, and a new attentiveness to environmental problems. It also mentioned the possibility to alter growth trends and to establish a condition of ecological and economic stability to the future. In the following years after the publication of *The Limits to Growth*, both positive and negative changes occurred in the world. On the positive side, there has been an increase in the awareness of situations that threaten the earth. However, a vain disregard of ecology has continued. This has led to the present critical moment where human beings are beginning to damage the planet permanently (Pezzoli, 1997 and Margolin, 1996).

On the other hand, the United Nations *Conference on the Human Environment* (Stockholm Conference), which was held in 1972, led to the establishment of the United Nations Environment Program (UNEP). The mission of UNEP was to provide leadership and encourage partnership in caring for the environment by inspiring, informing, and enabling nations and peoples, to improve their quality of life without compromising that of future generations. A decade later, in 1983, The World Commission on Environment and Development (WCED) was established by the General Assembly of the United Nations. WCED outlined an environmental program to set priorities for the period of 1990–1995. In 1987, *Our Common Future* (so called Brundtland Report) was accepted by WCED chaired by former Norway's Prime Minister, Gro Harlem Brundtland, and the commission was

composed of foreign ministers, finance and planning officials, policy makers in agriculture, science and technology, and other representatives drawn from a total of 21 countries.

It should be noted here that, during 1980s, world appeared to be wealthy, healthy, and satisfied because of the changes mainly in the industrial production owing to the technological developments which increased economic liberalization especially of the western world. However, Manzini (1994) identifies the environmental issues in the 1980s as "normalized" because it tended to be "normalized" within the cultural and economic atmosphere of the time. There were radical movements till 1980s; however, those were not mainstreams of the industry, economy and policy.

In the 1990s, the environmental issues were more related with other themes beside ecology such as society, economics, politics, and ethics. Faced with the interconnection of environmental, economic and socio-cultural contexts, it becomes clear that conservative movements are not remedial enough for wellbeing of the earth and innovative approaches with a high level of radicality, and for proposing alternative paths to those of the past and present should be implemented (Manzini, 1994). Specialists have tried to find solutions for saving the earth from its existing situation and contributing the development of nations.

A series of international conferences concerning environment-development relationship were organized after preceding efforts of WCED. Most notable was the United Nations Conference on Environment and Development (UNCED), known as the Earth Summit, which took place in Rio de Janeiro in 1992. The conference was the largest meeting that the UN ever held until that time. Three landmark documents were adopted at the Earth Summit by consensus: the Rio Declaration; Agenda 21; and the Statement of Principles on Forests. Mainly, the Rio Declaration mentions eradicating poverty worldwide; Agenda 21 includes actions to be taken globally, nationally and locally by organizations of the UN, governments, and major groups in every area, in which humans impact on the environment -the name 21 came from the century-; and the Statement of Principles on Forests is a document that makes several recommendations for forestry (UN, 1992).

These landmark documents show the way to the other conferences with respect to the development of environmental conscious approach. Conferences held in all over the world contributed to direct the understanding of environmentalism into a clearer perspective. However, the definitions of the terms of sustainability and sustainable are still ambiguous and this ambiguity complicates the implementation of practical solutions.

2.2 What is Sustainable Development?

Coincidently with the period that environmentalist thought was becoming widespread in the world, the term "sustainable development" was emerged in *Our Common Future* published by World Commission on Environment and Development in 1987. The commission's original definition, known as the Brundtland definition, of sustainable development is as "[the] development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (Brundtland, 1987). With respect to the acceptance of ecological concerns in time, Brundtland definition based primarily on that concerns related to development. There is an ambiguity in this definition making difficult to take an action for such kind of development; how can we predict the needs and abilities of future generations? Marshall and Toffel (2005) state that we should be able to do more than meeting their needs if we want the world a better place for future generations. There is a need to add social and economical concerns in the definition as well, because, we are talking about "the" development and its drivers that should be taken into consideration.

By the mid-1990s, there were more than a hundred definitions of sustainability. This definitional chaos has nearly rendered the term sustainability meaningless (Marshall and Toffel, 2005). Almost each profession has tried to define its own definition due to its own needs.

After Brundtland definition, following definitions have extended the notion of equity between the present and the future in order to take into account present conditions. Most

definitions focused on relationship between social development and economical opportunity. This does not inevitably limit the definition of "development"; however, it rather recognizes that definitions of development must evolve in relation to changing requirements and possibilities of present. UNESCO states in its document, *Educating for a Sustainable Future: a Transdisciplinary Vision for Concerted Action,* that,

> […] sustainable development is widely understood to involve the natural sciences and economics, but it is even more fundamentally concerned with culture: with the peoples' values and how they perceive their relations with others. It responds to an imperative need to imagine a new basis for relationships among peoples and with the habitat that sustains human life.
>
> (UNESCO, 1997, p.14)

In view of the definition of UNESCO (1997), sustainability should call for a *dynamic* balance among factors, including social, cultural and economic requirements of human kind and need to save the environment of which humanity is a part. The main concern of sustainable development is mentioned by the definition as humankind instead of environment which was the main-concern of environmentalist movements before 1990s.

Moore (2005a) has composed several views on sustainability and defined it with its three aspects:

> Sustainability is a concept, a goal, and a strategy. The concept speaks to the reconciliation of social justice, ecological integrity, and the well-being of all living systems on the planet. The goal is to create an ecologically and socially just world within the means of nature without compromising future generations. Sustainability also refers to the process or strategy of moving toward a sustainable future.
>
> (Moore, 2005a, p.78)

In Moore's definition, sustainability is defined firstly as a concept that will be the result of sustainable development; and then, it is set some goals to achieve sustainable development; and finally, it is mentioned a kind of strategy to put in action. However, the most indefinite term in this definition is *strategy: process of moving toward sustainable future*. One of the reasons making sustainability challenging is the process toward sustainable development cannot be absolutely defined because of the diverse understandings in the sustainable development.

Some higher education institutions have also made definitions of sustainability while developing their curriculum for sustainability. For instance, in the Delft University of Technology (TuDelft), the Netherlands, the term sustainability is needed to be defined in a more concrete form in order to "to meet the needs of engineering students in their education" (Mulder et al., 2004 in Kamp, n.d.). In their definition, people, profit and planet were located on a triangle referring the interconnection of these terms with each other like the other definitions do (See Figure 2.1).

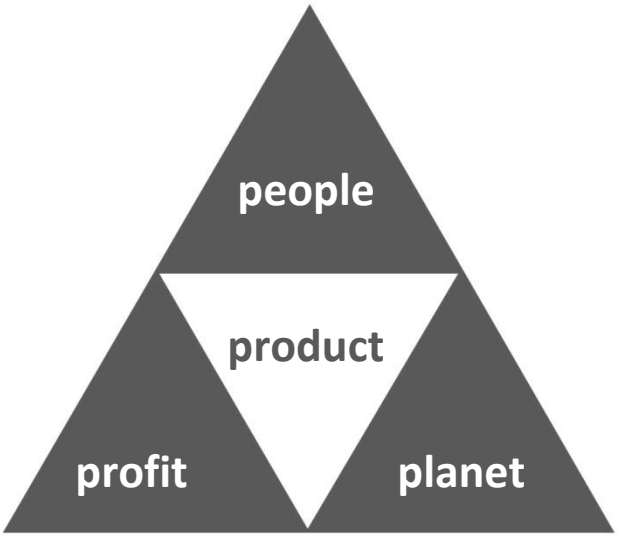

Figure 2.1 Design for sustainability (reproduced from Mulder et al., 2004 in Kamp, n.d.)

In this definition, firstly, it must be recognized that "sustainable development involves making a transition towards nonpolluting products that require only renewable resources with respect to the planet. Secondly, the 'people' component of sustainable development should be judged in a wide social context, from privileged to underprivileged societies. Finally, the 'profit' component involves making a long-term positive contribution to society, for which the company profit is a reward (Mulder et al., 2004 in Kamp, n.d.).

Another definition stated by TuDelft researchers is benefited from a formula named as IPAT. The formula is as < **I** = **P** x **A** x **T** > in which **I** means Impact (total impact of mankind on the planet); **P** means Population (total population size on the planet), and **A** means Affluence (number of products or services consumed per person, i.e. GDP per person);

whereas **T** means Technology (impact per unit consumed; this factor is often called 'technology efficiency') (Mulder et al., 2004 in Kamp, n.d.). As it is stated, the more population, production and consumption mean the more negative impact on planet. The aim should be optimizing variables in the formula.

Another definition that gives priority to humanity is Thorpe's (2007) definition: "Sustainable development is development that cultivates environmental and social conditions that will support human well being indefinitely" (p.7). In this sense, environmental conditions are explained as life sustaining products and services that ecosystem provides and social conditions are explained by breaking into two: culture and economics. Culture is all of our socially transmitted behaviors, including systems of belief and art forms. Economics is subset of culture, as a system for managing and developing our resources, whatever their form is (Thorpe, 2007).

In spite of the variations of sustainability definitions and the different visions on how sustainable future will be, environment, society and economy are the common aspects of all. However, this situation was challenging because of the economic and social considerations that were also the elements of sustainable development vary particularly in developed and developing countries and this made tricky to imply the same meaning in defining sustainability concept. In global terms, international development is aimed at bringing the least developed countries out of poverty, progressing toward human well being at its most complete. In industrialized societies development has come to meet economical development. These are seen as closely tied to well being (Thorpe, 2007).

All of those definitions can be exemplified more; however, "is it possible to categorize those definitions within a definite structure?" Marshall and Toffel (2005) proposed *Sustainability Hierarchy* to structure a broad range of issues that have been associated with sustainability. It categorizes *actions* according to their direct or indirect potential to

- endanger the survival of humans;
- impair human health, cause species extinction; or
- violate human rights; or

- reduce quality of life.

Marshall and Toffel (2005) agree that “sustainability means transforming our ways of living to maximize the chances that environmental and social conditions will indefinitely support human security, wellbeing, and health (McMichael et al., 2003 as quoted in Marshall and Toffel, 2005).”

2.3 Role of Education in Sustainable Development

> Education including formal education, public awareness and training should be recognized as a process by which human beings and societies can reach their fullest potential. Education is critical for promoting sustainable development and improving the capacity of the people to address environment and development issues.
>
> UN, 1992, unpaged

Unsustainable pattern that the earth faced with alarmed the authorities to take essential precautions. Education became one of the key elements to achieve sustainable development in the agenda of several conferences and meetings. Education, with its broadest meaning, includes teachers, lecturers, curriculum developers, administrators, support staff, industrial trainers, environmental health and planning officers, education officers with NGOs, community educators, youth leaders, parent association members, media people, representatives of learners in all contexts (UNESCO, 1997). The more clearly the relationship of those stakeholders with sustainable development is understood, the more sustainability can be integrated with success in all fields of education.

By considering the education, the importance of sustainability was first emphasized in 1975; the United Nations Education, Scientific, and Cultural Organization (UNESCO) recognized the importance of environmental education in the Belgrade Charter. In 1977 the world's first intergovernmental conference on environmental education was organized by UNESCO in cooperation with the United Nations Environment Programme (UNEP) and was held in Tbilisi, Georgia. Tbilisi Declaration mainly asserts the role, objectives, and characteristics of environmental education. However, these events were not for the same

objective. Education for sustainable development was clarified when world leaders agreed that the concept of sustainable development should be understood as a global goal. Ten years after Tbilisi, World Commission on Environment and Development (WCED) published "Our Common Future" mentioning the definition of sustainable development and the importance of education as the way to persuade and made individuals to act in the common interest.

From 1987 to 1992, the concept of sustainable development was matured and 40 chapters of Agenda 21 were written. It is a "comprehensive plan of action to be taken globally, nationally and locally by organizations of the United Nations System, Governments, and Major Groups in every area in which human impacts on the environment" (UN, 1992). In 1992, United Nations declared Agenda 21 in Rio de Janeiro. Previous attempt in subject was mainly related with environmental education rather than education for sustainable development with respect to the development of ideas in sustainability. Recommendations in the declaration of the Tbilisi Conference held in 1977 have provided the fundamental principles for the proposals in this document. Chapter 36 of Agenda 21 set the programme areas as reorienting education towards sustainable development, increasing public awareness and promoting training. In which extent the education effects the people's awareness about sustainability is as important as the education itself. With respect to each program area, objectives of that area, activities to be performed, means of implementation and financing and cost evaluation are clearly defined (UN, 1992). Carrying out the programme is the duty of UNESCO for the chapter 36 of Agenda 21. After the declaration of Agenda 21, series of UN conferences were held to develop sustainable development.

Twenty years after Tbilisi Conference, in 1997 the Intergovernmental Conference on Environmental Education, held in Thessaloniki, Greece, in the light of Belgrade and Tbilisi Conferences, general objectives for environmental education were declared:

- to raise awareness and sensitivity on environmental problems;
- to gain knowledge and basic understanding of the environment and associated problems;

- to change attitudes, values and motivation to actively participate in environmental protection and improvement;
- acquisition and development of skills to identify and solve environmental problems;
- participation of all social groups and business players.

It is widely agreed that education is the most effective mean that society possess for confronting the future challenges. However, as it is stated in the discussion paper for Thessaloniki Conference, education is not the whole answer to every problem. But with its broadest sense, it must be a vital part of all efforts to imagine and create new relations among people and to foster greater respect for the needs of the environment (Delors, 1998).

In 2002, the World Summit on Sustainable Development held in Johannesburg, South Africa, reaffirmed the importance of sustainable development as a base for overcoming poverty and improving the quality of life worldwide, and especially in the developing world. Just after the Johannesburg Summit, the United Nations General Assembly adopted the resolution ‘‘United Nations Decade of Education for Sustainable Development (DESD)’’, which emphasizes that education for sustainable development must provide specific skills such as learning to know, learning to live together, learning to do and learning to be (Delors, 1998). UNESCO and the Global Higher Education for Sustainability Partnership (GHESP) are the pioneers of UN DESD preparations, which include a series of international collaborations and the development of a “toolkit” to guide the incorporation of sustainability into university practices.

The main topics of those conferences not only include higher education but also both formal and non-formal education. In each conference, declaration and reports were published mentioning about the importance of education on the sustainability path.

In general term education for sustainable development (ESD) seeks to balance human and economic well-being with cultural traditions and respect for the earth’s natural resources

(UNESCO, 2002). From higher education perspective, universities have many roles for achieving this objective. In considering the roles and functions of the university in promoting sustainable development, following issues should be particularly addressed:

- increasing the relevance of teaching and research for the societal processes leading to more sustainable and discouraging unsustainable patterns of life,
- improving the quality and efficiency of teaching and research,
- bridging the gap between science and education, and traditional knowledge and education,
- strengthening interactions with actors outside the university, in particular with local communities and businesses,
- introducing decentralized and flexible management concepts (UNESCO,2005).

Universities form a link between knowledge generation and transfer of knowledge to society such as preparation of the future decision-makers of society into the labor market and contribution to the societal development through outreach and service to society. Universities can contribute to the sustainable development in three ways:

(1) by having it as a component in university curricula and educational and research programs;

(2) by playing a role as local knowledge centers for sustainable development; and,

(3) by making it a leading principle in their logistics and managerial process.

The core of several declarations adopted by universities such as the University Charter for Sustainable Development (Copernicus Campus), the Talloires Declaration (Association of University Leaders for a Sustainable Future, ULSF), the Kyoto Declaration (International Association of Universities, IAU), the Halifax Declaration, the Rio Declaration, the Thessaloniki Declaration and the Luneburg Declaration to contribute to education for sustainable development (UNESCO, 2005).

Many universities have tried to integrate sustainability issues in their educational programme and curricula. Several approaches were adopted by authorities in order to develop guides explaining what to do to integrate education for sustainable development into countries' educational policies, strategies, and plans (UNESCO, 2005 and Winkelmann,

2006). On the other hand, many universities published their sustainability reports mentioning their understanding and implementations about it on demand.

In the literature, there are several research studies about integration of sustainability in several curricula and results of these attempts. Most of those cases are related with engineering education. Studies can be classified according to their aim and methodologies such as:

1. *surveys on curricula* to determine the extent to which sustainability issues are integrated in the curricula and to find out how different disciplines integrate sustainability in their education (Vezzoli, 2003; Welsh and Murray, 2003; Bhamra, Lofthouse, and Norman, 2002; Ramirez, 2006; Sammalisto and Lindhqvist, 2008)
2. *case studies* to define an existing course on sustainability and assessment of the outcomes of the courses (Diehl and Brezet, 2004, Jua´rez-Na´jera, et al., 2005, Peet and Mulder, 2004, Lourdel et al., 2006, Eagan, et al., 2002, Corcoran, et al. 2004);
3. results of the *workshops* to determine the best solution to integrate sustainability in curricula (Cull and Malins, 2003, Martin, 2005) ;
4. *student oriented studies* to understand students' understanding of concept of sustainable development to present a proper educational tool, to evaluate the assessment of an educational tool or course from the students' point of view and to report on investigation of students' learning about education for sustainable development (Lourdel et al., 2006, Corney, et al., 2007, Clare, 2001);
5. *educator oriented studies* to investigate views of sustainable development and its contribution to the curriculum, to understand educators beliefs and attitudes to consider the possible directions for the future of sustainability education and to ascertain the extent to which they had begun to make connections between what teachers have heard and read informally about sustainable development and their responsibilities as teachers (Cotton, et.al, 2007, Elshof, 2005, Cross, 1998, Moore, 2005b).

Common results of those researches mentioned above indicate that radical changes are needed and routine pathway of educational system should be re-routed to become more

successful in integration instead of mentioning sustainability only in existing curricula as a subject (Jua´rez-Na´jera, et. Al., 2006, Mulder 2005). Peet and Mulder (2004) point out that adding a separate course on sustainability to a curriculum is not sufficient to achieve sustainable development therefore it should also be included by all courses in order to make sustainable development have a lasting impact on education. With respect to this idea, sustainability education must represent interdisciplinary approach to environmental issues, must be collaborative, experiential, and potentially transformative (Eagan, et al., 2002, Moore, 2005).

If we recall the definitions of sustainability, as the examples of TuDelft's sustainability definitions given in the section before, different disciplines may have their own sustainability definitions and approaches. Thus, it is not unexpected that the approaches to and priorities of sustainability are different for medicine and engineering professions. Variations in the sustainability definitions and approaches due to disciplinary differentiations also reflected on the educational approaches to sustainability of those disciplines.

Sustainability is defined also from the perspective of industrial design profession in order to define a concrete path in the sustainable development way. International Council of Industrial Design (ICSID) endeavors to create a world where design enhances our social, cultural, economic and environmental quality of life. ICSID attributes a set of tasks to design activity such as,

- enhancing global sustainability and environmental protection,
- giving benefits and freedom to the entire human community, individual and collective final users, producers and market protagonists,
- supporting cultural diversity despite the globalization of the world,
- giving products, services and systems, those forms that are expressive of and coherent with their proper complexity. ("Definition of Design", n.d.)

Above tasks of design activity are shaped with regard to global, social, and cultural ethics, semiology and aesthetics that are the issues of design ("About ICSID", n.d.). In order to understand sustainability as an issue of industrial design, firstly the necessity of

sustainability in business and the potential contribution of designers in sustainable development should be well understood.

Next section takes the concept of sustainability from the industrial design profession's point of view and examines the current situation of industrial design education for sustainability and sustainable development.

2.4 Role of the Profession of Industrial Design on Sustainable Development

> Industrial design differs from its sister arts of architecture and engineering. Whereas architects and engineers routinely solve real problems, industrial designers are often hired to create new ones. Once they have succeeded in building new dissatisfaction into people's lives, they are then prepared to find a temporary solution. Having constructed a Frankenstein, they are eager to design its bride.
>
> Papanek, 2000, p. 215

Papanek (1995) states that all systems - private capitalists, state socialists, and mixed economies - are built on the assumption that buying more, consuming more, wasting more, throwing away more, and, he adds that design, in order to be ecologically responsible, must be independent of concern for the gross national products. It can be said that this is partially true, design can change this pattern of economic system with respect to the ecology; however, the concern of profit in business cannot be underestimated. At this point, sustainability is becoming the part of new business agenda for companies worldwide. It is possible to gain money while respecting environment and society. It should be well-examined which strategies are suitable for which business condition. There are internal and external drivers defined for implementing design for sustainability strategies in manufacturing and service providing companies as summarized in the Table 2.1. Internal drivers originate in the company itself while external drivers come from the outside of the company (UNEP and TuDelft, 2006).

Table 2.1
Drivers for implementing design for sustainability strategies in business (UNEP and TuDelft, 2006)

Internal Drivers	**External Drivers**
-Social equity	-Public opinion
-Strong social policy	-NGO pressure
-Governance and management systems on social aspects	-Legislative requirements
	-Eco-labeling schemes
-Green marketing	-Consumer organization requirements
-Environmental awareness	-Norms and standards
-Reaching new consumers	-Suppliers competition
-Product quality improvement	-Consumer demand
-Saving costs	-Market competition
-Product innovation	
-Brand differentiation	
-New opportunities for value creation	

The accelerating processes of globalization and trade liberalization, supported by the advances in information technologies, have changed the pattern of private sector in all developed and developing economies, providing new opportunities and challenges to improve sustainability. However, external drivers for the companies in developing countries are less effective than in developed ones, that's one of the reasons of why sustainability is a more common concern in developed economies (UNEP and TuDelft, 2006).

For many companies, the transition towards sustainability is a learning process in which they have to learn to do business consuming fewer environmental resources, helping people to live better in a society and in an economy in which the overall material consumption decreases and in which the quality of physical and social contexts has to be improved. With the transition towards sustainability, new business ideas and new ideas on business can and must be developed by the contribution of competent designers. A re-thinking of the concept of "business", developing new ideas on business and, conceiving new and more sustainable business ideas are needed (UNEP and TuDelft, 2006). As Manzini (1994) says, design certainly cannot change the world but it can "give form" to a changing world, and "offer opportunities" for new types of behavior (Manzini, 1994).

After understanding the importance of sustainability in new business systems; role and responsibilities of industrial designers related with this issue should be defined well in order

to understand the margins of the context in which industrial design is relating with sustainability.

2.4.1 Paradigm Shifts in the Field of Industrial Design towards Sustainability

The profession of industrial design emerged in the twentieth century with modern industry; before that, the function of design in industry was not well-defined and performed by a variety of people, from major artist to anonymous workers. These unclear and distant circumstances caused particular problems and challenges. After the twentieth century, industrial design is concerned with the vast range of goods manufactured by serial- or mass-production methods (Heskett, 1987). Since industrial design's emergence, it was understood as an art of giving form to products for mass production. Industrial Design's first promoters in the 19th and early 20th centuries, Henry Cole in England and Herman Muthesius in Germany, for instance, valued industrial design in relation to the manufacture of products for the market. In the 1930s, a new practice of design consultancy emerged in the United States. In the postwar years, American practice in consultancy became a model for industrial designers throughout the world. This model continues to be important in the emerging global economy (Margolin, 1998).

Early understanding of industrial design was based on manufacturing goods and it was product centered rather than user centered. With the developing technologies, design grew from a trade activity to a segmented profession to a field for technical research (Buchanan, 1992). Papanek (2000) pointed out, the lack of social responsibility in early attitude of industrial design that industrial designers tend to focus on the needs of the 20 per cent of the wealthiest in the population ignoring the majority in the society. In time, with the consumer demands and current cultural, economical and environmental conditions, a paradigm shift has occurred from technology driven development to human centered development. The focus is shifting from materialistic and visible values to mental, intellectual and, possibly, less material values. An era of "cultural productivity" has begun, where modes of life, values and symbols may be more important than physical products. Consequently, roles of designers need to be extended and renewed with respect to this shift (Kyoto Design Declaration, 2008). On the other hand, the concern of industrial design

is not only the product but also the whole system and scenario that the product is involved. Design can play a fundamental role in the construction of this scenario in a complementary or competitive way. In order to do so, the basis of definition of design will have to be re-examined. Similarly, fundamental concepts such as form, function, client, user, and market, role of technology, aesthetics and design itself must be determined again (Manzini, 1994).

In Kyoto Design Declaration (2008), -signed by Cumulus members with the endorsement of several design associations and councils as stated before- it is mentioned that "global development, and an awareness of the growth of related ecological and social problems are posing new demands and offering new opportunities for design, design education and design research. Design is challenged to redefine itself and designers must assume new roles and commit themselves to developing solutions leading to a sustainable future" (unpaged).

With the need to redefine industrial design profession, many new design definitions concerning new demands of society and technology have occurred. For instance, in Kyoto Design Declaration (2008), design is defined as "a means of creating social, cultural, industrial and economic values by merging humanities, science, technology and the arts". Design is innovative and human-centered process which is proposing new values, new way of thinking and is open to adopt itself according to changes in technology and lifestyles. Design, is an activity that bridges the gap between the socio-cultural and the techno-economical dimensions of the production and consumption systems. Consequently, design should not only promote innovation, but also satisfy the emerging demand with new solutions (Macdonald, S. ed., 2004).

2.4.2 Design for Sustainability Approaches

Coincident with the criticisms on the role and responsibilities of industrial design profession, sustainability movement have been spreading out to other disciplines as mentioned before. Essentially, the concept of 'design for sustainability' first emerged in the 1960s when leading design theorists began to criticize modern and unsustainable

development and industrial design profession (Bhamra and Lofthouse, 2007). Papanek (2000) pointed at situation of the time as the main challenge for an industrial designer does not lie in the production of goods. Designers should deal with "how good?" rather than "how much?" as Papanek criticized,

> "[t]he changes, and our awareness of these changes, are becoming so highly accelerated that trying to make sense of change itself will become our basic industry. Moral, aesthetic and ethical values will evolve along with the choices to which they will be applied" (p.227).

Papanek (2000) predicted that, in the not-too-distant future, designers will be forced to design for these evolved values by the simple desire to survive. At the present, the situation is not exactly the same as he stated. Applying sustainability issues in design depends on designer's common sense; however there will not be any other chance from applying them if ongoing problems that the earth faced with will continue.

In time, 'sustainable design' (Thorpe, 2007), 'design for sustainability' (Birkeland, 2002; Diehl and Brezet, 2004; Bhamra and Lofthouse, 2007), 'design for environment' (Fiksel, 1996; Graedel and Allenby, 1996) and 'sustainable by design' (Walker, 2006) have become current issues in industrial design literature. Although they indicate almost the same concept, the divergence in the terms is resulted from the perspectives of the theorists who define them.

The emergence of sustainable design has the similar process as the emergence of environmentally-conscious approach. In the 1960s and 1970s with the birth of the Green Movement and the rise of Non-Governmental Organizations (NGOs), such as Friends of the Earth and Greenpeace, which focused on driving change via government policy and regulations, ecological concerns came to the agenda of industrial design profession. In the 1980s, economic crises (caused by the collapse of the Eastern Block) and environmental catastrophes (from Bhopal to Chernobyl) prompted a range of legislations and environmental, health and safety standards (Bhamra and Lofthouse, 2007). Furthermore, 1980s were the years when ecodesign became popular buzzword in the markets. The concept of ecodesign includes environmental concerns in product design that is the subset

of sustainable design which also includes social and ethical concerns (Tischner et al., 2000) (See Figure 2.2).

Figure 2.2 What is sustainable design? (Reproduced from Tischner et al., 2000)

In fact, if social, ethical and economical issues that form the building blocks of sustainability are ignored, a designer's vision for sustainable society would be incomplete (Ramirez, 2006). Thorpe (2007) defines sustainable design as "theories and practices for design that cultivate ecological, economic, and cultural conditions that will support human well-being indefinitely" (p.13). Then, how will that cultivation happen, how can a designer achieve sustainability by design process? Beside the diversity of sustainability definitions in industrial design profession, transition scenarios and strategies towards sustainability were also developed in many ways as presented in the following sections.

2.4.3 Sustainable Solutions by Industrial Design

Sustainable solutions by industrial design show similarities and differences in some ways according to the understandings of sustainability concept by theoreticians. The main theme of those solutions is building sustainable production and consumption scenarios.

Transition towards sustainability is a process in which human beings learn to consume fewer environmental resources and learn to live better by improving their physical and social contexts of life (Manzini, 2002a). However, it can be questioned that how economy cycle can sustain by consuming less. All stakeholders of business and economy are mainly based on production and consumption. However, it is possible to profit by thinking in a new way rather than re-designing existing systems and products. Seeing the world as a system where everything is connected; thinking about wellbeing with respect to everyday life; and imagining a world where services and systems are more important than products will constitute more sustainable lifestyles (Mulligan, 2007). New choices can be offered to society by new business systems instead of accepting the old ones. Therefore, sustainability in industrial design is defined as not only sustainable design but also sustainable solutions, systems and innovations.

Definitions of sustainable solution, sustainable system and sustainable innovation mostly overlap in the design literature. Meurer (1999) mentioned that new socially and ecologically recognized – sustainable - product-process system is an innovation that is one of the key issues of social, economic, politic and technological modernization. If anyone values this type of innovation will not only achieve environmental and social success but also gain value on the market with respect to economic terms.

Manzini (2002a) broadened the concept of sustainable system as a system referring to a "network of people, products, services and infrastructures that exists and reproduces itself in a sustainable way" that is consistent with the fundamental principles and characterized by low material-energy intensity and by a high degree of context quality (p.3). Sustainable solution and innovation are a set of processes to achieve sustainability.

Sustainable solution is a process using appropriate products, services and knowledge, transforms the existing systems and generates new ones. The success of sustainable solution depends on perception of new and sustainable combination of products and services by users as better than the existing one, or meeting a previously unexpressed and/or unanswered demand for potentially sustainable results (Manzini, 2002c). Moreover,

the change in the idea of well-being and the way society act to achieve it determines the success of sustainable solutions. Therefore, there is a relationship between solutions and new ideas of well-being. New solutions are developed by the help of new ideas of well-being and new solutions enable platform for new ideas as well (MacDonald ed., 2004). Sustainable solutions arise from sustainable innovation that is a critical dimension of sustainable development and strategies for achieving sustainable consumption and production.

Innovation includes all processes and stages in the commercialization of new products, services or processes, including research and development and technology/knowledge transfer (Charter and Clark, 2007). When design potential for innovation is orientated towards sustainability, design for sustainability (DFS) can exist. Design for sustainability is "a strategic design activity, which conceives and develops sustainable solutions and the corresponding new ideas of well-being" (MacDonald ed., 2004). As explained above, design is the core element for achieving sustainable society and forms sustainable systems. Sustainable systems are results of sustainable solutions and sustainable solutions are breakthrough of sustainable innovations (See Figure 2.3).

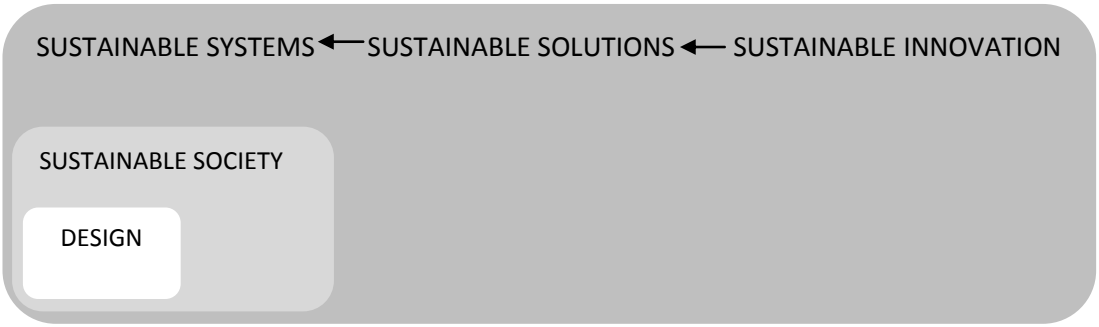

Figure 2.3 Hierarchy in sustainable innovation

2.4.3.1 Strategies for Sustainable Solutions

Bhamra and Lofthouse (2007) state that the design stages of the product development process have a direct influence over about 70 per cent of the final product. Cost, appearance, material selection, innovation, performance, environmental impact, and

perception of quality such as longevity, durability, and reparability are criteria for designers' critical decisions. Those mean that each decision that the designer make will affect the impact of the product on environment, society and economy. Using strategies from the beginning of the design process become important in order to maintain sustainable solutions.

A designer can reduce the negative environmental impacts of products by a new design focus through *product life cycle*. Product life cycle includes all the phases in product life such as pre-production, production, distribution, use and disposal. The aim of sustainability strategies is related with reducing negative environmental impacts of a product during these phases because of the design literature about sustainability is limited with the environmental aspects. In the related literature, although the statements are varied, the common headlines of strategies for sustainable solutions are listed as below:

- Materials with lower environmental impact
- Environmentally efficient distribution
- Cleaner manufacturing
- Energy/Water/Fuel efficient usage
- Lengthening product life
- Design using recycled or reused materials
- Design for disassembly & recyclability
- Dematerialized solutions
- Product service systems
- Life cycle analysis (Ramirez, 2007; Bhamra and Lofthouse, 2007; Vezzoli and Manzini, 2008)

Design for adaptability is another strategy used to achieve sustainability in industrial design. Product life ends if it is unable to adapt to change. A product may be retired for many reasons including that it is broken, out of style, or has become inefficient due to technological obsolescence. If the product is able to adopt to change or to be prepared for the future repair and upgrading, the rate replacement of the product with the new one will

decrease and this will reduce the consumption (Nes and Cramer, 2005; Kasarda, et al., 2007).

Another strategy to achieve sustainability in industrial design is to *orient customers' consumption patterns*. Addressing human needs and shaping them are in designers' responsibilities which should not be underestimated. With respect to that, the concept of service systems emerged as a new business model to shape and change the consumption customs (Al-Khafaji and Morse, 2006). The term 'service system' – mostly Product Service System (PSS) in the literature – is defined as the shift from producing products to producing a mix of products and services to fulfill the same need with less environmental impact and more economic gains (Manzini, et al., 2001).

Industrial designers are able to design with the lowest possible negative environmental impacts, by minimizing resource and energy consumption throughout the life cycle of products, structures, services, and systems; for the sake of equity and justice with the respect for cultural diversity. Designers can define scenes of what the future sustainable society will look like, and inspire people with designs to make it a reality (Executive Committee for Destination 2026, 2006). Related literature shows that industrial designers are seen as they have the potential to create a new way of living with respect to ecology and economy in a more sustainable way. In order to educate industrial design students with such awareness, sustainability should be a concern of industrial design education.

Despite of this, what are the obstacles for them to take action? Papanek (2000) mentioned about five myths that hinder designers self-determination such as myth of mass production, the myth of obsolescence, the myth of the people wants, the myth of designer's lack of control and the myth that quality no longer counts. Margolin (1998) states this situation of industrial designers as lack of empowerment. In a special design project that he witnessed, most product designers remained locked into the aims and arguments of their business clients, believing themselves unable to take any initiatives of their own. The role of industrial design education is undeniable in tackling with those kinds of obstacles.

Structuring the industrial design education consciously with respect to the sustainable development becomes important in educating empowered industrial designers.

2.4.3.2 Methods and Support Tools for Sustainable Design Solutions

In sustainable design process, after using the strategies mentioned previous section, it should be checked whether a product or system reaches a sustainable solution or not. There are many methods and support tools for industrial design professionals and students to tackle design for sustainability. They can be used in every phase of the design process. Some of them are not directly related with sustainability however they can be used to be inspired for sustainability. Selection of those which are relevant especially to sustainability will be listed according to data type collected by the methods and tools.

Environmental Assessment Tools

Environmental assessment tools give quantitative data about the environmental impact of the existing or new products.

Life Cycle Assessment Tools. Life cycle assessment (LCA) is a methodology for assessing the impacts of a product or service particularly in the light of environmental depletion of natural resources but does not consider its economic and social character. Although LCA has shortcomings such as being time consuming, expensive and not giving clear-cut answers, it is useful to inform the design process (Ayres 1995 in Bhamra and Lofthouse 2007). Most life cycle assessments are carried out with dedicated software packages (Cooper and Fava, 2006).

MET Matrix. It was developed at TuDelft in the Netherlands to guide designers to understand the environmental impacts associated with re-designing the products. MET matrix stands for materials, energy and toxicity to be examined through the matrix. Each area is assessed due to production and supply of materials and components, in-house production, distribution, utilization and end of life system of product or service.

Eco-indicator 99. Eco-indicator 99 is software created by Pré Consultants in the Netherlands, calculates the environmental impact of a product. It calculates standard indicator scores for frequently used materials and process.

Strategic Design Tools

Strategic design tools are qualitative assessment tools which assess the sustainability performance of the product.

Ecodesign Web. Ecodesign Web is a qualitative assessment tool that helps designers or design students on which area they need to focus. There are seven design areas on the Ecodesign web. The designer estimates how good or bad the selected design is on the sections of web. After marking estimated ratings with crosses on the web, they are joined together. The shape created will illustrate which areas need more attention for a sustainable solution (Bhamra and Lofthouse, 2007).

Since, it provides to criticize the product through the entire lifecycle with respect to the sustainability and it provides qualitative data about the negative impacts of the product on environment, this method is used as a model of the main study which aims to explore the awareness of industrial design students and educators about sustainability and to shed light on how sustainability can be integrated in the curriculum of the undergraduate program of Industrial Design at METU.

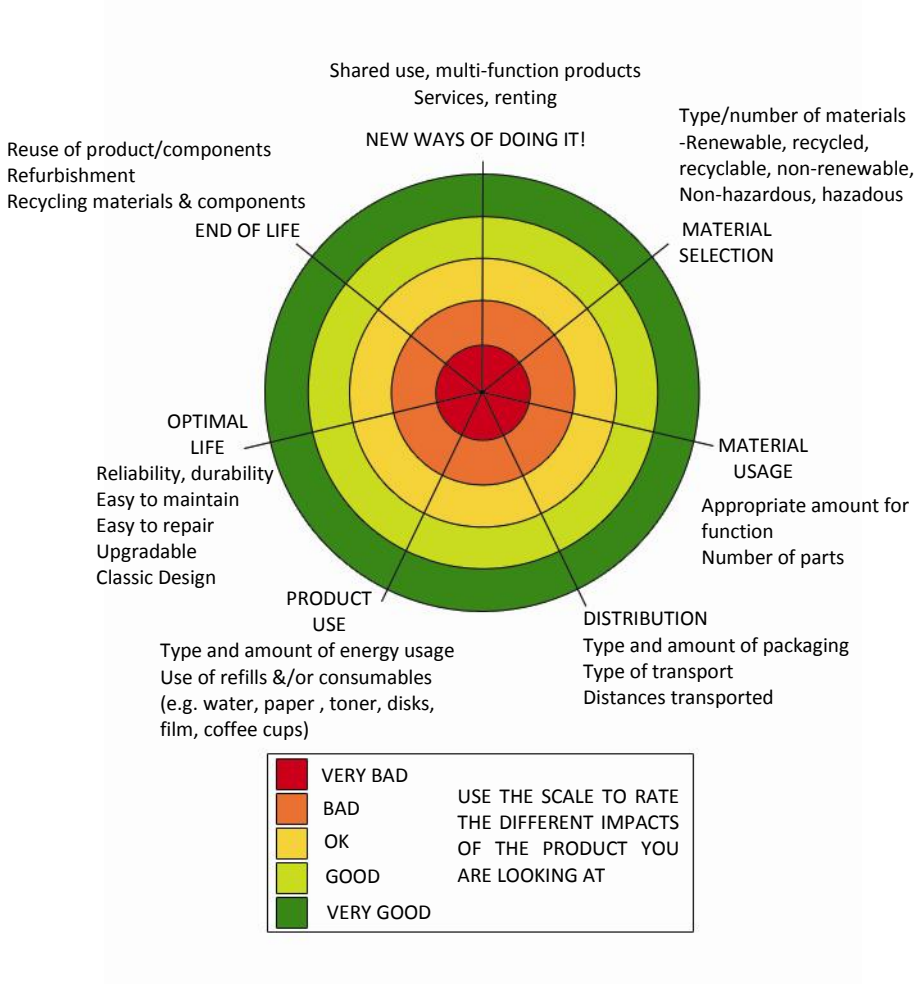

Figure 2.4 Ecodesign Web, downloaded from www.informationinspiration.org.uk

Design Abacus. The Design Abacus, created by Shot in The Dark which is a multi-media company specializing in producing environmental training materials, can be used to rate a product on social, economic and environmental areas to assess a design. A sheet is used in this method and a number of issues about social, economical and environmental areas that the designer would like to address are written on the sheet. It is estimated how good or bad the current product in each area and how confident the designer is. After then, a line is drawn to connect all the scores (+2, +1, 0, -1, -2) in the issues area and confidence levels.

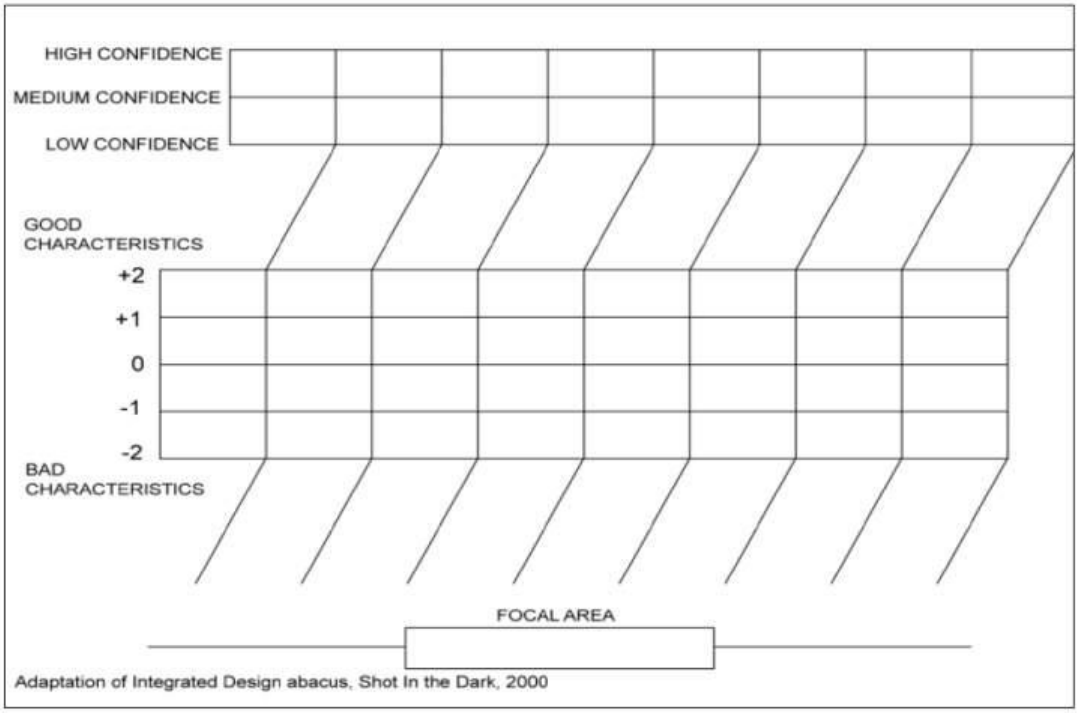

Figure 2.5 Design Abacus, downloaded from www.informationinspiration.org.uk

Fast Five. Phillips Co. uses this method to analyze its products quickly by asking five questions about energy, recycling, hazardous waste, product value and service:

> Energy – does the proposed design use energy less than the reference product?
> Recycling – is the new product more easily recycled than the reference product?
> Hazardous waste – does the proposed product contain less chemical waste that the reference product?
> Product value – does the new design contribute to a longer product life, increase the desirability of the product and make it easier to repair?
> Service – is this new way to provide a service with less environmental impact?
>
> Bhamra & Lofthouse, 2007, p.77

With this approach, proposed product is compared with a reference product.

In addition to those mentioned above, some design tools and manuals have been developed in academic environments in order to support sustainable design activity. Design for Sustainability (DfS) program in TuDelft published the "PROMISE" Ecodesign manual in collaboration with other Dutch partners from the industry and government. An updated version of the PROMISE has been launched in assignment of the United Nations Environment Program (UNEP) called "Ecodesign: a promising approach". This manual has

been the starting point for several international and local Ecodesign manuals such as Ecodesino CentoAmerica (Central America), Manual practico de Ecodiseno (Spain), Ecodiseno: como estrategia de innovacion (Latin America), Ecodesign: a promising approach to sustainable production and consumption (Norway) and Factor 10, information point for Ecodesign (Belgium) (Diehl and Brezet, 2004). The Design for the Environment Multimedia Implementation Project (DEMI) by Loughborough University (UK) is a web-based resource which offers information about design for sustainability was set up in response to a number of UK Government reports (Fletcher and Dewberry, 2002).

As stated above, these techniques can be used for sustainable solution at different phases of design process. While some of them are used in brief generation phase, some of them can be used for checking the design with respect to the sustainability strategies at the end of the process. Although none of them give exact results for sustainable solutions, findings and information collected inspire designers who are interested in sustainable solutions. Industrial design students can also benefit from those tools and techniques. During their educational period, industrial design students need to understand the importance of sustainability and how it can be implemented into design process. In order to educate capable industrial designers that can tackle with current problems, sustainability comes to agenda of industrial design education.

2.5 Sustainability as a Concern of Industrial Design Education

As many different departments of educational institutions have been trying to integrate sustainability into their curriculum, departments of industrial design has also attempted to it in many ways. Sustainable perspective is already being employed worldwide within some product design programs. For instance, as mentioned before many universities in Australia are so active in promoting sustainability through research and consulting (Ramirez, 2004). In Europe, there are some noteworthy attempts for sustainable design in the field of industrial design education. For example, the Delft University of Technology in the Netherlands has a Design for Sustainability (DfS) programme which is also providing

research and education platform about sustainability in industrial design. Loughborough University in UK is another example which developed a program called 'Tool-box' in 2004 for teaching sustainable design to mechanical engineering, manufacturing engineering, design engineering, industrial design and product design students, University College for the Creative Arts of UK provides Bachelor of Art degree in Product Design Sustainable Futures (Bould, 2007).

In Australia, a curriculum resource kit for teachers and students in industrial design has been developed in order to provide for an understanding of Design for Environment (DfE) principles, strategies and resources (CfD, 2005 in Ramirez, 2007). The curriculum has been pilot studied in Industrial Design Programs at RMIT University (Victoria) and University of Technology Sydney (NSW) and then a copy of the completed kit is being distributed to all industrial design teachers in Australia upon completion in early 2007 ("Sustainable Products," 2007). On the other hand, in the USA, Okala Design Guide was developed cooperatively by Philip White, Louise St. Pierre and Steve Belletire. Eastman Chemical, Whirlpool and the IDSA/EPA Partnership supported the development of the guide, which consists of course modules designed to integrate into existing classes and provides introduction to ecological and sustainable design for practicing and beginning designers (IDSA, n.d.).

Additionally, online networks has been set up which can be accessible for everyone interested in sustainable design. Politecnico di Milano in Italy established a university network (RAPI.RETE) and developed a group of tools (ECO.CATHEDRA, ECO.OFFICINA, ECO.DISCO and DPS.MANUAL) about sustainability to support teachers and students in the educational content and processes (Vezzoli, 2003). Sustainable Design Network (SDN) was set up as a forum which brings together people from industry, public and government bodies, and academia that have an interest in sustainable design. SDN is currently run by the staff in the Department of Design and Technology at Loughborough University. The aim of the network is to establish an inter-industry, inter-university, multi-disciplinary research network which addresses the issues of Sustainable Design (particularly the methods, tools and techniques to aid its implementation) (Lofthouse and Bharma, n.d.).

Another example of those kinds of networks is the Learning Network on Sustainability (LeNS), which is a project for curricula development and teaching on Design for Sustainability focused on product-service system innovation. It aims at contributing to human resources and curriculum development by promoting new generation of designers (and design educators). LeNS has produced an open e-learning package for curriculum development with teaching materials, tools for design educators and guidelines for course design ("The Learning Network," n.d.).

Emude, is a digital publication of an international project on sustainability with the same name, shows cases of social innovation, promising in terms of sustainable development. The articles in this site present particular cases through selections of pictures and written descriptions as they have been collected by the students of eight European schools participating in the EMUDE projects (EMUDE, n.d.). There are many other websites and discussion groups which set objectives to create a community network among design educators and students or anyone interested in sustainable design and to inform people about the importance and potential of design education in the way to achieve sustainability such as Gaia education, Deeds, Susdesignteach, and 2012 Imperative Teach-in and so on.

Programs, tools and methods that universities developed for sustainability aim to educate industrial design students about sustainability concept and how it is integrated into design process.

2.5.1 Research Studies on Sustainability and Education

In the last decade, various studies about the relationship between sustainability and industrial design education or higher education conducted through the world.

The Industrial Designers Society of America (IDSA) states that 12 percent of American industrial design educators integrated sustainability in their curricula in 2001 (Ramirez, 2006). The research studies on sustainability and education show that the integration of

and awareness on sustainability in industrial design education has suddenly increased since then.

In Ontario, Canada, Elshof (2005) conducted a study about teacher's interpretation of sustainable development. The aim of the study was to identify which aspects of sustainable development teachers deem to be the most significant, from a personal, collegial and student interest perspective. Cartoon interpretation was used as the method and forty-five teachers from technological studies were asked to rank several items related to which groups should be the focus of change in moving toward sustainability. Ten teachers also participated in semi-structured interviews to state their perspectives on the concept of sustainability and its relationship to the teaching of design and technology. According to the results of this study, population growth, human rights, international trade and pollution were considered as the most important components of sustainable development; while, biodiversity, international trade, perverse economic subsidies and global warming were considered as the least important components (Elshof, 2005).

To investigate the current situation of design education in Australia and to explore in which extent sustainability integrated in design education in Australia, Ramirez (2006) conducted a survey on industrial design curricula. A questionnaire was prepared and fielded via internet to 86 academic staff of 12 Australian universities offering industrial design or product design program. The results of the study show that students mostly took generic electives on environment or sustainability. Theory or methodology course with one or two lectures is following it. Only a few of the participants agreed that sustainability was only marginally addressed in their program. Other noteworthy results of this study are as follows:

- Calculation of the credits of courses which had the entire syllabus about learning sustainability -including studio and lecture type- showed that, on average, 12 out of every 100 credit points earned in an Australian industrial design program has sustainability content.

- Environmental impact scenarios, ecodesign checklists or rules of thumb, and simplified lifecycle analysis methods were mostly used tools in terms of sustainability evaluation in studio projects.
- Self-taught and continuing education, seminars, symposia, conferences are almost equal answers that educators chose in terms of methods to educate themselves about sustainability.
- Most of the educators were completely agreed that sustainability should be integrated in all ID curricula in Australia and disagreed that sustainability should be in separate course instead of in design studios (Ramirez, 2006).

After this survey, Ramirez (2007) conducted a similar survey worldwide. Again, an online questionnaire was used. Educators in industrial design programmes from 221 schools around the world responded to the survey about integration of sustainability within their undergraduate degree programs. The results of this international study show that the majority of the programs had either compulsory or elective courses on sustainable design. Prescribing materials with lower environmental impacts, designing using recycled or reused materials, designing for disassembly and recyclability and life cycle analysis were the most commonly used approaches in sustainable product development process. Respondents reported a very broad range of sustainable design activities initiated within their programs, either as final-year projects or embedded within studio courses.

More than half of respondents considered themselves as being interested or very interested in teaching sustainable design, and believe that design for sustainability should be integrated into design studio courses. Most of the participants believe that their industrial design graduates show a reasonable understanding of sustainable design issues and strategies. In spite of these, many of the respondents pointed drawbacks in integrating sustainability into their industrial design curricula, especially because the current programs are already full and there are other competencies that need to be covered for a well-rounded design education (Ramirez, 2007).

Concurrently with Ramirez's study, another study was conducted by Cotton et al. (2007) to investigate lecturers' views of sustainable development and its contribution to the higher education curriculum at University of Plymouth, UK. This study focused not only on lecturers of industrial design but also on lecturers from a variety of different disciplines. The research involved a two stage approach: questionnaire survey for lecturers across the institution and in-depth, semi-structured interviews which aimed to address the following key questions:

- What are lecturers' current understandings of sustainable development?
- What are their current attitudes towards sustainable development?
- What are their beliefs about incorporating sustainable development into the higher education curriculum?

The results showed that although agreement on the importance of sustainable development was widespread, understanding of sustainable development and supporting ideas about it were changing among respondents (Cotton, et al., 2007).

Beside studies to explore current structure of sustainability in higher education and teachers' understanding about sustainability, studies about students' understandings of sustainability were also conducted. For instance, Lourdel et al. (2007) developed a method for analysis of a student's sustainability comprehension, based on cognitive maps. Third year students in a graduate engineering school, the Ecole des Mines of St Etienne (ENSMSE, France) were asked to write all the terms that they associate to the concept of sustainable development and then connect them by arrows. The results showed that the students' perception of sustainable development seemed mainly focusing on environmental and economical aspects. After sustainability related course taken, perception of the students widened and the number of terms they associated with sustainability increased.

In 2009, an electronic surveys were distributed to approximately 27,000 University of British Colombia undergraduate students to point out perspectives on to which extent sustainability should be included within their degree; the priority sustainability subject

areas students want to learn more about; their interest in courses and / or degrees in sustainability; and the perceived benefit of interdisciplinary classes (Academic Programs Working Group, et al., 2009). In this study, 635 respondents participated and the noteworthy findings of this study are as follows:

- The majority of students believe that sustainability should be a component of their degree.
- Students find the subject of "Clean/Renewable Energy and Energy Efficiency" is the most interesting.
- For the most part students prefer to take specific *courses* in sustainability rather than pursue *degree options* in sustainability.
- Most of the students think that there is a medium to large added benefit of taking integrated classes with students from other departments, programs or faculties.

Although there are several studies about integration and understanding of sustainability in higher education, only a few of them are related with industrial design education. This scarcity in the industrial design literature inspires the author to conduct studies about current situation of sustainability in industrial design education especially in Turkey to shed light on how sustainability would be integrated in the curriculum of the undergraduate program of Industrial Design at METU. Before that, a web based study about the situation of sustainability in industrial design education in the international context was conducted.

By the date 09.10.2008, there were 12 Turkish universities offering undergraduate program in industrial design. In order to explore the current structures of sustainability teaching in industrial design education in Turkey, educational aims and curricula were scrutinized via web pages of eleven of those universities since information of one of twelve could not be obtained via internet. Three of them mention ecology and environment as concerns of their educational aims. One out of those three offers a course named as "Design for Sustainability" in its undergraduate curriculum. Furthermore, one department offers two courses about green design and biomimicry which means a discipline that studies nature's ideas and imitates these ideas and processes to solve human problems. To sum up, three

industrial design departments in eleven different Turkish universities offer courses on sustainability. Among these courses, one of them is a compulsory course and the others are elective courses.

Since this information is gathered from the websites of Turkish industrial design departments for having a general idea about the state of sustainability teaching in Turkish industrial design education, it should be pointed out here that, there might be other courses unspecified in the web but covering sustainability as subject or topic. For instance, besides the elective courses it offers, curricula of the Department of Industrial Design at METU has several compulsory courses covering sustainability as a subject or topic which are not mentioned in the catalog descriptions of those courses specified in the web. In order to identify the state of sustainability teaching in industrial design education in Turkey accurately, more than scrutinizing the websites of the departments is needed.

Furthermore, another web based study was conducted among ICSID educational members in order to understand the structure of teaching sustainability in industrial design undergraduate programs in the international context. The results of this web based study are presented in the following section.

2.5.1.1 The Structure of Teaching Sustainability in Industrial Design Education (of ICSID Educational Members)

> The International Council of Societies of Industrial Design (ICSID) is a global not-for-profit organization that promotes better design around the world. ICSID counts over 150 members in more than 50 countries, representing an estimated 150 000 designers (“About ICSID”, n.d.).

As stated above, ICSID has more than 150 educational, professional, promotional, corporate, associate members in more than 50 countries from Europe to Africa, Asia to America. It is a rooted council that promotes sustainability in industrial design. ICSID will be a good sample to be investigated to get a scene of sustainability teaching in industrial design in the international context.

The main vision of ICSID is as stated on its website that “striving to create a world where design enhances our social, cultural, economic and environmental quality of life.” “Design seeks to discover and assess structural, organizational, functional, expressive and economic relationships”, “enhancing global sustainability and environmental protection” counted as one of the tasks described as the ‘global ethic’ of industrial design (“Definition of Design”, n.d).

ICSID states that “industrial design will no longer regard the environment as a separate entity” and “we, as global designers shall pursue the path of sustainable development by coordinating the different aspects influencing its attainment, such as politics, economy, culture, technology and environment” (ICSID, 2001).

In order to explore the current structures or formations of teaching sustainability in industrial design education of ICSID member educational institutions, which are offering undergraduate programs in industrial design, curricula of programs were investigated via online instruments such as e-mailing and search engines.

Undergraduate curricula of industrial design programs of different educational institutions were primarily searched from their websites. Programs whose detailed information about the sustainability related courses (or the courses covering the subjects related with sustainability) could not be reached from their websites, were contacted via e-mailing, in order to explore the current situation of the subject of sustainability as a curriculum component in industrial design education. By e-mail, they were asked to provide detailed information about the sustainability related courses (or the courses covering the subjects related with sustainability) that are offered by their program. Required information on 25 over 46 ICSID member educational institutions were gathered via Internet search or responses to e-mail query and by printed documents provided by academic publications.

Information about the programs or courses offered by the industrial design educational institutions in four ICSID member countries could not be reached (Table 2.2). It might be because of the language limitations on the website or of the respondents.

Table 2.2

Distribution of ICSID member educational institutions according to the countries

	Number of institutions whose information was gathered	Number of ICSID member university
Australia	3	3
Botswana	-	1
Canada	3	4
Chile	-	2
People's Republic of China	1	3
Colombia	-	3
Finland	1	1
France	1	2
Hungary	-	1
India	3	5
Italy	2	2
Ireland	-	1
Mexico	1	1
Netherlands (the)	1	3
New Zealand	1	1
Norway	1	3
Singapore	1	2
Taiwan	1	1
Turkey	3	3
United Kingdom	1	2
United States of America	1	2
Total	**25**	**46**

With respect to the information gathered from educational institutions (EIs) offering industrial design degrees, some of them (4/25) do not offer sustainability as a subject in their curriculum, some (14/25) offers specific courses which are directly concerning sustainability by considering their course outline whereas some others (12/25) offer courses which are indirectly concerning sustainability, generally as a subject of entire outline. On the other hand, some institutions (9/25) have unique programs on

sustainability, which are conducted by the staff or by learning networks. The results of the scrutiny of the programs with the aim to explore in which extent they are concerned with sustainability are presented in the Table 2.3.

Table 2.3
EIs' tendency in taking sustainability as an educational concern

Educational Institutions (EIs)	**Number of courses directly related with**	**Number of courses contains term in content**	**Number of courses additional programs related with**	**Nothing related with sustainability**
EI1 (Australia)		3		
EI2 (Australia)	1	1		
EI3 (Australia)	3	1	1	
EI4 (Canada)				X
EI5 (Canada)	2	2	1	
EI6 (Canada)	1	1		
EI7 (China)	1	1	1	
EI8 (Finland)	1			
EI9 (France)	1			
EI10 (India)			1	
EI11 (India)		1		
EI12 (India)			1	
EI13 (Italy)				X
EI14 (Italy)	2	1	2	
EI15 (Mexico)	1			
EI16 (Netherlands)	2	1	1	
EI17 (New Zealand)		2		
EI18 (Norway)	2			
EI19 (Singapore)				X
EI20 (Taiwan)		1		
EI21 (Turkey)	1		1	
EI22 (Turkey)	1			
EI23 (Turkey)		1		
EI24 (UK)	1			
EI25 (USA)				X
Total number of courses	**20**	**16**	**9**	**-**
Total number of EIs	**14**	**12**	**8**	**4**

Four educational institutions (16%) do not offer any courses or programs about sustainability while 21 (84%) offer. Among 21 institutions, 6 of them only offer at least one course directly related with sustainability; 5 of them only offer at least one course indirectly related with sustainability, generally as a subject of entire outline; 2 of them have only at least one unique program on sustainability. Five institutions offer courses both directly and indirect related with sustainability at the same time they have unique programs on sustainability (See Figure 2.6).

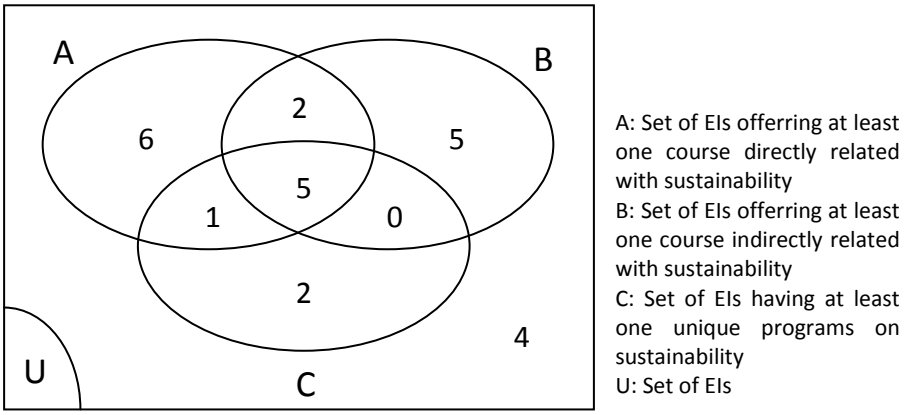

Figure 2.6 Set of EIs' tendency in taking sustainability as an educational concern

It is noteworthy that 5 percent of educational institutions explored in this study have been attended online network program called as Learning Network on Sustainability which is contributing to human resources and curriculum development, in a reciprocal understanding of cultures, by promoting - through the role of Higher Education Institutions (HEIs) in world regions - a new generation of designers (and design educators) capable to effectively contribute to a transition towards a sustainable society. In this network system participant institutions are trying to design an integrated system of products and services, to promote new socio-economic stakeholders' partnerships and to orientate the above processes towards socially equitable (socio-efficient) solutions. New projects, which are designed by the educational institution participation, is uploaded to the network and feed backed by the member actors in an interactive way.

Considering the information gathered from course outlines of ICSID member EIs providing undergraduate programs in industrial design, it seems that the courses directly related with sustainability touch on more theoretical subjects than courses covering sustainability in some sense in their contents. Ten courses offered by EI1, EI3, EI14, EI16, EI17 and EI23 which are related with *manufacturing processes* and *material technologies* include sustainability in their contents by referring how design and production can be achieved in a more environmental way. In those courses, the environmental effects and causes of the use of materials and manufacturing processes in product design are mentioned by taking into account product life cycle and environmental design considerations. Moreover, the information gathered from descriptions of studio courses related with sustainability shows that most of them use the terms 'inter-disciplinary' and 'cross-disciplinary' in their course descriptions.

In addition, not more than five educational institutions have considerable attempt to sustainability education in undergraduate design curriculum. These institutions are both offers courses related directly and indirectly about sustainability and have particular programs dealing with the sustainability concept.

In the following chapter, preliminary studies that are focused on the perceptions of METU ID students will be explained in detail. Then, the main study conducted with regards to the preliminary studies will be presented with the details of the methodology employed.

CHAPTER 3

METHODOLOGY

This chapter is composed of two main parts. In the first part, two preliminary research studies which were conducted in order to set up the main research study well are presented and then, in the second part, details of the methodology followed in the main research study are explained.

All the research studies were conducted in the Department of Industrial Design at Middle East Technical University (METU), Turkey. It was selected as the study subject of this thesis since it is one of the leading industrial design departments in Turkey with its well-established curriculum offering various courses, with its emphasis on international activities and support to the development of an interdisciplinary product development culture. METU Department of Industrial Design is also a member of the International Council of Societies of Industrial Design (ICSID). Additionally, the researcher is employed at METU.

The findings of the study can be used to recommend ways for implementation of sustainability in industrial design education at METU. Besides, the findings of this study would be a reference to other industrial design departments in Turkey and affect the sensibility of Turkish industrial designers about sustainability and sustainable development.

3.1 Preliminary Research Studies

Preliminary research studies are both related with the perceptions of undergraduate industrial design students at METU on sustainability concerning sustainability issues in design processes. In the lights of these studies, the final study was developed in order to explore the perceptions of industrial design students and educators on sustainability at

METU, and to recommend how sustainability can be integrated in the undergraduate curriculum of Industrial Design at METU.

3.1.1 Preliminary Study I

In 2008, it was given a project about designing a solar powered product to 3rd year students under the studio course titled Industrial Design IV (ID302) curriculum at METU (See Appendix A). The author, as a researcher aiming to study on sustainability education in industrial design and as a member of teaching team of this studio course, thought that conducting a preliminary study with this group of students would be inspiring for the oncoming phases of this thesis. So, simultaneously, a research study was carried out focused on the students working on this specific project, in order to understand their perceptions about sustainability issues.

After the project brief handed out to the students, in order to realize the objectives of the assigned project from the student's perspective, the open-ended pre-question below was asked on paper:

> "What might be the objectives of "designing solar powered products" project given under ID 302 course?"

Thirty students among 35 were replied to this question by writing their answers down on the handed out papers. Besides figuring out the objectives of the project from the students' perspectives, keywords retrieved from the answers were also used to explore the students' awareness of sustainability and environmental problems.

"Raising the awareness of environmental and social responsibility" was the most mentioned objective (8/35) of the project by the students. "Gaining knowledge about new technologies and trends" and "using alternative energy resources" had the same scores. The results of the pre question can be seen in Figure 3.1.

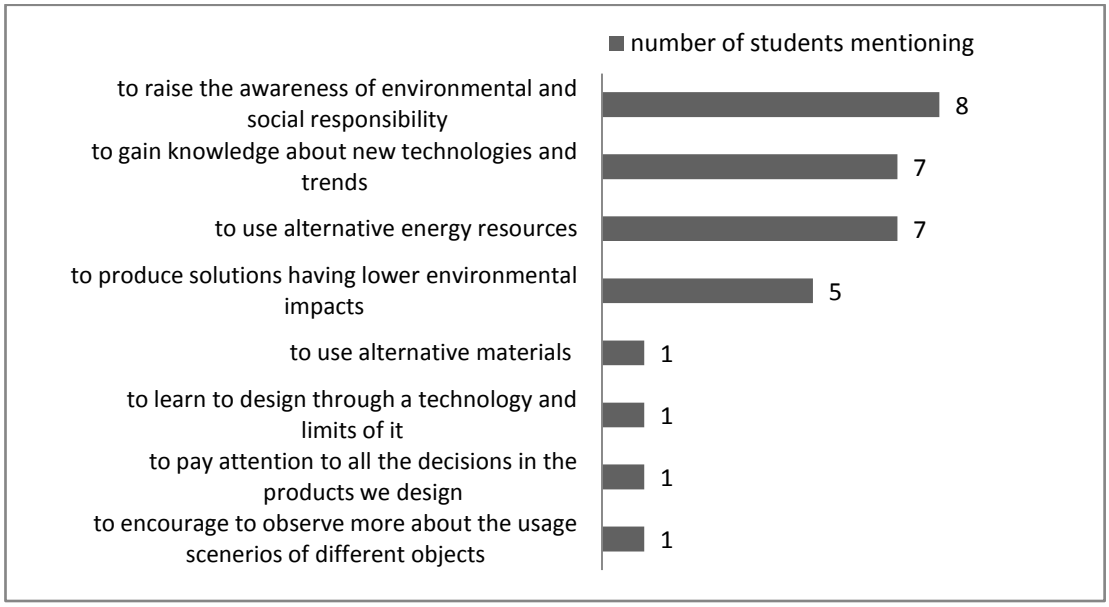

Figure 3.1 Students' thoughts about the objectives of the project given under ID 302 course, 2007-2008 Spring (Frequencies)

Keywords about sustainability and industrial design retrieved from answers showed that the terminology of sustainability used by students is limited by the terms used in the project brief. *Environmental responsibility*, *alternative energy resources* and *global warming* are the most mentioned keywords which typically imply environmental aspect of sustainability. As it is seen in the Figure 3.2, environmental aspect of sustainability is the most common aspect among students.

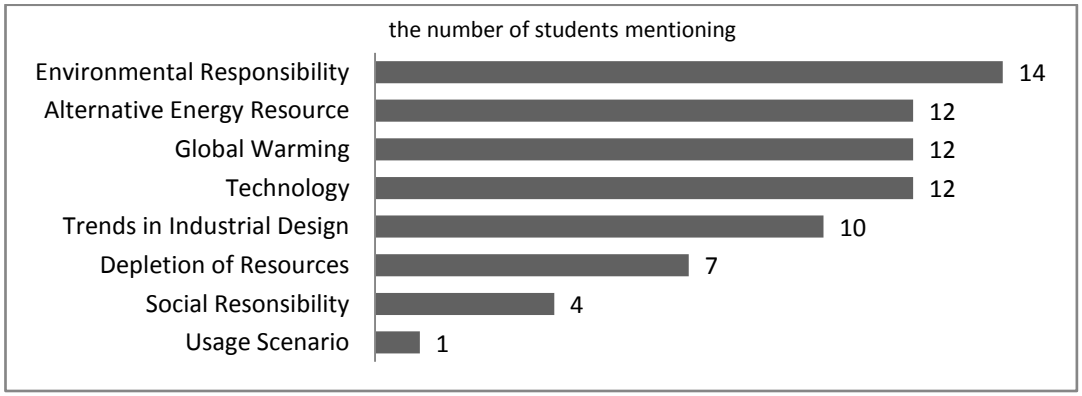

Figure 3.2 Keywords about sustainability retrieved from students' answers to the pre-question (Frequencies)

One week after the project submission a post question was asked in order to explore to which extent primarily defined objectives were achieved. The open-ended post-question is as follow:

> "What are your opinions about the contributions of the project titled "designing solar powered product" that you carried out in the previous weeks?"

Fifteen among 18 students replied the question stated the several contributions of the project. Many of them have similarities with the objectives of the project that they anticipated before (Figure 3.3).

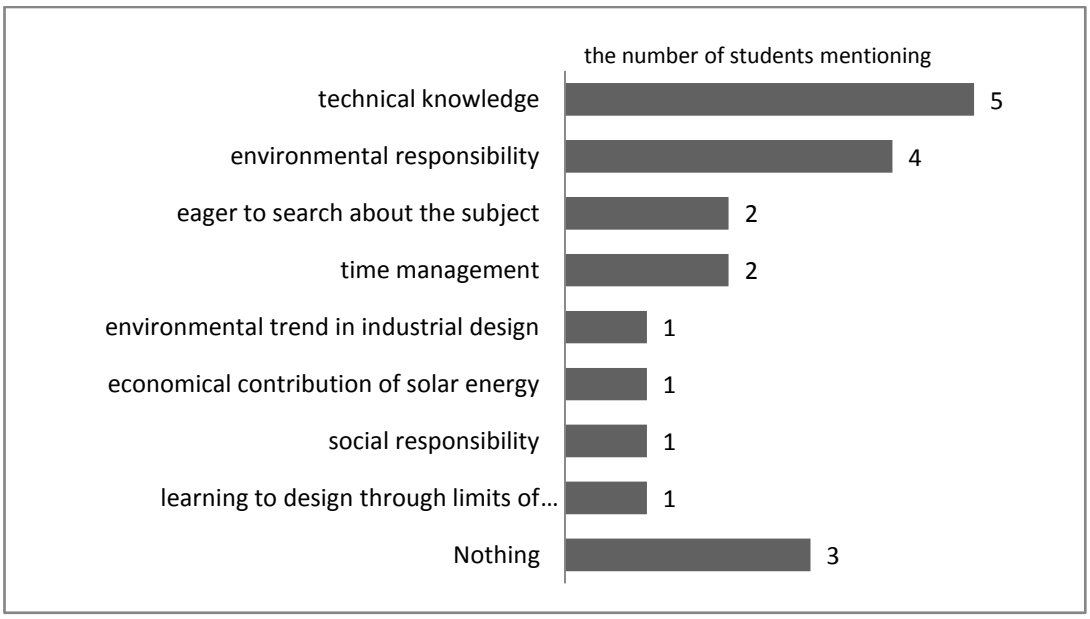

Figure 3.3 Students' thought about the contributions of the project (Frequencies)

Three of the students did not mention about any contribution of the project, and they criticized the project in a negative way. This encouraged the researcher to explore other negative criticisms in the answers if there were any. Although it was not asked, eleven students among 18 complained about the project management and the lack of technical knowledge given on the subject (Figure 3.4).

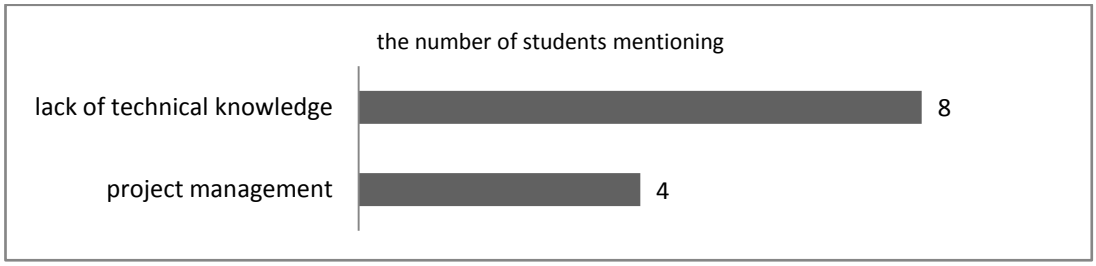

Figure 3.4 Students' complaints about the design project given under ID 302 course (Frequencies)

The results of this study show that the students' perceptions about sustainability is limited with the statements in the project brief and not every student can benefit from the anticipated contribution of the project. Most of them are concerned about lack of technical knowledge and weak project management. The limitation of this study was that it was conducted with third year industrial design students who did not complete their undergraduate education in industrial design. Therefore, it was intended to conduct another study with the same students one year later. The second preliminary study was arranged in order to provide a basis for this intended study.

3.1.2 Preliminary Study II

After the research study on the third year industrial design students at METU; in 2008, a questionnaire with close-ended questions was prepared to explore the awareness among final year undergraduate METU ID students of the same year concerning sustainability issues in the design processes. Fourth year industrial design students were selected for this questionnaire since it was supposed that they had completed their entire undergraduate degree studies. Thirty-eight students among total 41 participated in this study. The questionnaire was conducted during the METU ID 2008 Graduation Project Exhibition after the 2008 Spring Semester.

At the beginning of the questionnaire, brief descriptions of sustainable development and sustainable design were given in order to warm students up for the case of some of them

were unfamiliar with the terms. The questionnaire was composed of two parts (See Appendix B). In the first part, students were asked to rank the given items about the design process by considering the possible effects of "industrial design activity" on "sustainable development". Five point Likert Scale evaluation method is used to find out which of industrial designers' responsibilities are considered more important by the students. The results showed no significant difference between the thirteen items given. Nonetheless, *deciding on the materials of the product* got the maximum score (*mean: 4.71*) while *addressing to lower class while designing a product or service* got the minimum score *(mean: 3.13)* (Figure 3.5).

a Assessing the environmental impacts of the product during manufacturing or usage
b Considering the life cycle of the product (from conceptual design to manufacturing, material, packaging, transportation, usage, end of use etc.)
c Assessing the possible scenarios of consumption customs of the product (buying, renting, sharing, disposing etc.)
d Deciding on the materials of the product
e Considering the amount of materials will be used in the product
f Using alternative energy sources in the product
g Consuming less energy during the manufacturing and usage of the product
h Mimicking the nature to solve the design problem
ı Success of the product in the market
j Contribution of the product to economical development of the society in the long term
k Meeting the needs of society
l Considering the possible needs of the future generation
m Addressing to lower class
n Other...

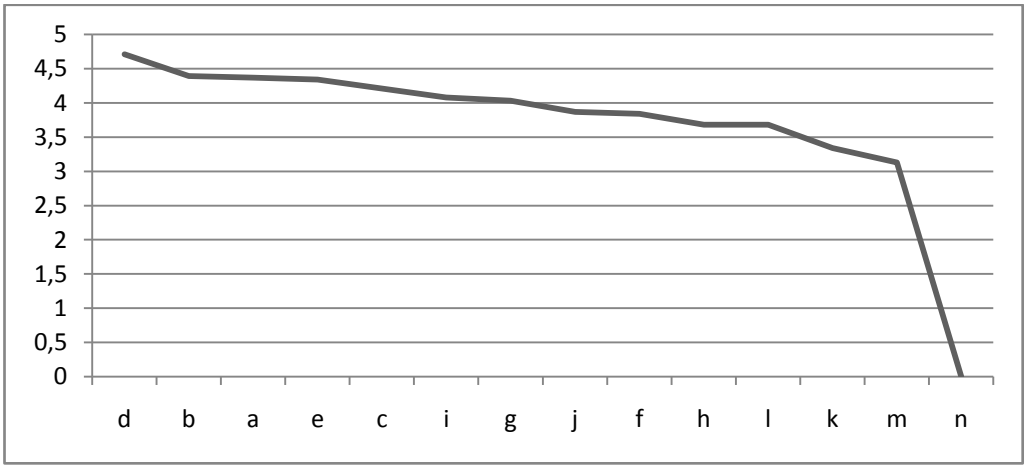

Figure 3.5 Distribution of the scores given by the student participants to the items about the design process by considering the possible effects of "industrial design activity" on "sustainable development"

In the second part of the questionnaire, four close-ended questions were asked to explore the self-evaluation of students considering their consciousness about sustainability.

Question 1 was about their level of knowledge on sustainability. Twenty-two students among 38 indicated that they had little knowledge about sustainability while one of them stated having very detailed knowledge about it (See Figure 3.6).

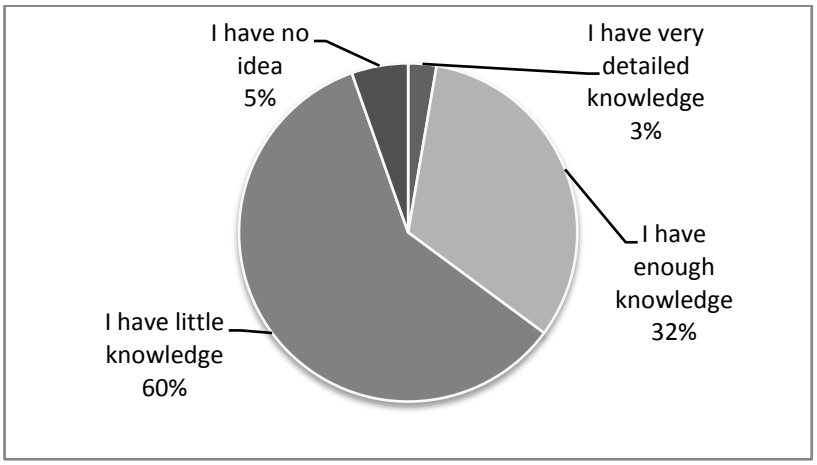

Figure 3.6 Participant students' self evaluation of their level of knowledge about sustainability (Percentage)

Question 2 was about the courses on sustainability which they took during their undergraduate industrial design education. Twenty students indicated that they did not take any course about sustainability or sustainable design and 15 students indicated that there was a title/subject in the course that they took (See Figure 3.7).

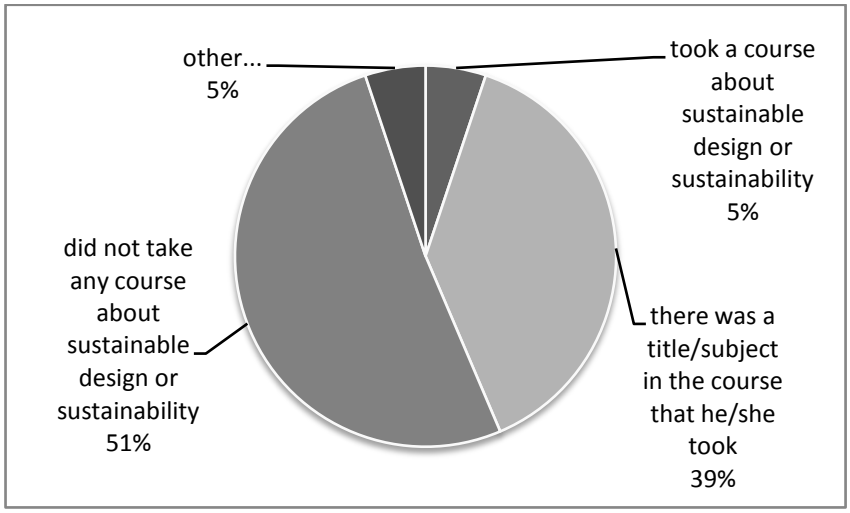

Figure 3.7 Distribution of the answers to the question about the courses related with the sustainability which participant students had taken (Percentage)

Question 3 asked the activities that they participated in during their educational period. Sixteen students answered that they did not participate in any activity about sustainability during their education (See Figure 3.8).

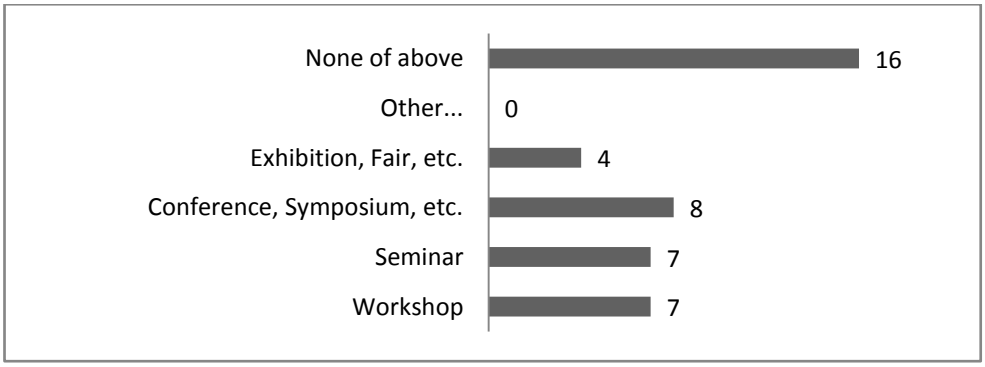

Figure 3.8 Number of activities about sustainability that the respondent students participated in

Finally, question 4 asked in which extent students considered sustainability in their design projects. Twenty-four students among 38 answered that they only considered sustainability when it was one of the requirements mentioned in the project brief (See Figure 3.9).

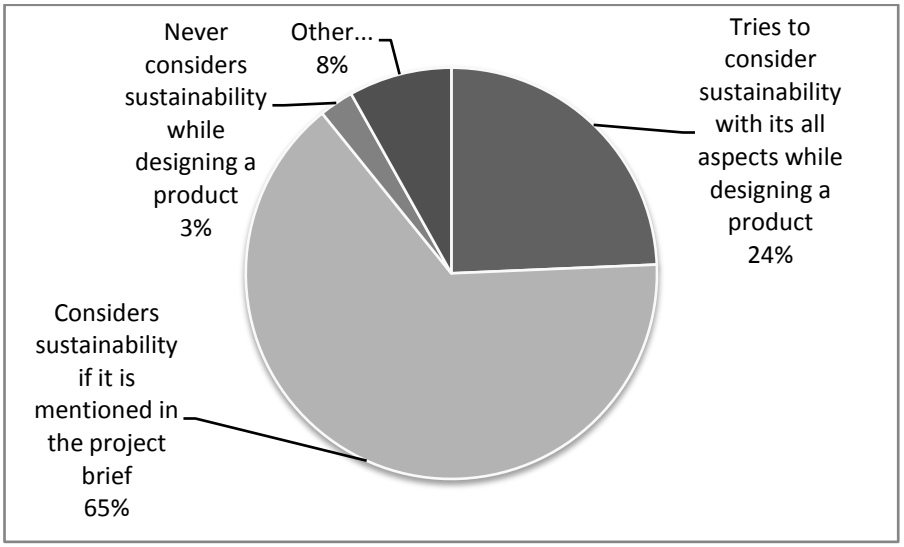

Figure 3.9 Distribution of the respondent students' thoughts on their sustainability consideration in their design projects (Percentage)

Results indicate that METU senior year ID students assess the material selection as the most important criterion in their design processes, followed by the environmental impacts of the product during manufacturing or usage, and the life cycle of a product. Those criteria are generally related with environmental aspect of sustainability. Items related with the social aspect of sustainability such as *meeting the needs of society* and *designing for lower class* have the lowest scores. However, it can be accepted as the limitation of this question that the items were created by the author and some are composed of more than one phrase while others might overlap.

According to the findings of Preliminary Study II, most of the students (25/38) perceive themselves that they have no or little knowledge about sustainability. Few students (2/38) had taken a course about sustainability or sustainable design. Although there were events about sustainability at METU and in the Department of Industrial Design during the period covered by the studies and even in the semester that the study conducted, almost half of the students (16/38) state that they did not participate in any kind of activities about sustainability. As a result, most of the students (25/38) stated that, during their undergraduate education, they only considered sustainability if it was mentioned so in the project brief.

Correlatively, those preliminary studies present that METU ID students have limited level of awareness and knowledge about sustainability. Besides, the findings retrieved from close-ended questions of the second preliminary study were used as an input of questionnaire design of the final study.

3.2 Main Research Study

The experiences gained in the preliminary studies guided the structure and procedure of the main research study of this thesis. In the lights of the literature review and the preliminary studies conducted, it was realized that gathering information about the educators' perceptions on sustainability by well prepared questionnaire statements based on the literature review results would be more valuable to reach the aims of this thesis. Besides, both qualitative and quantitative data are required for well-built results.

Therefore, in the main research study, students' and educators' perceptions of sustainable development, their opinions about relationship between the concept of sustainability and the industrial design profession, and the responsibilities of industrial designers in a design process, and their thoughts about industrial design education at the Department of Industrial Design, METU were investigated in order to recommend how sustainability can be integrated in the curriculum of the Industrial Design undergraduate program at METU. This section gives details of the main research study of this thesis, its population and sample, data collection tool, data collection procedure, and questionnaire and interview schedules.

Specific research question addressed in the study:

- What are the perceptions of industrial design students and educators about sustainability at METU?
- What are the educators' and students' opinions about integration of sustainability in industrial design education?

- To which extent do students consider and realize the requirements for the sustainability in their design processes?
- What are the factors affecting the industrial design students' realization of sustainability in their design process?

3.2.1 Limitations of the Main Research Study

The main research study is structured in order to gather both quantitative and qualitative data. Qualitative data are gathered by asking three open ended questions which are about the fields of activity related with the sustainable development; relationship between industrial design activity and sustainability; and, the integration of sustainability into industrial design education. So, the conclusions of this thesis related with these questions are limited with the author's interpretations and the answers for these open ended questions might be subject for other researchers' interpretations in different ways.

The findings of this study are valid for the senior students of 2008-2009 academic year and their educators in the Department of Industrial Design at METU, Ankara. Within this study, data over four years undergraduate period of 2008-2009 METU ID graduates was gathered. Although the conclusions of this study will give chance to generalize neither about the sustainable design education in Turkey nor at METU, it give information about a specific educational period at the particular piece of entire industrial design education in Turkey, that is the METU ID.

3.2.2 Population and Sample

Because of they were about to complete their undergraduate education and had an overall idea about their entire undergraduate period, fourth year METU ID of the 2008-2009 academic year were selected and asked to participate in the study. Thirty-four of the total 40 senior students voluntarily participated in the study.

As it was mentioned before, besides students, also the educators were the participants of this study unlike the preliminary studies.

Industrial design educators were recruited through e-mail and phone. In total, 11 educators who held a studio course or a theoretical course in the undergraduate industrial design program at METU participated in the study. Nine of them were full time staff and two were the part time staff.

3.2.3 Data Collection Procedure

The data collection procedure of the final research study began at 22nd May, 2009 and ended 9th June, 2009. A pilot study was conducted with two educators and with one student. There were no significant changes needed after the results of the pilot study were evaluated, except some wording corrections and a few changes in the organization of the items.

The whole study was conducted in the Faculty of Architecture at METU, in the places which were preferred by the participants such as industrial design studios, garden or staff offices. All the interviews were recorded by tape with permissions of the participants.

3.2.4 Data Collection Tools

This study is composed of 4-item questionnaire and 3-item interview schedule. In order to gather detailed information about the opinions of the participants and to give the opportunity to the participants to express themselves freely, semi-structured interview was conducted at the same time with the questionnaire study. The sequence of the questions was determined with the aim of not directing the responses of participants with any other questions asked before. Two different sets of questions were prepared for students and educators separately. Although the content of the questions for the educators and the

students are exactly the same, the ways they are posed were different in some questions (see APPENDICES C and D).

3.2.5 Structures of the Questionnaire and the Interview Schedules

At the beginning, a brief description of the study objective was explained to the participants. Then, a definition of sustainable development was given in order to warm up the participants up to the concept of sustainability. For this sake, Brundtland definition (1987) was used because it is quite well known and frequently cited definition of sustainable development.

After giving the definition of sustainable development, participants were asked to signify the areas related to sustainable development in order to get their opinions about it. The aim of this question was to understand which areas the participants find related with the sustainable development. As mentioned before, sustainability is mainly related with environment, economy and society. The results of this question help to gather information on which aspect of sustainability the participants find more important and on their perceptions about sustainability. The first question asked for both groups was as follows:

> "By considering the general definition given at the beginning of this questionnaire, would you please signify the areas/fields related to the sustainable development?"

The second interview question was again the same for both groups. In order to understand the relationship between industrial design activity and the sustainability concept from the point of the participants' views; the second question was posed as follows:

> "Would you please explain the kind and nature of relationship between industrial design activity and sustainability?"

Another aim of this question was to detect if there were any differences between the participants' understandings of sustainability, which was asked in the first question and its relation with industrial design activity.

Third question was mainly about the situation of teaching sustainability in industrial design specifically at METU. As it is known from the curriculum of undergraduate industrial design

program at METU, there is no specific course offered completely related with sustainability. However, there are courses including sustainability as a subject in their schedule. Additionally, there are courses about sustainability offered by other departments at METU. All METU ID students have the chance to take courses from other departments as electives after their fourth semester of the 8-semester educational program. Moreover, METU is hosting several activities or events about sustainability through the academic year in order to support sustainability on the campus. Therefore, the third question was asked to explore to which extent the students are aware of and interested in the courses about sustainability and to identify the activities or events about sustainability that both groups participated in. Six choices given for checking the most suitable ones for educators were as below:

> "Please check the most suitable ones when you think about the courses that you teach in ID bachelor level.
>
> - I did not teach any course about sustainability or sustainable design because they are not covered by my area of specialization.
> - I teach course(s) about sustainability or sustainable design.
> - There was a title/subject in the course that I teach.
> - There was a project about sustainable design in the studio course that I teach.
> - In the last four years, I participated in at least one event about sustainability or sustainable design (seminar/conference/workshop/exhibition/film etc.).
> - Other…"

For students, the amount of and the idea behind the choices were similar with the educators', but the sentences have been changed in a way that the subject of the sentences as the students. An additional question was asked to the students in order to find out whether sustainability affected their design processes or not, after taking courses or participating in activities or events if there were any.

This question was also used as a link to the following questions, which is mainly about sustainability and industrial design education.

In the fourth question, participants were asked to recommend how sustainability would have been integrated into industrial design education:

> "In your opinion, how would sustainability be integrated into industrial design education?"

After this question, the interview part was ended. In the fifth question, respondents were asked to specify their level of agreement to a set of statements on a five point Likert Scale. The question aimed to understand the responsibilities of an industrial designer in a sustainable design process from the participants' point of view. The results of this question believed at identifying in which processes students and educators think that an industrial designer should have more competence. In the question statement, the terms "sustainability" or "sustainable design" are not mentioned since the participants' understandings of sustainability may not match with the statements given. Therefore, the question was asked as follows:

> "Please assess the items below in the context of an industrial designer's responsibility in design process."

The set of statements asked to be assessed was prepared with the guide of Ecodesign Web tool that was mentioned before in the section 2.3.3.2. Ecodesign Web is a qualitative assessment tool that helps designers or design students on which area they need to focus in a sustainable design process. There are seven design areas on the Ecodesign Web (Bhamra and Lofthouse, 2007) as:

- new ways of doing things,
- material selection,
- material usage,
- distribution,
- product use,
- optimal life and
- end of life

There are sub-topics listed under these seven areas which an industrial designer can focus on to improve the environmental performance of a product or service. For this study, areas of material selection and material usage are combined because of both are overlapping with each other most of the time. Therefore, six design areas are used. In the questionnaire, the main areas written on the column at the left hand side were not seen by the participants as it is seen in the Table 3.1 in order not to direct them.

Table 3.1

Items of the sustainability related issues in industrial design process

new ways of doing it	Considering the products/services' possible consumption scenarios (purchasing, renting, sharing, using and disposing, etc.)
	Designing the product with the aim of reducing the opportunity for crime or misuse by making it difficult or risky
	Offering multi-functional solutions for particular product groups with the aim of consuming less energy and material
	Analyzing the possible negative impacts of the product during its usage and offering design solutions aiming to reduce them.
material	Deciding on the materials of the product
	Considering the amount of materials will be used in the manufacturing process of the product
	Considering the waste will be produced during the manufacturing process of the product
	Considering the number of parts of the product
distribution	Designing the package of the product
	Taking the amount of materials will be used in the package of the product into consideration.
	Considering the possible environmental impacts during the transportation of the product
	Assessing the usage scenarios of the product package (re-use, re-use for another purpose, etc.)
product use	Deciding the type of energy consumed during the usage of the product
	Designing the product with the aim of decreasing the amount of energy consumed during its usage
	Designing the product with the aim of increasing the efficiency of consumed energy during its usage
	Considering the waste produced during the usage of the product
	Designing the product with the aim of directing the consumers' behaviors in the way that anticipated
optimal life	Developing/using product-life extending strategies to avoid premature disposal.
	Designing the products which are easy to repair and maintenance.
	Designing the product with the aim of enabling it to be easily upgraded instead of replacing it with a new one
	Considering how long the life of a product should be
end of life	Planning for the phase after the end of usage of the product (how does it throw out or is it collected, where is it stored? etc.)
	Designing processes of re-use or re-cycling scenarios of the product at the end of its life

The fifth question aimed to create a certain level of understanding about design for sustainability as a base for the further questions. The sequence of this question was very critical because before this question participants' were asked to express their own opinions freely without any orientation by no means. The statements in this question may affect the answers of the previous ones unless it is given after the interview questions.

In order to figure out what educators and students think about how much of the issues that the statements, assessed before, were applied in graduation projects, the sixth question asked students to evaluate themselves and educators to evaluate their students. The choices were: all (100%-75%), more than half (75%-50%), half (%50), less than half (50%-25%), and almost none (25%-0%).

Besides, the project reports prepared by the students defining the constraints, objectives and directives of their projects will also be scrutinized in order to find out how much of the constraints, objectives or directives mention sustainability related subjects. It is thought that, this information would help to attest the results of the sixth question (See Appendix E).

Finally, the sixth question was directed to the participants who evaluated the degree of students' sustainability realization in their graduation projects as asked in the previous question as half (50%) or below half; because, in the last question, it was aimed to understand the negative factors affecting the industrial design students' attitude towards the sustainability concept in a design process. The students and educators were asked to sign the items as true or not true in their opinion (See Table 3.2).

Table 3.2

Statements of the reasons that prevent students to implement sustainability related issues in industrial design process

For Educators	**For Students**
Students think that project requirement does not include subjects mentioned above.	Project requirement does not include subjects mentioned above.
Students think that subjects mentioned above are not relevant to their design projects.	Subjects mentioned above are not relevant to my design projects.
Subjects mentioned above are relevant to many design projects; however students think that there is no time for those because of time spent for designing the product.	Subjects mentioned above are relevant to my design projects; however there is no time for those because of time spent for designing the product.
Students are not interested in the subjects mentioned above because the firms/companies that they work with do not ask them to do so.	The firm/company that I work with does not ask me to do so.
Students think that they do not need to consider the subjects mentioned above as they are not professionals.	I think that I do not need to consider the subjects mentioned above as I am not professional.
Students do not have necessary knowledge/facilities to implement the subjects mentioned above. Other;	I do not have necessary knowledge/facilities to implement the subjects mentioned above. Other;

3.2.6 Data Analysis Procedure

The data were analyzed separately for each question of the study, then cross-compared with the findings for each group.

As mentioned before in the section 3.2.3, this study is composed of open-ended and structured questions that corroborate each other in order to gather more detailed information about the subject. Therefore, different data analysis procedures were considered for different kinds of questions.

First two questions and the fourth question were interview questions; therefore thematic coding and categorization methods have been used for analyzing them. The voice recordings of the participants were transcribed on an Excel Worksheet; then, data-driven codes (the codes coming from the text by comparisons and asking questions) and concept-driven (the codes coming from the literature review study, preliminary studies and so on) were used to categorize the responses. After defining the codes, it was counted how many times they were mentioned by the participants. An example of a data analysis document is seen in the Appendix F.

In the fifth question, five point Likert Scale was used for 23 items. Individual items in Likert Scale had five-response alternatives as 'strongly approve', 'approve', 'undecided', 'disapprove', and 'strongly disapprove' to the items that are related with the industrial designers' responsibilities. At first, the means of each item were analyzed separately; then, the items referring to six design areas (new ways of doing it, material, distribution, product use, optimal life, end of life) mentioned in the section 3.2.4, were analyzed together. Independent sample T-test was conducted by SPSS 15 software in order to find significant differences among each group of the participants' answers.

In the rest of the questions, the data was analyzed by counting the responses of each participant separately. Next chapter presents the results and the findings of the main research study of the thesis.

CHAPTER 4

RESULTS

In the following sections, the results of the main research study of this thesis are presented question by question. In this chapter, results are given without any discussion so that they might be used by other researchers who will be interested in the similar subjects in the future. It should be mentioned here again that this study is related merely with the fourth year undergraduate education period of METU ID graduates of 2008-2009.

4.1 Sustainable Development Areas

"By considering the general definition given at the beginning of this questionnaire, would you please signify the areas related to the sustainable development?"

The responses to the question were transcribed and the data-driven codes were retrieved from the texts. Firstly, the codes were counted separately without categorization. The code frequencies of the first question by students and educators are given as Figure 4.1 and Figure 4.2.

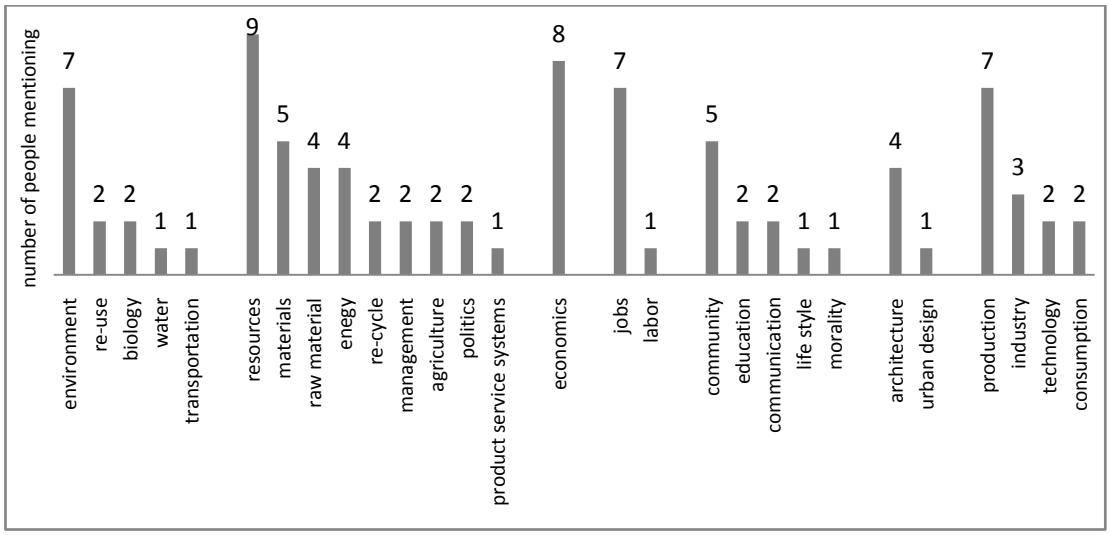

Figure 4.1 Areas related to sustainable developments according to the students (Frequencies)

The numbers in the graph show how many times the keywords were mentioned by the participants. If a participant mentioned the same keyword more than once, it was counted as one, therefore it can be said that the numbers in the graph also indicate how many participants mentioned the keywords. Resources (9), economics (8), environment (7), jobs (7) and production (7) were the most mentioned relations with sustainable development according to students. Material (5), raw material (4), community (5), energy (4), architecture (4) were following them. On the other hand, water, transportation, product service systems, labor, life style, morality and urban design were mentioned once and the least mentioned areas as seen in the figure above.

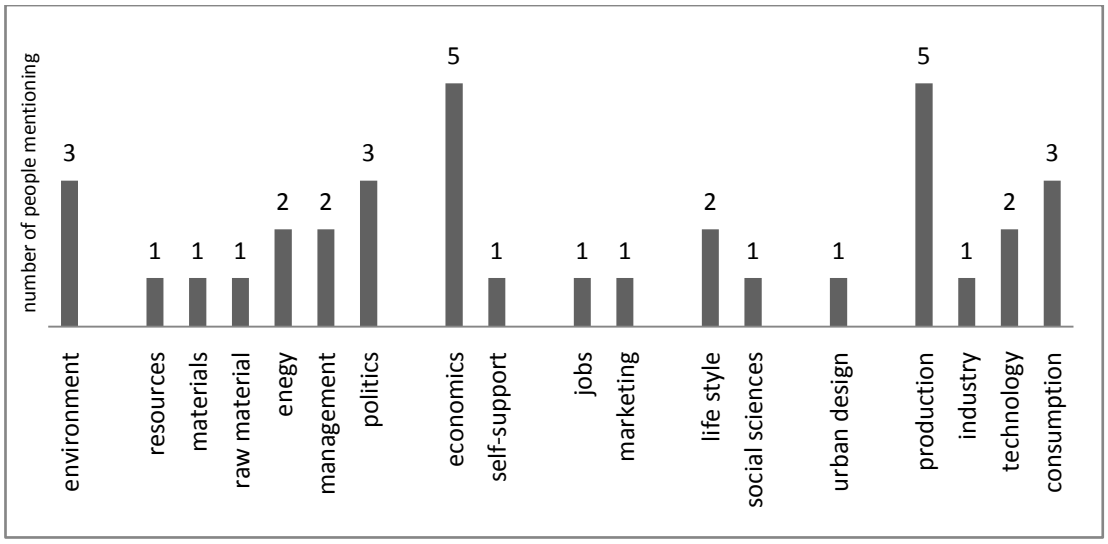

Figure 4.2 Areas related to sustainable developments according to the educators (Frequencies)

Economics (5) and production (5) were the most mentioned areas as related with sustainable development according to educators; while, resources, materials, raw materials, self-supporting economies, jobs, marketing, social sciences, urban design and industry are the least mentioned areas as seen in the Figure 4.2.

After counting the codes separately; they were categorized according to what they refer in order to compare the students' and educators' responses. The categories are created according to the three aspects of sustainability which are named as the environment, the

economy and the society in the literature. What the codes refer was inferred from the conversations of the participants. Therefore, the categorization of the codes depends on the awareness about the terms of the participants. To analyze, the number of keywords mentioned by both groups was counted separately (See Figure 4.3). Thirty-four students mentioned 90 keywords while 11 educators mentioned 36.

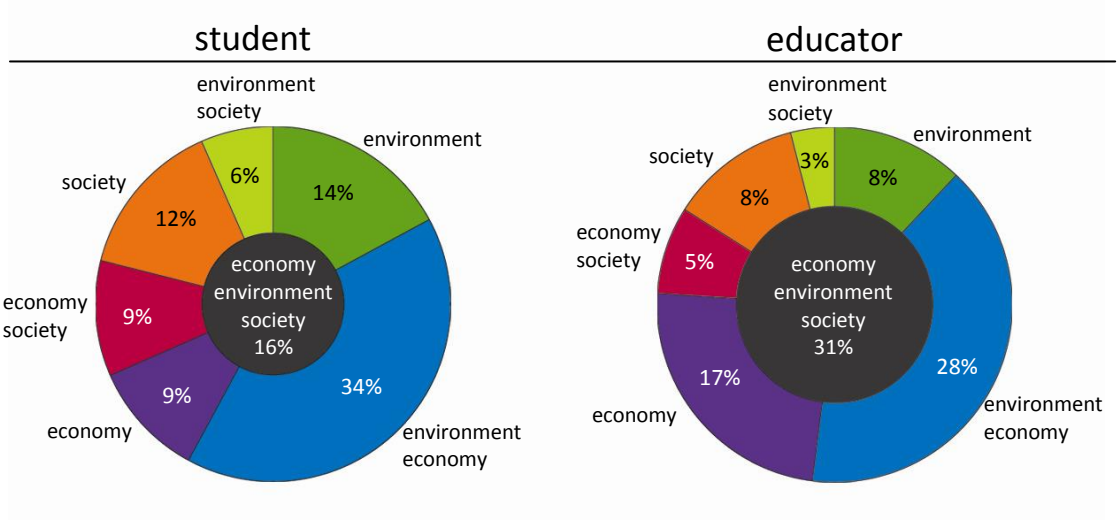

Figure 4.3 Distribution of keywords of the students and the educators in relation to the sustainability aspects (Percentile)

Some keywords are related to more than one aspect of sustainability such as production (environment, economy and society), labor (economy and society), urban design (society and environment) and so on (See Appendix G). Educators' keywords mentioning environment, economy and society together are more than the students' keywords mentioning all of three. That is why the educators' central area in the circle in the figure 4.3 is larger than the students'. Students found environmental economical areas (34%) more related with sustainable development. Besides, environmental social (6% for the students and 3% for the educators) areas were the least mentioned by both group.

In order to understand the main category mentioned, each codes that are related with environment, economy or society are counted together (See Figure 4.4).

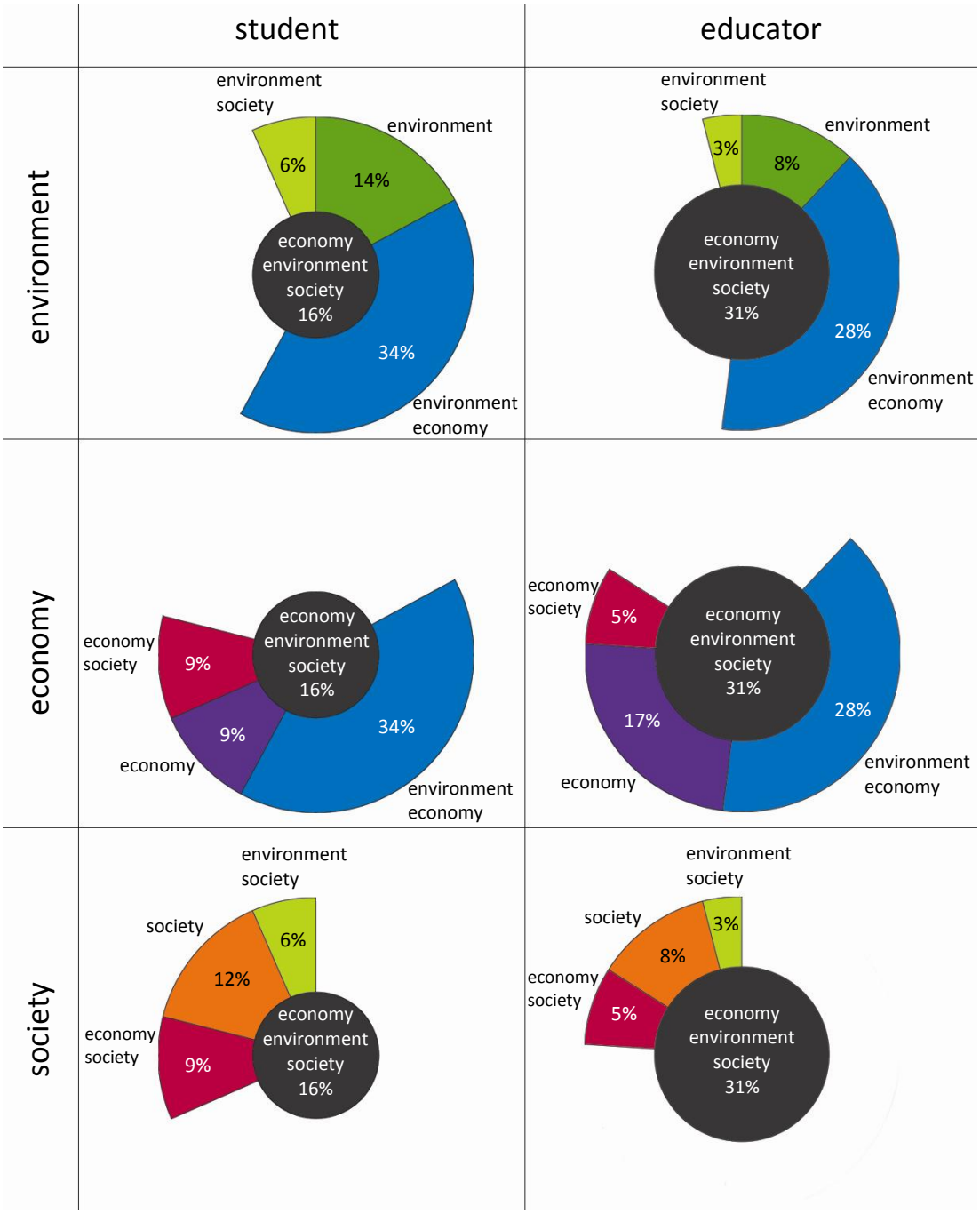

Figure 4.4 Distribution of keywords according to environment, economy and society concerns of sustainability by both groups (Percentile)

Environment was the most mentioned aspect of sustainability by students whereas economy is the most by educators. However society was the least mentioned concern of sustainability by both students and educators (See Figure 4.4).

Three of the student and one of the educators mentioned *design* as an area of sustainable development, however; they might reply so because of being industrial design students or educators. Therefore, "design" is omitted in this question. The relationship between industrial design and sustainability is asked separately in the second question.

4.2 The Relationship between Industrial Design Activity and Sustainability

"Would you please explain the kind and nature of relationship between industrial design activity and sustainability?"

After gathering the students' and educators' opinions on the areas related with the sustainable development, the relation between industrial design activity and sustainability was asked in order to understand how they relate them. The keywords retrieved from transcriptions mention the areas that the designer ought to pay attention during sustainable industrial design activity. The frequencies of keywords are as seen in Figures 4.5 and 4.6.

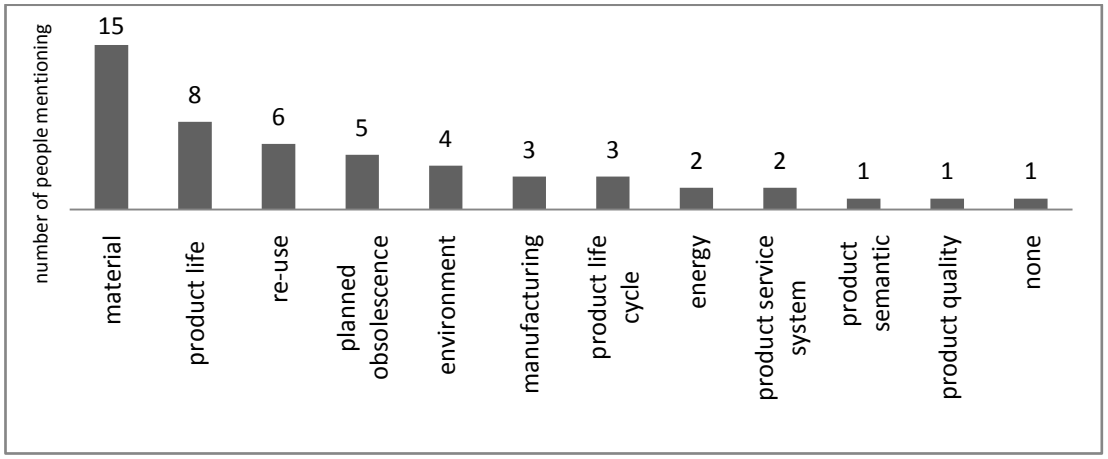

Figure 4.5 Keywords indicating the relationship between industrial design activity and sustainability according to the students (Frequencies)

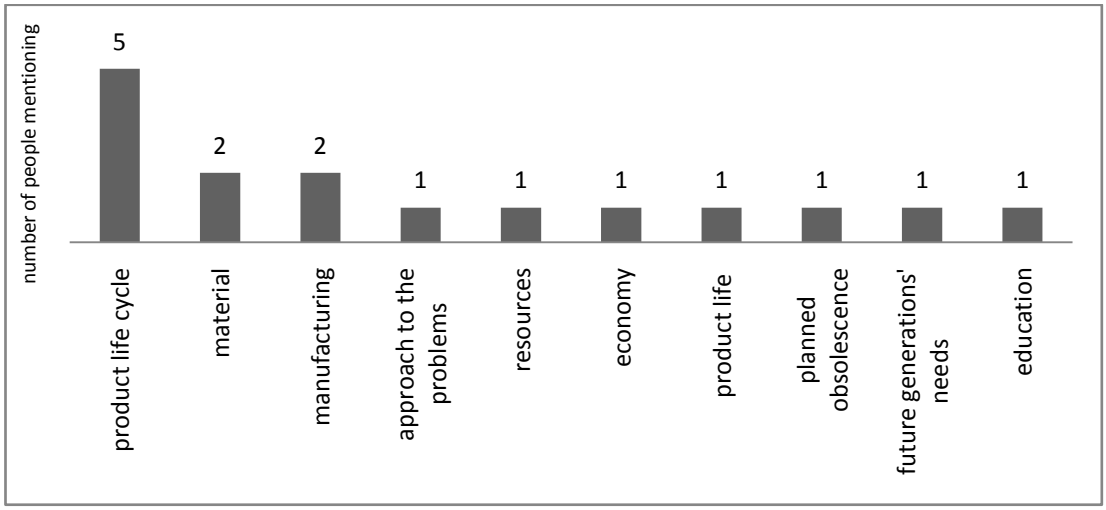

Figure 4.6 Keywords indicating the relationship between industrial design activity and sustainability according to the educators (Frequencies)

Decision of the *type and amount of material that is used in a product* is the most critical relationship between industrial design activity and sustainability according to the students; on the other hand, the educators mostly considered *product life cyc*le more important in this relationship.

Among 15 students mentioning *material* as the important area of the relationship between industrial design and sustainability, one mentioned *amount of material used in a product*, while the rest mentioned the *type of material used in a product*. Among type of materials, five students mentioned *recycled materials* or *material recycle* as the important area of the relationship between industrial design and sustainability (See Figure 4.7).

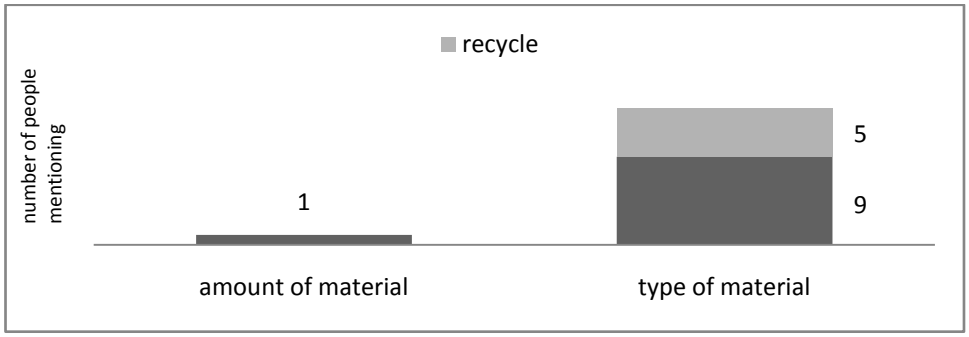

Figure 4.7 Material as the area of the relationship between industrial design and sustainability according to students (Frequencies)

On the other hand, some participants indicated that industrial designers were not the only authority making decisions in a sustainable design process. Two students and four educators think that industrial designer is a part of a multidisciplinary team.

Additionally, some participants (8) have reservations about concerning sustainability in industrial design activity. Five students do not believe current implications of sustainability in industrial design because they think that design for sustainability approaches are marketing centered. On the other hand, two students and one educator think that the concerns of sustainability conflicts with the economical concern of industrial design.

4.3 Structure of Teaching Sustainability at METU

In the third question, a set of statements mentioned in the section 3.2.4 was given to check in order to find out the thoughts of participants about teaching sustainability at METU ID and to identify the activities or events about sustainability that students and educators participated in.

The answers were counted separately. The participants were allowed to tick off more than one statement and allowed to add more items to each statement given. The numbers of students that ticked off each statement are seen in Figure 4.8.

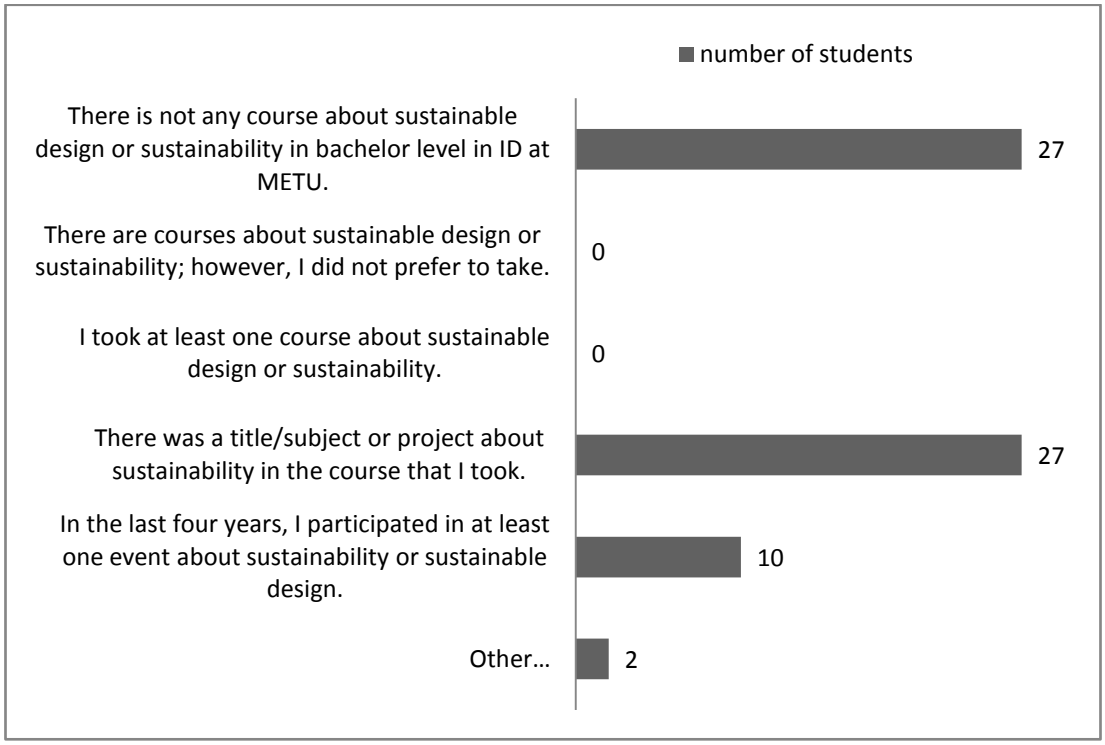

Figure 4.8 The students' agreement to the statements above when they considered the courses they took or activities they participated in bachelor level

Most of the students pointed out that there was no course about sustainability in undergraduate level in industrial design at METU and there had been a title/subject or project about sustainability in the course that they had taken. Within 27 students who checked "there was a title/subject or project about sustainable design or sustainability in the course that I took" statement, two indicated that sustainability was mentioned by educators during the studio critics. As mentioned before, students can take courses from other departments at METU if they wish; however no one mentioned taking any non-departmental course about sustainability. Two students mentioned that they did not take any course or participated in any activity about sustainability. Except those two, it was asked 32 students whether sustainability affected their design processes after taking the courses or participating in the activities as they mentioned. Sixty two percent of 32 students replied as *no, it did not* and 38 percent as *yes, it did*.

The names of the courses containing sustainability as a title/subject or project that the students have taken are presented in the Figure 4.9.

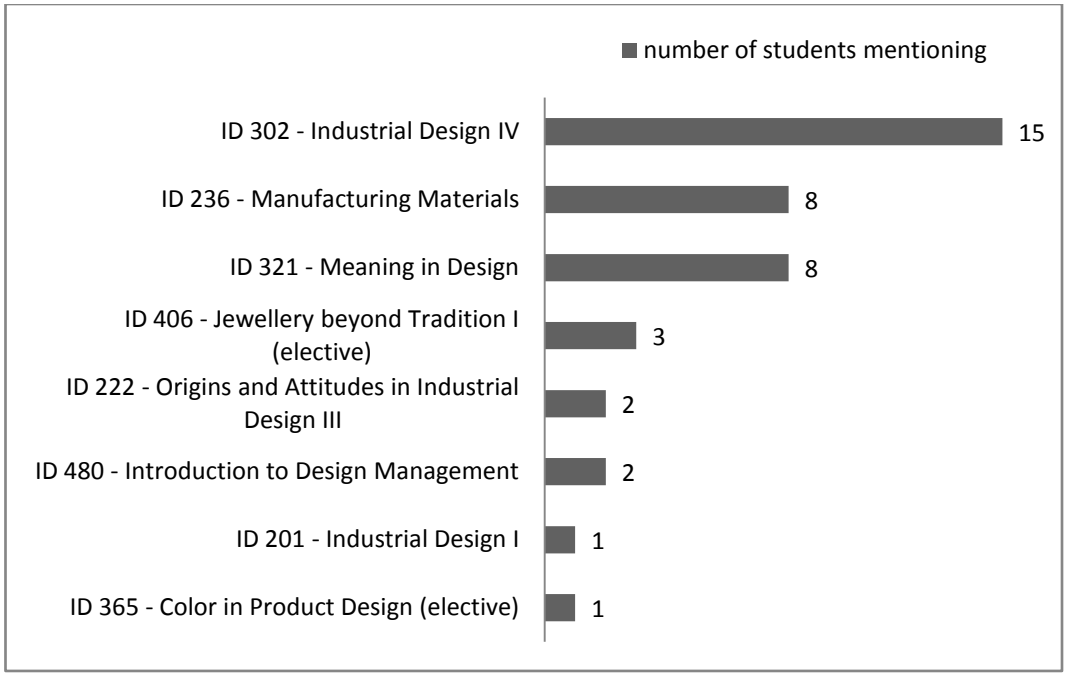

Figure 4.9 Courses containing sustainability as a title/subject or project mentioned by students

Within the courses containing sustainability in a way or another, the third year studio course titled Industrial Design IV (ID302) is the most mentioned one. The students stated "designing solar powered product" project as the sustainability related project in ID302 which was the study subject of the Preliminary Study I.

One student selecting "other" option states that he/she read a book about sustainability and the other participated in a research study about sustainability.

The numbers of educators that selected each statement are presented in the Figure 4.10.

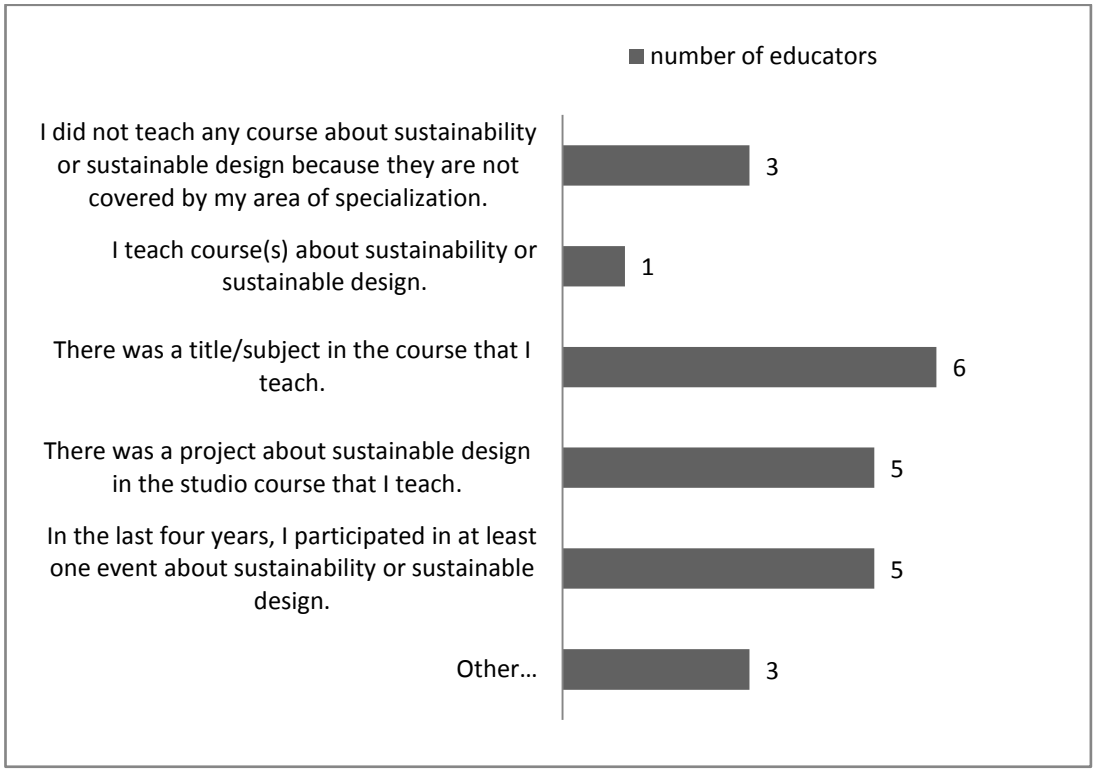

Figure 4.10 The educators' agreements with the statements about the courses they teach or activities they participated in

As they mentioned before, half of the educators teach a course containing a subject or at least a title about sustainability and participated in a studio course covering a project about sustainability as seen in the figure above.

Three educators selected "other" option; one had read publications and watched movies, the other had been the advisor of a thesis and co-author of an article, and one had been the advisor of a thesis about sustainability.

Six educators indicated that there had been a subject in the course that they taught; one mentioned about sustainability being off the schedule; and two taught courses about sustainability at other universities. The names of the courses that five educators mentioned were as below:

- ID 121 - Introduction to Industrial Design
- ID 222 - Origins and Attitudes in Industrial Design III

- ID 236 - Manufacturing Materials
- ID 321 - Meaning in Design

Among five educators indicating that there had been a project about sustainable design in the studio course that s/he taught, three mentioned that they touched on sustainability issues in the studio critics; one remembered the projects about sustainability in ID 201 and ID 202 Industrial Design II and III in different years. One of them taught a studio course about sustainable design at another university.

4.4 Integration of Sustainability into Industrial Design Education

"In your opinion, how would sustainability be integrated into industrial design education?"

The responses to this question were transcribed and the data-driven codes were retrieved from the transcriptions. The codes were counted separately without categorization. Except one of the students, all participants believe that sustainability should be integrated into industrial design education somehow. The codes signify how sustainability in industrial design education can be integrated and the mediums that can increase the industrial design students' understanding and awareness of sustainability concept. The code frequencies of the third question by the students and the educators are given as Figure 4.11 and Figure 4.12.

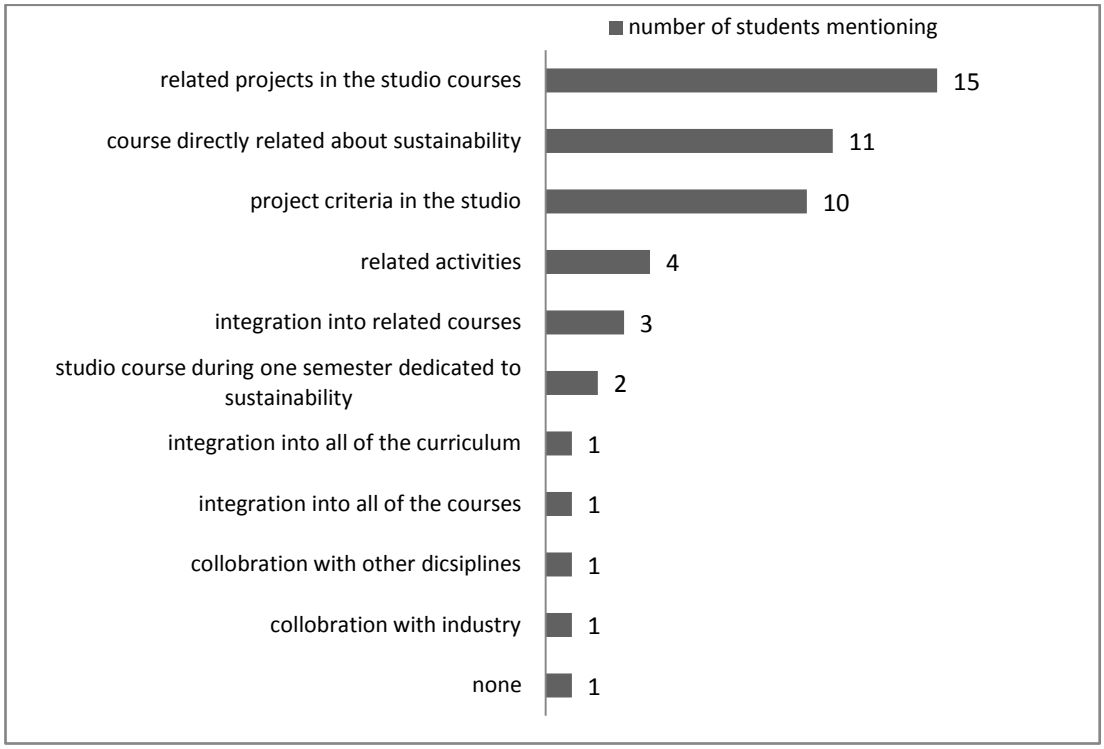

Figure 4.11 Students' opinions on the mediums for integrating sustainability into undergraduate industrial design education (Frequencies)

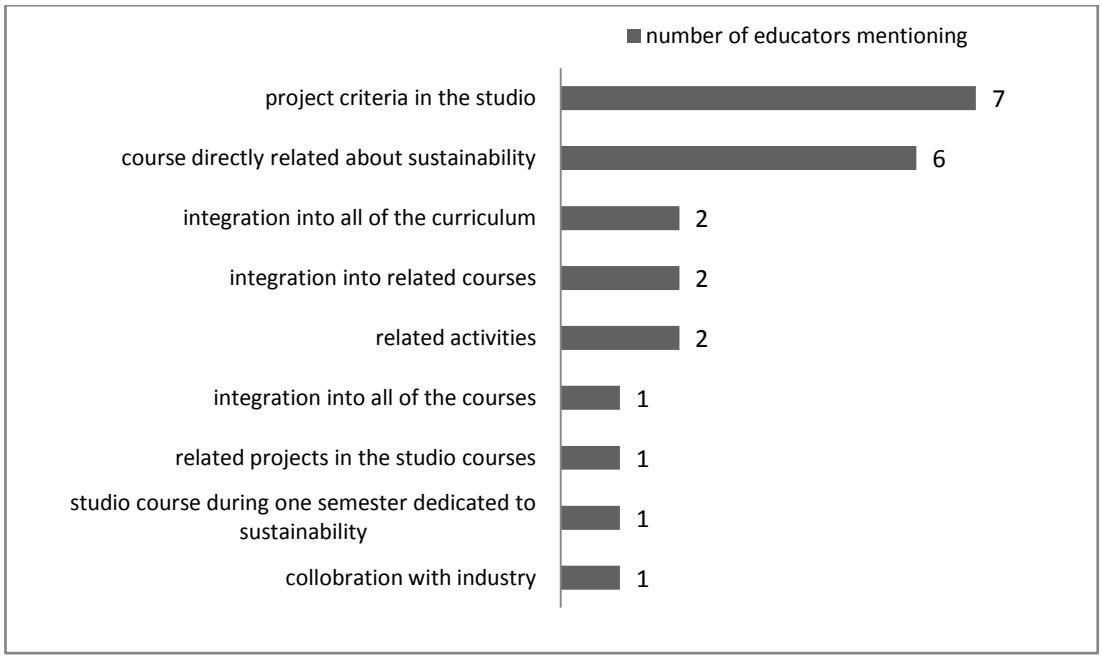

Figure 4.12 Educators' opinions on the mediums for integrating sustainability into undergraduate industrial design education (Frequencies)

Fifteen students suggested that related design projects in the studio courses would be useful to increase the level of awareness of students about the subject. Correspondingly, educators suggested that sustainability would be a project criterion in the studio courses. Eleven students and six educators suggested that there might be courses about sustainability beside studio projects. The common suggestions of students and educators were activities about sustainability and sustainable design (4 students and 2 educators), integration of sustainability into related courses (3 students and 2 educators), studio courses during one semester dedicated to sustainability (2 students and 1 educator), integration of sustainability into all of the courses (1 student and 1 educator), collaboration with industry (1 student and 1 educator).

The participants who suggested offering courses directly related with sustainability specified the course's content as seen in the Figure 4.13 and 4.14.

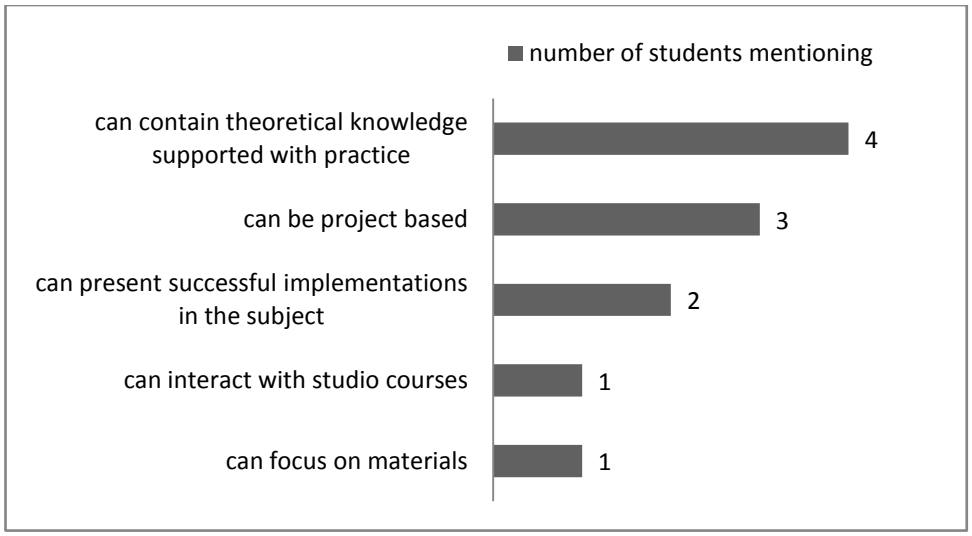

Figure 4.13 Students' opinions about the content of the courses directly related with sustainability (Frequencies)

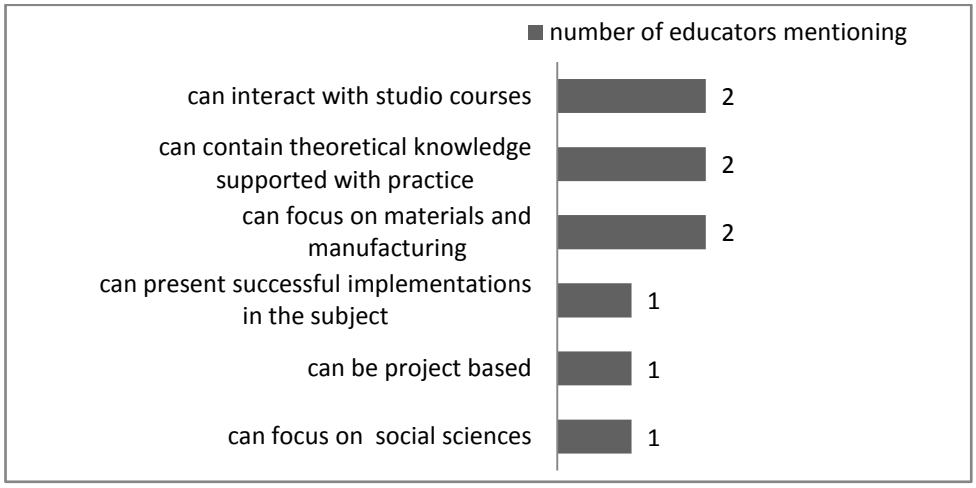

Figure 4.14 Educators' opinions about the content of the courses directly related with sustainability (Frequencies)

According to four students and two educators, this course about sustainability can contain theoretical knowledge supported with practice. Similarly, three students and one educator thought that it could be project based. Other suggestions on the courses directly related with sustainability were that, the course might illustrate successful implementations about sustainable design (2 students and 1 educator), coordinate with studio courses (1 student and 2 educators), focus on materials or manufacturing (1 student and 2 educators), and focus on social sciences (1 educator). Three students and two educators among participants suggesting a course directly or indirectly related with sustainability indicated that it must be compulsory. Conversely, one of the students indicated that it should be elective.

4.5 Issues in a Sustainable Design Process

In the fifth question five point Likert Scale is used as mentioned in the section 3.2.4. The mean scores of responses of each item on the industrial designer's responsibilities were calculated for students and educators separately (Figure 4.15). After finding the results of each item, the means of six design areas mentioned previously were calculated (See Figure. 4.16).

1. Considering the products/services' possible consumption scenarios (purchasing, renting, sharing, using and disposing, etc.)
2. Designing the product with the aim of reducing the opportunity for crime or misuse by making it difficult or risky
3. Offering multi-functional solutions for particular product groups with the aim of consuming less energy and material
4. Analyzing the possible negative impacts of the product during its usage and offering design solutions aiming to reduce them.
5. Deciding on the materials of the product
6. Considering the amount of materials will be used in the manufacturing process of the product
7. Considering the waste will be produced during the manufacturing process of the product
8. Considering the number of parts of the product
9. Designing the package of the product
10. Taking the amount of materials will be used in the package of the product into consideration.
11. Considering the possible environmental impacts during the transportation of the product
12. Assessing the usage scenarios of the product package (re-use, re-use for another purpose, etc.)
13. Deciding the type of energy consumed during the usage of the product
14. Designing the product with the aim of decreasing the amount of energy consumed during its usage
15. Designing the product with the aim of increasing the efficiency of consumed energy during its usage
16. Considering the waste produced during the usage of the product
17. Designing the product with the aim of directing the consumers' behaviors in the way that anticipated
18. Developing/using product-life extending strategies to avoid premature disposal.
19. Designing the products which are easy to repair and maintenance.
20. Designing the product with the aim of enabling it to be easily upgraded instead of replacing it with a new one
21. Considering how long the life of a product should be
22. Planning for the phase after the end of usage of the product (how does it throw out or is it collected, where is it stored? etc.)
23. Designing processes of re-use or re-cycling scenarios of the product at the end of its life

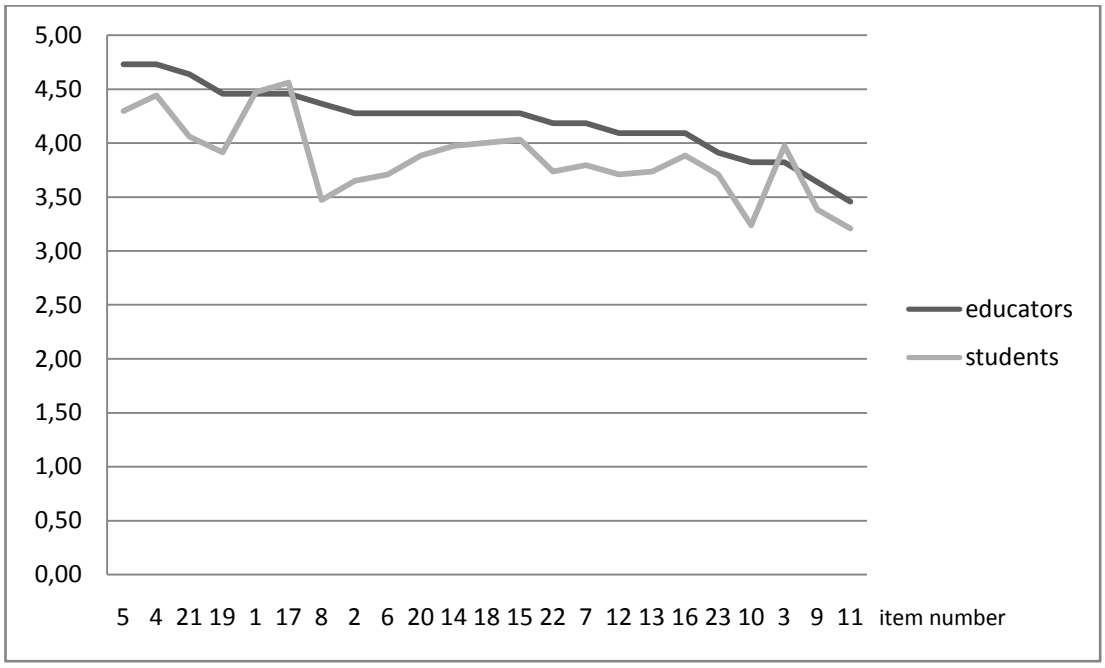

Figure 4.15 The mean scores of items related with the responsibilities of an industrial designer in a design process

Except the item *offering multi-functional solutions for particular product groups with the aim of consuming less energy and material* (item 3) and *designing the product with the aim of directing the consumers' behaviors in the way that anticipated* (item 17), the mean scores of educators are higher than the students'. *Analyzing the possible negative impacts of the product during its usage and offering design solutions aiming to reduce them* (item 4) and *deciding on the materials of the product* (item 5) have the highest mean scores (*mean: 4.73*) by educators while *designing the product with the aim of directing the consumers' behaviors in the way that anticipated* (*mean: 4.56*) has the highest mean score by students. Item *considering the possible environmental impacts during the transportation of the product* (item 11) has the lowest score *(means: 3.45 and 3.21)* for both educators and students.

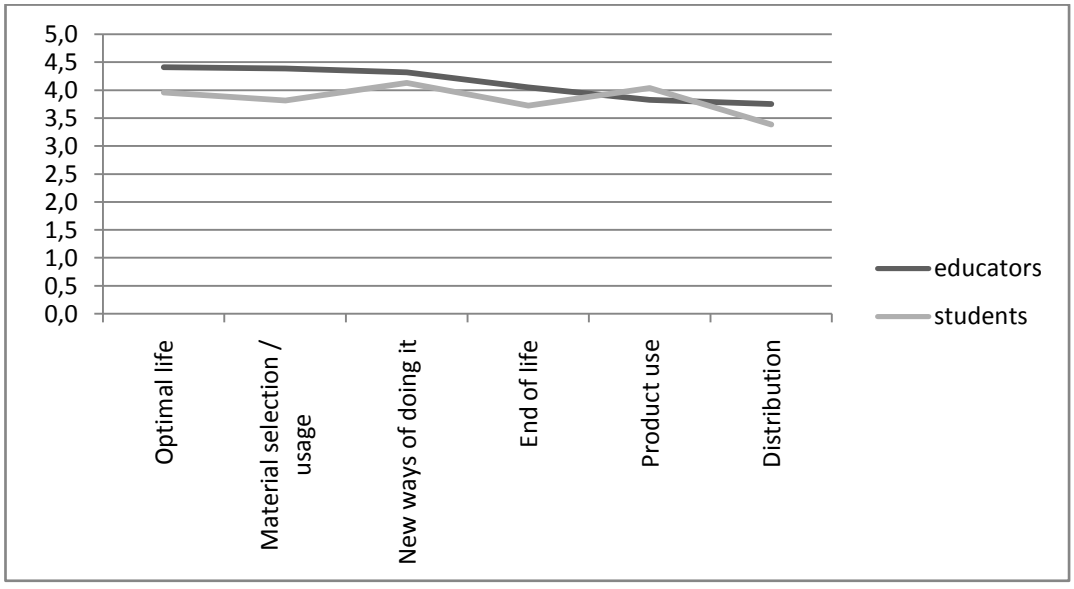

Figure 4.16 The mean scores of design areas related with the responsibilities of an industrial designer in a design process

Considering how the products will be distributed to the consumer get the lowest score from both groups. *Thinking about different ways of delivering a product function by reducing the environmental and social impacts* get the highest scores from students while *considering the optimal life of the product* has the highest score by educators.

Additionally, it was analyzed whether there were statistically significant differences or not among students' and educators' understandings of the responsibilities of industrial designers in sustainable design processes. For this end, independent sample T-tests were conducted for each item and design area, with a conventional α-level of .05, by utilizing SPSS 15. The assumptions of independent sample T-tests (random sampling, independent observation, normality and equality of variances between groups) were checked and met for 23 items and six design areas comparisons (See Appendix H).

It was found that there are statistically significant differences between students and educators in terms of their understandings in *designing the product with the aim of reducing the opportunity for crime or misuse by making it difficult or risky* (item 2), *considering the number of parts of the product* (item 8) and *considering how long the life of a product should be* (item 21). Moreover, *material selection and usage* in a product and *optimal life of a product* are design areas in which statistically significant differences were observed between students' and educators' understandings. Educators assessed those three items and two design areas more important when compared with students (See Appendix H).

4.6 Realization of Sustainability Related Issues in a Design Process and Barriers

In order to figure out the students' and the educators' thoughts about to what extent the issues that the items refer in the previous section are realized in graduation projects, the responses of each group were counted separately. The results of the students' answers are given as can be seen in the Figure 4.17.

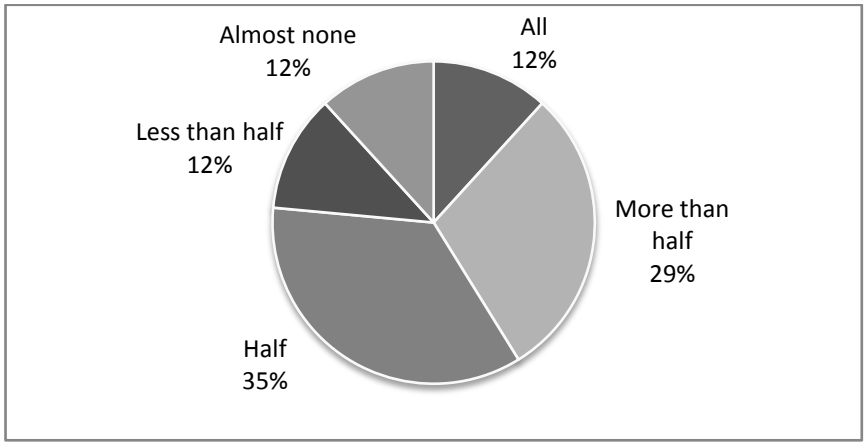

Figure 4.17 Students' thoughts about how much of the issues about sustainability were realized in their graduation project (Percentile)

Thirty-five percent of the students believe that they realized half of the issues about sustainability that the items refer. Students who think that they considered more than half of the issues in their graduation project are 29 percent of all. Twelve percent of students believe that in their graduation project, they considered all of the issues that the items refer.

When it was asked educators to rate the students with respect to the issues referred from the items assessed before, none of them answered *more than half* or *all* of the issues realized in students' graduation projects (See Figure 4.18).

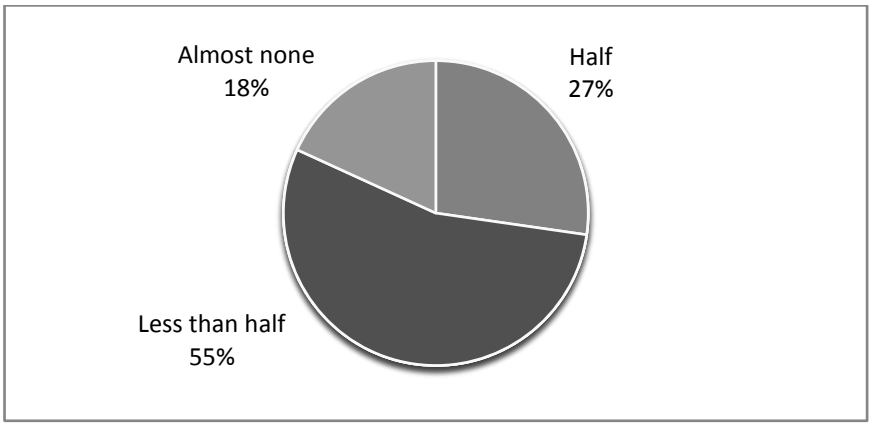

Figure 4.18 Educators' thoughts about how much of students realized sustainability related issues in their graduation project (Percentile)

Although, more than half of the educators (55%) think that the students realize less than half of those issues about sustainability in their graduation projects, only 12 percent of the students agree that.

After answering this question, the respondents who think that the students realize half or less than half of those issues about sustainability in their graduation projects were asked to answer the last question by evaluating the statements as they are true or not. Twenty students among 34 and all of the educators answered this question. The result of the last question is shown in Table 4.1 and 4.2.

Table 4.1

The number of students' ticks for each items related with the barriers to realize the issues about sustainability in industrial design process

	TRUE	FALSE	NOT SURE
Project requirement does not include subjects mentioned above.	10	10	
Subjects mentioned above are not relevant to my design projects.	5	14	1
Subjects mentioned above are relevant to my design projects; however there is no time for those because of time spent for designing the product.	11	9	
The firm/company that I work with does not ask me to do so.	15	5	
I think that I do not need to consider the subjects mentioned above as I am not professional.	3	16	1
I do not have necessary knowledge/facilities to implement the subjects mentioned above.	12	8	
Others...			
Time is limited	4		
The facilities of firm/company is limited	3		
The studio critics do not mention these issues	1		
We did not learn to design with such a kind of approach	1		
Design process is defined by the educators	1		
Functionality is more important than sustainability in the research process	1		
It is because of social unawareness	1		

Table 4.2

The number of educators' ticks for each items related with the barriers to realize the issues about sustainability in industrial design process

	TRUE	FALSE	NOT SURE
Students think that project requirement does not include subjects mentioned above	8	2	1
Students think that subjects mentioned above are not relevant to their design projects.	7	4	
Subjects mentioned above are relevant to many design projects, however students think that there is no time for those because of time spent for designing the product.	5	3	3
Students are not interested in the subjects mentioned above because the firms/companies that they work with do not ask them to do so.	8	2	1
Students think that they do not need to consider the subjects mentioned above as they are not professionals.	7	3	1
Students do not have necessary knowledge/facilities to implement the subjects mentioned above.	7	4	
Others...			
There is a gap between studio courses and the other courses	1		
There is not such a level of awareness in industrial design education	1		
Most of the time, project requirement does not include subjects mentioned above	1		
The subject (sustainability) is not in the center of curriculum/does not have priority in the curriculum	3		
The level of students' awareness is not enough	1		
Constraints, objectives and directives are changing according to each project	1		
There is not enough courses containing these issues in the curriculum	1		
Students focus on presentation rather than content	1		

As seen in the Table 4.1, 15 students think that the firm/company that they worked with did not ask them to realize sustainability related issues. Only three students think that they did not need to consider the issues mentioned in the items as they were not professionals. Furthermore, they added seven more items that can be the barriers of taking sustainability into account in their graduation projects.

As seen in the Table 4.2, eight educators think that students thought project requirements did not include subject about sustainability, and students were not interested in the subjects about sustainability because the firms/companies that they worked with did not ask them to do so. Educators also added eight more items that can be the barriers of realizing sustainability in students' graduation projects.

CHAPTER 5

CONCLUSION

This chapter presents an overview of the answers to the research questions of this thesis which are acquired from the literature review study and the research studies conducted. Revisited research questions are followed by the concluding remarks. The chapter closes with the implications for research and practice.

5.1 Research Questions Revisited

The questions addressed in the literature review and field study were set out in the section 1.2, are as follows.

"Why and how 'sustainability' became such an important global concern?"

Environmentalist movement emerged with different motivations during different time periods in particular societies as mentioned in the section 2.1. Although, the history of environmentalist movements rooted to 18th century, the concept of sustainability had begun to emerge after realization the affects of the Industrial Revolution and the Second World War on society and economy as well as environment. However, it was in 1987 that the term "sustainability" was first pronounced in order to *change the world's existing condition* caused by the unsustainable pattern of industry and economy. After then, *various* international conferences concerning environment, economy and society were organized to find possible solutions for saving the Earth from its existing condition and contributing the development of nations.

"What is the role of education in sustainable development?"

When sustainable development was understood as a global goal, education became one of the key elements in the agenda of several conferences and meetings for finding solution to

achieve it. Especially the United Nations Conference on Environment and Development (UNCED), known as the Earth Summit, held in Rio de Janeiro in 1992 was a milestone, since it set its programme for reorienting education towards sustainable development, increasing public awareness and promoting training. On the other hand, many programmes in the universities began to integrate sustainability in their curricula in order to contribute changing the world's existing conditions, and to rethink professions with respect to the effects on environment, economy and society. Through education, people would have an awareness of what sustainability is and why it is important, then they would know how to take action to achieve sustainable development.

"What is the role of industrial design profession in sustainable development?"

With the realization of sustainable development as a necessity rather than a choice, industrial design profession has been challenged to redefine its own definition. In Kyoto Design Declaration (2008), design is defined as "a means of creating social, cultural, industrial and economic values by merging humanities, science, technology and the arts". The concern of industrial design is not only product but also services and scenarios which are considered with the effects on environment, economy and society.

Chapman (2005) believes that "the mess we are in today is more likely to be a result of unsustainable development in the way we design, manufacture and consume objects in the modern world" (p.3). Industrial designers have an important role on how sustainability can be achieved, because what people use, consume and dispose are the decisions of designers. Industrial designers can reduce the negative impacts of a product or service on environment, economy and society by considering sustainability related issues in the entire design process.

"How industrial design educational institutions in the world support sustainable design with their programs?"

To educate industrial designers with respect to the responsibilities for the sustainable development, many institutions have started to integrate sustainability in their curricula by

some means. While, some of them integrated sustainability in their entire curricula; some offers specific courses about sustainable design as mentioned in sections 2.5 and 2.5.1.

The results of the research study conducted among ICSID education members as a part of the literature review study of this thesis show that many (21 over 25; 84%) of them are covering sustainability as a subject of study somehow in their industrial design programs. Besides, Ramirez (2007), as a dedicated researcher in this area, evidenced by his comprehensive research study that the majority of the industrial design programs in the world have either compulsory or elective courses on sustainable design, and sustainable design activities are embedded within studio courses (Ramirez, 2007).

"What is the current state of sustainable design education in the undergraduate industrial design program at METU, what are the perceptions of its students and educators about sustainability and what are their opinions on the integration of sustainability in industrial design education?"

The Department of Industrial Design at METU, Ankara, is offering several compulsory courses covering sustainability as a subject or topic. All the students completing their undergraduate education took those courses; however, the results of the study show that 27 students among 34 agreed that there was "a" topic or project in "a" course that they took during their bachelor level (See Figure 4.8). None of the students among the 27 indicated that all the courses mentioned by educators as the courses covering sustainability as a subject. The students might not relate their sustainability understanding with the subjects about sustainability in the courses. Besides, 68 percent of students indicating that they took courses including the subject about sustainability believed that those courses did not affect their design process with respect to sustainability. The reason of this result might be so since the effect of those courses may not been efficient enough to raise the students' awareness about sustainability.

Figuring out what students and educators understand from sustainability and what they think about its relation with industrial design activity will be helpful for making suggestions on teaching sustainability. As it was mentioned in the literature review (Chapter 2), there

are several definitions of sustainability and sustainable development. Although there is a consensus among these definitions on environmental, economical and social aspects of sustainability, the priority of them depends on the understanding of sustainable development concept. The findings of the research study showed that environment is the most mentioned aspects of sustainable development according to students, followed by economy and society is the least mentioned (See Figure 4.4). Consequently, the relationship between sustainability and industrial activity is shaped in the shade of this view. Material selection is the most important criteria in a sustainable design according to the students (See Figure 4.5). None of the students built a direct link between society and sustainable design. These results are not surprising because most of the existing references in literature about sustainability and industrial design concentrate mainly on environmental issues.
On the other hand, educators' understandings about sustainable development are more related with economic aspects beside environment. However, society is also the least mentioned aspect among educators as well as the students (See Figure 4.7). Opposite to the students, a product life cycle including all the phases in product life such as pre-production, production, distribution, use and disposal is the most mentioned relationship between sustainability and industrial design according to educators (See Figure 4.6).

The educators' scores of Likert Scaled items in the context of an industrial designer's responsibility in the design process are higher than the students', except two items (See Figure 4.15). When considering the items as the issues covering a product life cycle in the sustainable product design process, the high scores of educators are not surprising. Although material selection and usage in a product design is the most mentioned issue by the students, the scores of it significantly lower than that of the educators.

Considering the possible environmental impacts during the transportation of a product receives the lowest scores among both students and educators. Correspondingly; according to the design areas mentioned before, distribution decisions during a design process have the lowest scores by both groups (See Figure 4.16). The reason of why some items related with industrial designer's responsibility have lower scores than the others might be that participants think that they are not totally competence in those issues or the decisions

about those issues are not their own initiatives. A decade ago, Margolin (1998) and Papanek (2000) had named this situation of industrial designers as “lack of empowerment”. This lack of empowerment that industrial designers face with might be destroyed by education that embrace the sustainability related issues and the knowledge of how they can be realized in the design process.

Graduation projects in the Department of Industrial Design at METU are conducted in collaboration with various design firms or manufacturing companies. The project requirements mainly set by a negotiation jointly between the firm, student and the instructors in a project report by connecting responsibilities of industrial designer with the needs and facilities of firm/company that they are working with. The project period lasts one semester.

More than half of the educators (55%) participated in the study believed that students realized less than half of the sustainability issues given in the questionnaire in their graduation projects (See Figure 4.18). On the contrary, 12 percent of students agreed that they realized less than half of the sustainability issues given in the questionnaire in their graduation projects (See Figure 4.17). Although, 41 percent of the students believed that they realized more than half and all of the issues about sustainability in their graduation project, none of the educators agreed with them. In order to prove the result of this study, the project reports of students mentioning constraints, objectives and directives of their graduation project were scrutinized (See Appendix E). The results of this effort showed that five of the students among 34 did not mention any criteria about sustainability in their project reports. Twenty-six students mentioned decision on the material of the product; however, it was not clear whether it was about reducing negative environmental impact of the product or not. The same was valid for the other constraints, objectives and directives of the students’ graduation projects. If it was assumed that all the questionable criteria were about reducing negative environmental, economical and social impact of the product, it would be still not enough to assert that students realized sustainability related issues in their graduation projects with regards to all items in the questionnaire.

In addition, most of the educators think that the project requirements do not include subjects about sustainability by considering that the project requirements are set by the students. Half of the students (50%) agree on this idea. Besides, 66 percent of the students agreed that the firm/company that they worked with did not ask them to realize sustainability related issues in their projects. Eight educators among eleven also agreed with them on this inference (See Tables 4.1 and 4.2). This might be because sustainability is not in the core agenda of firms and companies. This is would be a real barrier to implement sustainability issues in industrial design. As mentioned in the section 2.3, there are external and internal drivers for implementing sustainability in business such as governance, green marketing, legislative requirements, norms and standards and so on. These drivers in developing countries are less effective than in developed ones. As Turkey takes further steps in this development path, it will be in need of design for sustainability.

On the other hand, the students and the educators agree that students do not have necessary knowledge and facilities to implement the subjects about sustainability to their graduation projects. Although there are some attempts about sustainability in industrial design education at METU, these findings verify that they are not yet adequate to realize in students' design activity.

Time limitation is another drawback for the students. They think that there is not much time for issues about sustainability because of the time spent for designing the product. Furthermore, three students also stated that *time is limited* as an additional item. Students might have experienced a problem with time management whilst designing because, as the results show, educators believe that the given time is adequate. Another interesting point related with this situation is that the students may consider sustainability related issues apart from *designing a product*. Sustainability in industrial design might not be comprehended well by the students. As a matter of fact, some of the students indicated that the studio critics did not mention these issues and they did not learn to design with such kind of an approach. Although, there are similar opinions of educators, three of them stated directly that the sustainability neither was in the center of their teaching nor it had the priority in the whole curriculum.

In spite of all the drawbacks in integrating sustainability into the industrial design process, both groups, with an exception of one student, believe that sustainability should/can be integrated into industrial design education by some means. More than half of the educators think that sustainability can be a studio criterion for the students' design processes, whereas most of the students stated that there can be projects directly related with sustainability in the studio courses. The answers for the question of "how sustainability can be integrated into industrial design education?" illustrate that the point of view of the educators on the subject is broader than the students'. Sustainability should be an industrial design concern such as ergonomics, aesthetics, and functionality and so on. It should be taken into consideration in every project by several means. There can be courses directly related with sustainability or covering a subject or topic about sustainability but it would not be enough separately to raise the awareness level of prospective industrial designers. In the related literature, there are course suggestions directly related with the sustainability subject; however, as Peet et al. (2004) point out, adding a separate course on sustainability to a curriculum might not be sufficient enough to achieve sustainable development. Similarly, adding a separate course into the curriculum of industrial design might not be sufficient enough for industrial design students to accomplish their responsibilities for sustainable development properly.

5.2 Concluding Remarks and Suggestions on the Integration of Sustainability into Industrial Design Education

Opinions of the participants about the integration of sustainability into industrial design education give clues about the gaps in the design education. For instance, a participant suggesting a course about sustainability indicated that it can be project based, with a focus on materials and manufacturing, and it should involve theoretical knowledge, and should be in parallel with the studio courses. According to the participants, if there would be a course directly related with sustainability, it should combine theoretical knowledge with practice. This course should teach students how to realize sustainable design solutions in a product or service with strategies and support tools which was mentioned in the section

2.3.2 and 2.3.3. Correspondingly, industrial design students should know the strategies they will use, the phases of the design process that strategies can be applied, and the ways to apply those strategies.

Taking students' agreement on *their lack of necessary knowledge/facilities to implement the subjects about sustainability* into consideration, knowledge of how sustainability can be achieved by design should be taught and this knowledge should be realized in the design processes. Issuing specific projects about sustainability may affect students in such a negative way that they can think sustainability should be considered in particular projects and they may not consider it in other design processes.

On the other hand, there might be institutional principles set about sustainability to raise awareness of the business as well as of the students' and the educators'. For this end, graduation projects can be conducted in collaboration only with the firms and companies that recognize the importance of design for sustainability.

Integrating sustainability in industrial design education require staff qualified on the subject. Educators from other programs such as environmental engineering, industrial engineering, economics and so on can help to transform knowledge about sustainability until qualified staff is trained. In fact, as stated in the literature review study, sustainability education must be collaborative, experiential, and potentially transformative (Eagan, et Al., 2002, Moore, 2005). The University of British Colombia, Canada, students think that there is an added benefit of taking integrated classes with students from other departments, programs or faculties (Academic Programs Working Group, et al., 2009). The projects can be conducted with students from different departments. Therefore, students can have chance to work within an interdisciplinary working environment like in the real professional life.

To sum up, integration of sustainability in industrial design education can be achieved not only with a course directly related with sustainability but also with other components of the curriculum such as learning environment, teaching strategies.

Like other courses, the outputs of such a course should also reflect on the students' design processes especially in the studio courses. Students and educators from different departments could take part in this special sustainability course to create an interdisciplinary atmosphere as needed by thriving sustainable development.

Furthermore, extracurricular activities such as workshops, seminars, exhibitions about sustainability or sustainable design can be held in collaboration with business and other disciplines. Students might be encouraged to work with firms/companies who are interested in sustainability for their graduation projects.

Finally, sustainability, like ergonomics, production or cost or aesthetics, should be an issue in studio courses which is a part of all the phases of a design process. As a result of these, the students' perception of sustainability would be widen over environmental aspects and they would comprehend sustainability as an indispensible issue whilst designing new products.

5.3 Implications for Practice

In the main study of this thesis, it was mainly concentrated on the perception of students and educators about sustainability, formation of the educational program and the courses, ways of teaching sustainability and extracurricular activities about sustainability. To achieve sustainable development, following a sustainable design process can be seen as a must in the responsibilities of industrial designers. Other components of curriculum such as policy linkages, learning environment, motivation should also be reconsidered for a sustainable design process.

Without an expression about sustainability or sustainable development in the mission and vision statements of industrial design departments, it is hard to expect that sustainability would be integrated into the curriculum of industrial design education. Therefore, industrial design departments should periodically update their missions and visions in order to orient

their curricula according to the facts of the changing world. Governmental and institutional policies are other drivers that might influence and encourage departments to refresh themselves.

On the other hand, motivation of a student is one of the factors that affecting a sustainable design process. Beside different factors, it is also related with the learning environment. The role of educational institution is to motivate students by providing sufficient and well equipped learning environments in studios, workshops and laboratories. Extracurricular activities about sustainability would also provide an environment that encourages students to consider sustainability as an indispensible part of their design process.

Besides valuing sustainability as an issue in studio critics, it should be one of the critera in the grading and assessment. In the jury evaluation processes, effects of the products designed by the students with respect to sustainability should be questioned by several means. The results of the main study show that there are divergences among students and educators about the understanding of sustainable development and understanding of barriers of realizing sustainability in student works. Sustainability as a mean in studio critics and jury evaluations will strengthen the communication between students and educators about the issue. This might also affect the motivation of students about sustainability.

5.4 Implications for Research

As its student participants are the senior students of the Department of Industrial Design at METU in the 2008-2009 Academic Year, this study is limited with its student participants' period of four year undergraduate study and their educators in this period. The population of a further study would be extended to cover the other universities in order to look into the overall picture of sustainability teaching in industrial design education in Turkey.

One of the aims of this study was to designate the perception of students and educators about sustainability and sustainable development. For further research, specific scales –

similar to others developed for measuring technology acceptance, emotions and user preferences– may well be developed in order to measure the sustainability awareness as well as designating perception.

Teaching-and-learning-environment is an important component for the sustainable design education as mentioned in the section 5.2. In this study, the effects of educational environment on the sustainable design education were not examined. How a teaching-and-learning-environment should be in order to realize sustainability in industrial design process might be another research area in the field.

Furthermore, teaching strategies and lecture plan about design for sustainability might be studied to explore which teaching materials and methods to increase the students' awareness and understanding about sustainability in the industrial design process.

Sustainable development of the only planet that humans can live on in our solar system, should not be something that only environmentalists are interested in. Industrial designers should also be in this progress toward sustainable development and the decision makers of industrial design education should be encouraged to restructure the curricula with respect to this responsibility of industrial designers.

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APPENDIX A

BRIEF OF THE "*SOLAR POWERED PRODUCTS*" PROJECT OF ID 302 -METU ID Spring 2008

MIDDLE EAST TECHNICAL UNIVERSITY
Department of Industrial Design

Assoc. Prof. Dr. Mehmet Asatekin, Dr. Suzan Boztepe, Alper Çalgüner (PT), Aslı S Kutluay (PT), Armağan Karahanoğlu (TA), Senem Tural (TA)

ID 302 – Industrial Design IV- Spring 08 **PROJECT 3: Solar Powered Products**

Global warming is supposedly one of the most challenging problems our planet is faced today. As designers, we could ensure minimal negative environmental impact by designing ecologically friendly, green and sustainable products, and by utilizing a cradle-to-grave environmental approach in our designs. A particularly significant way to contribute to the reversal of climate change would be the reduction of users' carbon footprint through use of renewable and clean energy sources such as wind and solar power in our designs.

Design a product that relies on solar power. Your product:

- will use solar power as heat, energy, or direct light,
- may belong to any product category (lighting, appliance, urban fixture, transportation, etc.),
- will rely on developing or existing technology (i.e., no inventions),
- will encourage users to adopt environmentally friendly consumption habits,
- will be sensitive to physical, social, and cultural human factors associated with the product's use,
- will be robust in fulfilling its function,
- will be functionally and visually well suited to the proposed type(s) and the context(s) of use,
- will be accessible to users, and
- be feasible for mass production or small scale manufacturing.

Deliverables
1- Perspective Renderings & Context Renderings: required
2- Orthographic and Section Drawings: required
3- Details: required
4- Research Board: as needed
5- Storyboards: as needed

Format for Deliverables: A3

Grading
This project accounts for 30% of your final grade for the course.

Project Due: 1 April 2008, by 4 pm
Project Review: 2-4 April 2008

APPENDIX B (a)

PRELIMINARY STUDY II - QUESTIONNAIRE

Dünya çapında kabul gören "sürdürülebilir kalkınma" ihtiyacı, seri tüketim malları ile işlevsel bağlamlarının, sürekli gelişen ekonomik, sosyo-kültürel ve çevre ile ilgili değerlerle birlikte tanımlanması gerektiğine işaret eder.

Sürdürülebilir tasarım anlayışının çıkış noktası "sürdürülebilir kalkınma değerleri" doğrultusunda problemlerin ortaya çıkarılması, tanımlanması, anlaşılması ve yorumlanması ile üstün kalitede ürün ve ürün servis sistemlerinin geliştirilmesi ve tasarım imkanlarının oluşturulmasıdır. Sürdürülebilir tasarımın tarih içindeki gelişiminde 'yeşil(ci) tasarım/green design', 'eko(lojik) tasarım/eco design', 'çevreci tasarım/environmental design' gibi yaklaşımların etkisini de görebiliriz.

Ekte sunulan anket ODTÜ, Endüstri Ürünleri Tasarımı Bölümü'nde yürütülmekte olan bir yüksek lisans tez çalışması kapsamında hazırlanmıştır. Verdiğiniz cevaplar sadece akademik amaçlı çalışmalarda kullanılacaktır. Vereceğiniz bilgiler doğru ya da yanlış olarak değerlendirilmeyeceğinden, düşüncelerinize en yakın cevapları vermeniz çalışmanın başarısı açısından önemlidir. Teşekkürler.

Araş. Gör. Senem Tural
ODTÜ EÜTB

Okulunuz: …….. **Sınıfınız:** …… **Cinsiyetiniz:** ……

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1. Lütfen "endüstriyel tasarım" aktivitesinin "sürdürülebilir kalkınma"ya olası etkisini göz önüne alarak tasarım süreci ile ilgili aşağıdaki ifadeleri değerlendiriniz.
İfade sizin için çok önemliyse **5**, önemliyse **4**, fikriniz yoksa **3**, önemsizse **2**, hiç önemi yoksa **1** veriniz.

	5	4	3	2	1
Tasarlanan ürünün üretimi ya da kullanımı sırasında çevreye zararlarının değerlendirilmesi	☐	☐	☐	☐	☐
Tasarlanan ürünün yaşam döngüsünün (kavramsal tasarım başlayıp üretim, malzeme, paketleme, nakliye, kullanım ve kullanım sonrası basamaklarının değerlendirilmesi) de kurgulanması	☐	☐	☐	☐	☐
Tasarlanan üründe tüketim alışkanlıklarındaki olası senaryoların değerlendirilmesi (satın almak, kiralamak, paylaşmak, kullanıp atmak, vb...)	☐	☐	☐	☐	☐
Tasarlanan üründe kullanılan malzemelerin doğru seçimi	☐	☐	☐	☐	☐
Tasarlanan üründe kullanılan malzemelerin uygun miktarda kullanımı	☐	☐	☐	☐	☐
Tasarlanan üründe alternatif enerji kaynaklarının kullanımı	☐	☐	☐	☐	☐
Tasarlanan ürünün üretiminde ve kullanımında daha az enerji tüketilmesi	☐	☐	☐	☐	☐
Tasarım problemlerini çözmek için doğanın örnek alınması	☐	☐	☐	☐	☐
Tasarlanan ürünün pazarda başarı elde etmesi	☐	☐	☐	☐	☐
Tasarlanan ürünün uzun vadede toplumun ekonomik kalkınmasına katkı sağlaması	☐	☐	☐	☐	☐
Tasarlanan ürünün toplumun ihtiyaçlarını karşılaması	☐	☐	☐	☐	☐
Tasarlanan üründe gelecek nesillerin olası ihtiyaçlarının göz önünde bulundurulması	☐	☐	☐	☐	☐
Tasarlanan ürünün toplumun sosyo-ekonomik açıdan seviyesi düşük olan kesimine hitap ediyor olması	☐	☐	☐	☐	☐
Diğer	☐	☐	☐	☐	☐

2. Sürdürülebilirlik kavramı üzerine bilgi birikiminizi değerlendirerek aşağıdaki ifadelerden size en uygun olanını işaretleyiniz. Sürdürülebilirlik hakkında,

- ☐ çok detaylı bilgim var.
- ☐ yeterince bilgim var.
- ☐ biraz bilgim var.
- ☐ hiç bilgim yok.

3. Lisans eğitiminiz boyunca aldığınız dersleri düşünerek aşağıdaki ifadelerden size en yakın olanları işaretleyiniz. Bu konuda farklı herhangi bir görüşünüz varsa lütfen belirtiniz.

- ☐ Sürdürülebilir tasarım veya sürdürülebilirlikle ilgili bir ders aldım.
- ☐ Aldığım bir derste sürdürülebilirlik kavramı ile ilgili bir konu başlığı vardı.
- ☐ Sürdürülebilir tasarım veya sürdürülebilirlikle ilgili herhangi bir ders almadım.
- ☐ Diğer...

4. Üniversitenizde ya da üniversiteniz dışında "sürdürülebilirlik" ve "sürdürülebilir tasarım" kavramlarını konu eden herhangi bir etkinliğe katıldıysanız lütfen aşağıda işaretleyerek detaylarını yazınız.

- ☐ Çalıştay
- ☐ Seminer
- ☐ Konferans, Sempozyum vs.
- ☐ Sergi, fuar vs.
- ☐ Diğer ...

5. Lisans eğitiminiz süresince yaşadığınız ürün tasarımı süreçlerini göz önünde bulundurarak aşağıdaki ifadelerden size en uygun olanları işaretleyiniz. Başka bir değerlendirmeniz varsa boş bırakılan satırlara ekleyebilirsiniz.

- ☐ Ürün tasarımı yaparken sürdürülebilirlik kavramını her yönü ile göz önünde bulundurmaya çalışırım.
- ☐ Ürün tasarımı yaparken, sürdürülebilirlik kavramı ile ilgili kriterleri ancak proje tanımında belirtilmişse göz önüne alırım.
- ☐ Ürün tasarımı yaparken sürdürülebilirlik kavramı ile ilgili kriterleri hiç göz önünde bulundurmam.
- ☐ Diğer....

TEŞEKKÜRLER :)

APPENDIX B (b)

ENGLISH VERSION OF QUESTIONNAIRE OF THE PRELIMINARY STUDY II

The worldwide-accepted need for sustainable development implies that mass consumption goods and their functional contexts should be characterized by continuously improving environmental, economic and social-cultural values.

The starting point of sustainable design is the exploration, description, understanding and prediction of problems and opportunities to innovate and design products and product service-systems with superior quality with respect to sustainable development values. Many approaches such as 'green design', 'ecodesign' and 'environmental design' have affected the historical development of sustainable design.

This questionnaire was prepared within the thesis study conducted at the Department of Industrial Design, METU. Answers will only be used for academic purposes. Giving the closest answers to your opinion is importation for the success of the research, since your answers will not be assessed whether true or false. Thank you.

Res. Asst. Senem Tural
METU ID Graduate Student

University: ..... **Class:** ..... **Gender:** .....

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1. Please rank the given items about design process by considering the possible effects of "industrial design activity" on "sustainable development"
If the item is very important check **5**, important check **4**, neither important nor unimportant check **3**, of little importance check **2**, unimportant check **1**.

	5	4	3	2	1
Assessing the environmental impacts of the product during manufacturing or usage	☐	☐	☐	☐	☐
Considering the life cycle of the product (from conceptual design to manufacturing, material, packaging, transportation, usage, end of use etc.)	☐	☐	☐	☐	☐
Assessing the possible scenarios of consumption customs of the product (buying, renting, sharing, disposing etc.)	☐	☐	☐	☐	☐
Deciding on the materials of the product	☐	☐	☐	☐	☐
Considering the amount of materials will be used in the product	☐	☐	☐	☐	☐
Using alternative energy sources in the product	☐	☐	☐	☐	☐
Consuming less energy during the manufacturing and usage of the product	☐	☐	☐	☐	☐
Mimicking the nature to solve the design problem	☐	☐	☐	☐	☐
Success of the product in the market	☐	☐	☐	☐	☐
Contribution of the product to economical development of the society in the long term	☐	☐	☐	☐	☐
Meeting the needs of society	☐	☐	☐	☐	☐
Considering the possible needs of the future generation	☐	☐	☐	☐	☐
Addressing to lower class	☐	☐	☐	☐	☐
Other...	☐	☐	☐	☐	☐

2. Check the most suitable one below by considering your knowledge about sustainability.
About sustainability,

- ☐ I have very detailed knowledge.
- ☐ I have enough knowledge.
- ☐ I have little knowledge.
- ☐ I have no idea.

3. Check the most suitable ones below by considering the courses that you took during your bachelor of industrial design. Please specify if you have any other opinion.

- ☐ I took a course about sustainable design or sustainability.
- ☐ There was a title/subject in the course that I took.
- ☐ I did not take any course about sustainable design or sustainability.
- ☐ Other...

4. Please check and give details if you attend an activity about "sustaianbility" and "sustainable design" at the university or somewhere else.

- ☐ Workshop
- ☐ Seminar
- ☐ Conference, symposium etc.
- ☐ Exhibition, fair etc.
- ☐ Other ...

5. Check the most suitable item below by considering the design process that you experienced during your bachelor of industrial design. Please specify, if you have any other assessment.

- ☐ I try to consider sustainability with its whole aspect while designing a product.
- ☐ I only consider sustainability provided that it is mentioned in the project brief.
- ☐ I never consider sustainability while designing a product.
- ☐ Other....

THANK YOU :)

APPENDIX C (a)

QUESTIONNAIRE AND INTERVIEW SCHEDULE OF THE MAIN STUDY -STUDENTS' EDITION

Bu anket ve görüşme ODTÜ Endüstri Ürünleri Tasarımı Bölümünde yürütülmekte olan bir tez çalışması kapsamında hazırlanmıştır. Verdiğiniz cevaplar sadece akademik amaçlı çalışmalarda kullanılacak ve isminiz sonuç çalışmada herhangi bir amaçla yer almayacaktır. Vereceğiniz bilgiler doğru veya yanlış olarak değerlendirilmeyeceğinden düşüncelerinize en yakın cevapları vermeniz çalışmanın başarısı açısından önemlidir.

Vakit ayırdığınız ve çalışmaya katkıda bulunduğunuz için teşekkür ederim.

Araş. Gör. Senem Tural

ODTÜ EÜTB Yüksek Lisans Öğrencisi

"Sürdürülebilir kalkınma, günümüz ihtiyaçlarını gelecek nesillerin kendi ihtiyaçlarını karşılayabilme yeterliliğini riske atmadan karşılayan bir kalkınma şeklidir." (Brundtland, 1987).

1. Size genel anlamıyla sürdürülebilir kalkınmanın tanımını vermiştim. Peki sizce sürdürülebilir kalkınma hangi alanlarla ilgilidir?

Çevre	Toplum Çevre	Toplum	Toplum Ekonomi	Ekonomi	Çevre Ekonomi
Su	sağlık ve güvenlik (safety)	İnsan hakları	İş olanakları	Yatırım	Doğal kaynaklar(ın verimliliği)
Hava	İklim (değişimi)	Suç	İş ahlakı	Kar	Enerji (tasarrufu)
Toprak	Kanun / yönetmelik / kural / düzenleme	Eğitim	Güvenlik (security)	Maliyet	Çevre yönetimi
Biyolojik çeşitlilik	Kriz yönetimi	Yaşam standartları	İşçi-işveren ilişkileri	Tutarlı ve karlı gelişim	Yaşam döngüsü yönetimi (Life cycle management)
Atıklar Vahşi yaşam	Çevresel adalet	Kamuya açık alanlar	Yerel (local) ekonomi	Risk yönetimi	Ürün servis sistemleri
		Fırsat eşitliği	Serbest ticaret	Araştırma & geliştirme	
		Etnik çeşitlilik			
		Birliktelik (community)			

2. Sizce endüstriyel tasarım disiplini ile sürdürülebilirlik arasında nasıl bir ilişki vardır?

3. Lisans eğitiminiz boyunca aldığınız Bölüm ya da Bölüm dışı dersleri düşünerek aşağıdaki ifadelerden size en yakın olanları işaretleyiniz.

☐ Bölümümüz dersleri arasında sürdürülebilir tasarım veya sürdürülebilirlikle ilgili bir ders yoktu.

☐ Bölümümüzde sunulan dersler arasında sürdürülebilir tasarım veya sürdürülebilirlikle ilgili olanlar vardı ama almayı tercih etmedim.

☐ Lisans eğitimim boyunca sürdürülebilir tasarım veya sürdürülebilirlikle ilgili en az bir ders aldım.

Dersin adı (farklı Bölümden aldıysanız Bölüm adını belirtiniz)

☐ Lisans eğitimimde aldığım bir derste sürdürülebilirlik kavramı ile ilgili en az bir konu başlığı/proje vardı.

Dersin adı (farklı Bölümden aldıysanız Bölüm adını belirtiniz)

☐ Lisans eğitimim boyunca sürdürülebilir tasarım veya sürdürülebilirlikle ilgili en az bir etkinliğe (seminer/ konferans/çalıştay/sergi/film gösterimi vb.) katıldım.

Etkinliğin adı (hatırlıyorsanız tarihi ve kim tarafından organize edildiğini belirtiniz)

☐ Diğer...

4. Sizce sürdürülebilirlik kavramı tasarım eğitiminde nasıl işlenebilir? *Hangi düzeylerde işlenmesi uygundur?*

Yukarıda bahsettiğiniz dersi/dersleri aldıktan sonra sürdürülebilirlik kavramının tasarım sürecinizi etkilediğini söyleyebilir misiniz? Hangi yönde?

5. Aşağıdaki ifadeleri bir tasarımcının tasarım sürecindeki sorumlulukları kapsamını düşünerek -kendi bakış açınızla- değerlendiriniz. (ör: eğer çok katılıyorsanız 5'i, hiç katılmıyorsanız 1'i işaretleyiniz)

	(hiç fikrim yok çok) 1 2 3 4 5
Tasarlanan ürünün tüketimine yönelik olası senaryoların değerlendirilmesi (satın almak, kiralamak, paylaşmak, kullanıp atmak, vb.)	☐ ☐ ☐ ☐ ☐
Vandalizm, hırsızlık gibi kanunlara aykırı ya da doğru olmayan şekilde kullanım ihtimalini azaltmak için ürün veya serviste caydırıcı çözümler sunmak/tasarlanan ürün veya servisi suistimal için zor veya riskli hale getirmek	☐ ☐ ☐ ☐ ☐
Daha az enerji ve malzeme kullanımı için belirli ürün gruplarında çok fonksiyonlu çözümler sunmak	☐ ☐ ☐ ☐ ☐
Tasarlanan ürünün kullanımdan kaynaklanan olası olumsuz etkilerini analiz etmek ve bu etkileri azaltan çözümler sunmak	☐ ☐ ☐ ☐ ☐
Tasarlanan üründe kullanılacak malzemelere karar vermek	☐ ☐ ☐ ☐ ☐
Tasarlanan ürünün üretiminde kullanılacak malzemelerin miktarını dikkate almak	☐ ☐ ☐ ☐ ☐
Tasarlanan ürünün üretimi sırasında açığa çıkan atıkları dikkate almak	☐ ☐ ☐ ☐ ☐
Tasarlanan üründeki parça sayısını dikkate almak	☐ ☐ ☐ ☐ ☐
Tasarlanan ürünün ambalajının tasarımını yapmak	☐ ☐ ☐ ☐ ☐
Tasarlanan ürünün ambalajında kullanılan malzemelerin miktarını dikkate almak	☐ ☐ ☐ ☐ ☐
Tasarlanan ürünün nakliyatında oluşabilecek olası çevresel etkileri dikkate almak	☐ ☐ ☐ ☐ ☐
Tasarlanan ürününün ambalajının kullanım senaryolarını değerlendirmek (yeniden kullanılabilir, başka amaçlar için kullanılabilir, vs)	☐ ☐ ☐ ☐ ☐
Ürünün kullanımı sırasında tüketilecek enerji çeşidine karar vermek	☐ ☐ ☐ ☐ ☐
Ürünü kullanım sırasında tüketilen enerjinin miktarını azaltacak şekilde tasarlamak	☐ ☐ ☐ ☐ ☐
Ürünü kullanımı sırasında tükettiği enerjinin verimliliğini artıracak şekilde tasarlamak	☐ ☐ ☐ ☐ ☐
Ürünün kullanımı sırasında açığa çıkaracağı atıklarını dikkate almak	☐ ☐ ☐ ☐ ☐
Ürünü kullanıcı davranışlarını öngörülen doğrultuda yönlendirecek biçimde tasarlamak	☐ ☐ ☐ ☐ ☐
Ürünün erken elden çıkmasını önlemek için ürün ömrünü uzatan stratejiler kullanmak	☐ ☐ ☐ ☐ ☐

Bakımı ve tamiri kolay ürünler tasarlamak	☐ ☐ ☐ ☐ ☐
Zaman içindeki gelişmeler doğrultusunda yerine yeni bir ürün almak yerine performansı iyileştirilebilir/yükseltilebilir ürünler tasarlamak	☐ ☐ ☐ ☐ ☐
Tasarlanan ürünün ömrünün ne kadar olması gerektiğini dikkate almak	☐ ☐ ☐ ☐ ☐
Ürünün kullanım ömrü bitiminden sonrasını planlamak (nasıl atılacağı ya da toplanacağı, nerede depolanacağı, vs.)	☐ ☐ ☐ ☐ ☐
Kullanım ömrü bitiminden sonra ürünle ilgili yeniden kullanım senaryolarını veya geri dönüşüm süreçlerini kurgulamak (parçaların demontajı, temizlenmesi, vs)	☐ ☐ ☐ ☐ ☐

6. Yukarıda endüstriyel tasarımcının sorumluluğu kapsamında (3, 4, 5) olarak değerlendirdiğiniz ifadelere karşılık gelen eylemlerin ne kadarını mezuniyet projenizi gerçekleştirirken yerine getirdiğinizi düşünüyorsunuz?

hepsi	yarıdan çok	yarı yarıya	yarıdan az	hemen hemen hiç
% 100-75	%75-50	%50	%50-%25	%25-%0
☐	☐	☐	☐	☐

Yukarıdaki cevabınız %50 ve altı ise -nedenlerini düşünerek- aşağıdaki ifadeleri kendi açınızdan değerlendirir misiniz?

	DOĞRU	YANLIŞ
Proje tanımındaki "yapılması gerekenler" listesi yukarıda sözü edilenleri kapsamıyor.	☐	☐
Tasarladığım ürün için yukarıda sözü edilen konular geçerli değil.	☐	☐
Tasarladığım ürün için yukarıda sözü edilen konular geçerli ama ürünü tasarlamaktan bunlara fırsat kalmıyor.	☐	☐
Birlikte çalıştığım firma benden bunları beklemiyor.	☐	☐
Ben henüz öğrenciyim, bunları yapmama gerek olduğunu düşünmüyorum.	☐	☐
Bunları gerçekleştirmek için gerekli bilgiye/donanıma sahip değilim.	☐	☐
Diğer;		

APPENDIX C (b)

QUESTIONNAIRE AND INTERVIEW SCHEDULE OF THE MAIN STUDY -STUDENTS' EDITION (ENGLISH VERSION)

This questionnaire/interview was prepared within the thesis study conducted at the Department of Industrial Design, METU. Answers will only be used for academic purposes and your name will not be mentioned for any purpose in the final study. Your answers will not be assessed whether true or false. Thank you for your time and consideration.

Res. Asst. Senem Tural

METU ID Graduate Student

"Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs." (Brundtland, 1987).

1. By considering the general definition given at the beginning of this questionnaire, would you please signify the areas related to the sustainable development?

Environmental	Social environmental	Social	Social economical	Economical	Eco economical
Water	safety	Human rights	Occupation/labor	investment	Natural resources
Air	climate	crime	business ethics	profit	energy
Soil	Government / regulations	education	security	cost	Environmental management
Biological diversity	Crisis	Living standards	Employee-employer	Coherent, profitable development	Life cycle management
waste	Environmental justice	Public places	Local economy	Risk management	Product service systems
Wild life		equality of opportunity	free trade	Research and development	
		Ethnical diversity			
		community			

2. Would you please explain the kind and nature of relationship between industrial design activity and sustainability?

3. Please check the most suitable ones when you think about the courses that you took in ID bachelor level.

☐ There is not any course about sustainable design or sustainability in bachelor level in ID at METU.

☐ There are courses about sustainable design or sustainability; however, I did not prefer to take.

☐ I took at least one course about sustainable design or sustainability.

Name of the course

☐ There was a title/subject or project about sustainability in the course that I took.

Title of the Project/Content (class and academic year if you remember)

☐ In the last four years, I participated in at least one event about sustainability or sustainable design. (seminar/conference/workshop/exhibition/film etc.).

Name of the event (the date and organization if you remember) please specify.

☐ Other...

4. In your opinion, how can sustainability be integrated into industrial design education? In which level..?

Did sustainability affect your design process after taking the courses or participating in activities that you indicated?

5. Please assess the items below in the context of an industrial designer's responsibility in design process. (e.g. if you strongly disapprove the item check 1, if you strongly approve the item check 5)

	1	2	3	4	5
Considering the products/services' possible consumption scenarios (purchasing, renting, sharing, using and disposing, etc.)	☐	☐	☐	☐	☐
Designing the product with the aim of reducing the opportunity for crime or misuse by making it difficult or risky	☐	☐	☐	☐	☐
Offering multi-functional solutions for particular product groups with the aim of consuming less energy and material	☐	☐	☐	☐	☐
Analyzing the possible negative impacts of the product during its usage and offering design solutions aiming to reduce them.	☐	☐	☐	☐	☐
Deciding on the materials of the product	☐	☐	☐	☐	☐
Considering the amount of materials will be used in the manufacturing process of the product	☐	☐	☐	☐	☐
Considering the waste will be produced during the manufacturing process of the product	☐	☐	☐	☐	☐
Considering the number of parts of the product	☐	☐	☐	☐	☐
Designing the package of the product	☐	☐	☐	☐	☐
Taking the amount of materials will be used in the package of the product into consideration.	☐	☐	☐	☐	☐
Considering the possible environmental impacts during the transportation of the product	☐	☐	☐	☐	☐
Assessing the usage scenarios of the product package (re-use, re-use for another purpose, etc.)	☐	☐	☐	☐	☐
Deciding the type of energy consumed during the usage of the product	☐	☐	☐	☐	☐
Designing the product with the aim of decreasing the amount of energy consumed during its usage	☐	☐	☐	☐	☐
Designing the product with the aim of increasing the efficiency of consumed energy during its usage	☐	☐	☐	☐	☐
Considering the waste produced during the usage of the product	☐	☐	☐	☐	☐
Designing the product with the aim of directing the consumers' behaviors in the way that anticipated	☐	☐	☐	☐	☐

Developing/using product-life extending strategies to avoid premature disposal.	☐ ☐ ☐ ☐ ☐
Designing the products which are easy to repair and maintenance.	☐ ☐ ☐ ☐ ☐
Designing the product with the aim of enabling it to be easily upgraded instead of replacing it with a new one	☐ ☐ ☐ ☐ ☐
Considering how long the life of a product should be	☐ ☐ ☐ ☐ ☐
Planning for the phase after the end of usage of the product (how does it throw out or is it collected, where is it stored? etc.)	☐ ☐ ☐ ☐ ☐
Designing processes of re-use or re-cycling scenarios of the product at the end of its life	☐ ☐ ☐ ☐ ☐

6. By considering the items you assessed above, what do you think about how much of them you realized in your graduation projects?

All	More than half	Half	Less than half	Almost none
100%-75%	75%-50%	50%	50%-25%	25%-0%
☐	☐	☐	☐	☐

If your answer is 50% or below –by thinking of the reasons – could you check the items below even if they are true or not with respect to your opinion?

	TRUE	FALSE
Project requirement does not include subjects mentioned above.	☐	☐
Subjects mentioned above are not relevant to my design projects.	☐	☐
Subjects mentioned above are relevant to my design projects; however there is no time for those because of time spent for designing the product.	☐	☐
The firm/company that I work with does not ask me to do so.	☐	☐
I think that I do not need to consider the subjects mentioned above as I am not professional.	☐	☐
I do not have necessary knowledge/facilities to implement the subjects mentioned above.	☐	☐
Other;		

APPENDIX D (a)

QUESTIONNAIRE AND INTERVIEW SCHEDULE OF THE MAIN STUDY -EDUCATORS' EDITION

Bu anket ve görüşme ODTÜ Endüstri Ürünleri Tasarımı Bölümünde yürütülmekte olan bir tez çalışması kapsamında hazırlanmıştır. Verdiğiniz cevaplar sadece akademik amaçlı çalışmalarda kullanılacak ve isminiz sonuç çalışmada herhangi bir amaçla yer almayacaktır. Vereceğiniz bilgiler doğru veya yalnış olarak değerlendirilmeyeceğinden düşüncelerinize en yakın cevapları vermeniz çalışmanın başarısı açısından önemlidir.

Vakit ayırdığınız ve çalışmaya katkıda bulunduğunuz için teşekkür ederim.

Araş. Gör. Senem Tural

ODTÜ EÜTB Yüksek Lisans Öğrencisi

"Sürdürülebilir kalkınma, günümüz ihtiyaçlarını gelecek nesillerin kendi ihtiyaçlarını karşılayabilme yeterliliğini riske atmadan karşılayan bir kalkınma şeklidir." (Brundtland, 1987).

1. Size genel anlamıyla sürdürülebilir kalkınmanın tanımını vermiştim. Peki sizce sürdürülebilir kalkınma hangi alanlarla ilgilidir?

Çevre	Toplum Çevre	Toplum	Toplum Ekonomi	Ekonomi	Çevre Ekonomi
Su	sağlık ve güvenlik (safety)	İnsan hakları	İş olanakları	Yatırım	Doğal kaynaklar(ın verimliliği)
Hava	İklim (değişimi)	Suç	İş ahlakı	Kar	Enerji (tasarrufu)
Toprak	Kanun / yönetmelik / kural / düzenleme	Eğitim	Güvenlik (security)	Maliyet	Çevre yönetimi
Biyolojik çeşitlilik	Kriz yönetimi	Yaşam standartları	İşçi-işveren ilişkileri	Tutarlı ve karlı gelişim	Yaşam döngüsü yönetimi (Life cycle management)
Atıklar Vahşi yaşam	Çevresel adalet	Kamuya açık alanlar	Yerel (local) ekonomi	Risk yönetimi	Ürün servis sistemleri
		Fırsat eşitliği	Serbest ticaret	Araştırma & geliştirme	
		Etnik çeşitlilik			
		Birliktelik (community)			

2. Sizce endüstriyel tasarım disiplini ile sürdürülebilirlik arasında nasıl bir ilişki vardır?

3. EÜTB lisans eğitiminde verdiğiniz dersleri düşünerek aşağıdaki ifadelerden size en yakın olanları işaretleyiniz.

☐ Sürdürülebilir tasarım veya sürdürülebilirlik uzmanlık alanım dışında olduğu için bu konu ile ilgili herhangi bir ders vermedim.

☐ Sürdürülebilir tasarım veya sürdürülebilirlikle ilgili ders verdim.

Dersin adı

☐ Verdiğim bir derste sürdürülebilirlik kavramı ile ilgili bir konu başlığı vardı.

Dersin adı

☐ Verdiğim bir stüdyo dersinde sürdürülebilir tasarım ile ilgili bir proje verildi.

Projenin Başlığı/İçeriği (verildiği sınıf ve hangi akademik yıl ve dönemini hatırlıyorsanız belirtiniz)

☐ Geçtiğimiz dört yıl içinde sürdürülebilir tasarım veya sürdürülebilirlikle ilgili en az bir etkinliğe (seminer/ konferans/çalıştay/sergi/film gösterimi vs.) katıldım.

Etkinliğin adı (hatırlıyorsanız tarihi ve kim tarafından organize edildiği), lütfen belirtiniz.

☐ Diğer...

4. Sizce sürdürülebilirlik kavramı tasarım eğitiminde nasıl işlenebilir? *Hangi düzeylerde işlenmesi uygundur?*

5. Aşağıdaki ifadeleri bir tasarımcının tasarım sürecindeki sorumlulukları kapsamını düşünerek -kendi bakış açınızla- değerlendiriniz. (ör: eğer çok katılıyorsanız 5'i, hiç katılmıyorsanız 1'i işaretleyiniz)

	(hiç fikrim yok çok) 1	2	3	4	5
Tasarlanan ürünün tüketimine yönelik olası senaryoların değerlendirilmesi (satın almak, kiralamak, paylaşmak, kullanıp atmak, vb.)	☐	☐	☐	☐	☐
Vandalizm, hırsızlık gibi kanunlara aykırı ya da doğru olmayan şekilde kullanım ihtimalini azaltmak için ürün veya serviste caydırıcı çözümler sunmak/tasarlanan ürün veya servisi suistimal için zor veya riskli hale getirmek	☐	☐	☐	☐	☐
Daha az enerji ve malzeme kullanımı için belirli ürün gruplarında çok fonksiyonlu çözümler sunmak.	☐	☐	☐	☐	☐
Tasarlanan ürünün kullanımdan kaynaklanan olası olumsuz etkilerini analiz etmek ve bu etkileri azaltan çözümler sunmak	☐	☐	☐	☐	☐
Tasarlanan üründe kullanılacak malzemelere karar vermek	☐	☐	☐	☐	☐
Tasarlanan ürünün üretiminde kullanılacak malzemelerin miktarını dikkate almak	☐	☐	☐	☐	☐
Tasarlanan ürünün üretimi sırasında açığa çıkan atıkları dikkate almak	☐	☐	☐	☐	☐
Tasarlanan üründeki parça sayısını dikkate almak	☐	☐	☐	☐	☐
Tasarlanan ürünün ambalajının tasarımını yapmak	☐	☐	☐	☐	☐
Tasarlanan ürünün ambalajında kullanılan malzemelerin miktarını dikkate almak	☐	☐	☐	☐	☐
Tasarlanan ürünün nakliyatında oluşabilecek olası çevresel etkileri dikkate almak	☐	☐	☐	☐	☐
Tasarlanan ürününün ambalajının kullanım senaryolarını değerlendirmek (yeniden kullanılabilir, başka amaçlar için kullanılabilir, vs)	☐	☐	☐	☐	☐
Ürünün kullanımı sırasında tüketilecek enerji çeşidine karar vermek	☐	☐	☐	☐	☐
Ürünü kullanım sırasında tüketilen enerjinin miktarını azaltacak şekilde tasarlamak	☐	☐	☐	☐	☐
Ürünü kullanımı sırasında tükettiği enerjinin verimliliğini artıracak şekilde tasarlamak	☐	☐	☐	☐	☐
Ürünün kullanımı sırasında açığa çıkaracağı atıklarını dikkate almak	☐	☐	☐	☐	☐
Ürünü kullanıcı davranışlarını öngörülen doğrultuda yönlendirecek biçimde tasarlamak	☐	☐	☐	☐	☐

Ürünün erken elden çıkmasını önlemek için ürün ömrünü uzatan stratejiler kullanmak	☐	☐	☐	☐	☐
Bakımı ve tamiri kolay ürünler tasarlamak	☐	☐	☐	☐	☐
Zaman içindeki gelişmeler doğrultusunda yerine yeni bir ürün almak yerine performansı iyileştirilebilir/yükseltilebilir ürünler tasarlamak	☐	☐	☐	☐	☐
Tasarlanan ürünün ömrünün ne kadar olması gerektiğini dikkate almak	☐	☐	☐	☐	☐
Ürünün kullanım ömrü bitiminden sonrasını planlamak (nasıl atılacağı ya da toplanacağı, nerede depolanacağı, vs.)	☐	☐	☐	☐	☐
Kullanım ömrü bitiminden sonra ürünle ilgili yeniden kullanım senaryolarını veya geri dönüşüm süreçlerini kurgulamak (parçaların demontajı, temizlenmesi, vs)	☐	☐	☐	☐	☐

6. Yukarıda endüstriyel tasarımcının sorumluluğu kapsamında (3, 4, 5) olarak değerlendirdiğiniz ifadelere karşılık gelen eylemlerin ne kadarını ögrencilerin mezuniyet projelerini gerçekleştirirken yerine getirdiklerini düşünüyorsunuz?

hepsi	yarıdan çok	yarı yarıya	yarıdan az	hemen hemen hiç
% 100-75	%75-50	%50	%50-%25	%25-%0
☐	☐	☐	☐	☐

Yukarıdaki cevabınız %50 ve altı ise -nedenlerini düşünerek- aşağıdaki ifadelerin sizin açınızdan doğru ya da yanlış olup olmadıklarını belirtir misiniz?

	DOĞRU	YANLIŞ
Proje tanımındaki "yapılması gerekenler" listesinin yukarıda sözü edilenleri kapsamadığını düşünüyorlar.	☐	☐
Öğrenci tasarladığı ürün için yukarıda sözü edilen konuların geçerli olmadığını düşünüyor.	☐	☐
Tasarlanan çoğu ürün için yukarıda sözü edilen konular geçerli ama öğrenciler ürünü tasarlamaktan bunlara fırsat kalmadığını düşünüyorlar.	☐	☐
Birlikte çalıştıkları firmanın öğrencilerden böyle talepleri olmadığı için bu konularla ilgilenmiyorlar.	☐	☐
Henüz öğrenci oldukları için bunları yapmaya gerek olmadığını düşünüyorlar.	☐	☐
Öğrenciler, bunları gerçekleştirmek için gerekli bilgiye/donanıma sahip değiller.	☐	☐
Diğer;		

APPENDIX D (b)

QUESTIONNAIRE AND INTERVIEW SCHEDULE OF THE MAIN STUDY - EDUCATORS' EDITION (ENGLISH VERSION)

This questionnaire/interview was prepared within the thesis study conducted at the Department of Industrial Design, METU. Answers will only be used for academic purposes and your name will not be mentioned for any purpose in the final study. Your answers will not be assessed whether true or false. Thank you for your time and consideration.

Res. Asst. Senem Tural

METU ID Graduate Student

"Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs." (Brundtland, 1987).

1. By considering the general definition given at the beginning of this questionnaire, would you please signify the areas related to the sustainable development?

Environmental	Social environmental	Social	Social economical	Economical	Eco economical
Water	safety	Human rights	Occupation/labor	investment	Natural resources
Air	climate	crime	business ethics	profit	energy
Soil	Government / regulations	education	security	cost	Environmental management
Biological diversity	Crisis	Living standards	Employee-employer	Coherent, profitable development	Life cycle management
waste	Environmental justice	Public places	Local economy	Risk management	Product service systems
Wild life		equality of opportunity	free trade	Research and development	
		Ethnical diversity			
		community			

2. Would you please explain the kind and nature of relationship between industrial design activity and sustainability?

3. Please check the most suitable ones when you think about the courses that you teach in ID bachelor level.

☐ I did not teach any course about sustainability or sustainable design because they are not covered by my area of specialization.

☐ I teach course(s) about sustainability or sustainable design.

Name of the course

☐ There was a title/subject in the course that I teach.

Name of the course

☐ There was a project about sustainable design in the studio course that I teach.

Title of the Project/Content (class and academic year if you remember)

☐ In the last four years, I participated in at least one event about sustainability or sustainable design (seminar/conference/workshop/exhibition/film etc.).

Name of the event (the date and organization if you remember) please specify.

☐ Other...

4. *In your opinion, how can sustainability be integrated into industrial design education? In which level..?*

5. Please assess the items below in the context of an industrial designer's responsibility in design process. (e.g. if you strongly disapprove the item check 1, if you strongly approve the item check 5)

	1	2	3	4	5
Considering the products/services' possible consumption scenarios (purchasing, renting, sharing, using and disposing, etc.)	☐	☐	☐	☐	☐
Designing the product with the aim of reducing the opportunity for crime or misuse by making it difficult or risky	☐	☐	☐	☐	☐
Offering multi-functional solutions for particular product groups with the aim of consuming less energy and material	☐	☐	☐	☐	☐
Analyzing the possible negative impacts of the product during its usage and offering design solutions aiming to reduce them.	☐	☐	☐	☐	☐
Deciding on the materials of the product	☐	☐	☐	☐	☐
Considering the amount of materials will be used in the manufacturing process of the product	☐	☐	☐	☐	☐
Considering the waste will be produced during the manufacturing process of the product	☐	☐	☐	☐	☐
Considering the number of parts of the product	☐	☐	☐	☐	☐
Designing the package of the product	☐	☐	☐	☐	☐
Taking the amount of materials will be used in the package of the product into consideration.	☐	☐	☐	☐	☐
Considering the possible environmental impacts during the transportation of the product	☐	☐	☐	☐	☐
Assessing the usage scenarios of the product package (re-use, re-use for another purpose, etc.)	☐	☐	☐	☐	☐
Deciding the type of energy consumed during the usage of the product	☐	☐	☐	☐	☐
Designing the product with the aim of decreasing the amount of energy consumed during its usage	☐	☐	☐	☐	☐
Designing the product with the aim of increasing the efficiency of consumed energy during its usage	☐	☐	☐	☐	☐
Considering the waste produced during the usage of the product	☐	☐	☐	☐	☐
Designing the product with the aim of directing the consumers' behaviors in the way that anticipated	☐	☐	☐	☐	☐

Developing/using product-life extending strategies to avoid premature disposal.	☐ ☐ ☐ ☐ ☐
Designing the products which are easy to repair and maintenance.	☐ ☐ ☐ ☐ ☐
Designing the product with the aim of enabling it to be easily upgraded instead of replacing it with a new one	☐ ☐ ☐ ☐ ☐
Considering how long the life of a product should be	☐ ☐ ☐ ☐ ☐
Planning for the phase after the end of usage of the product (how does it throw out or is it collected, where is it stored? etc.)	☐ ☐ ☐ ☐ ☐
Designing processes of re-use or re-cycling scenarios of the product at the end of its life	☐ ☐ ☐ ☐ ☐

6. By considering the items you assessed above, what do you think about how much of them are realized by students in their graduation projects?

All	More than half	Half	Less than half	Almost none
100%-75%	75%-50%	50%	50%-25%	25%-0%
☐	☐	☐	☐	☐

If your answer is 50% or below –by thinking of the reasons – could you check the items below even if they are true or not with respect to your opinion?

	TRUE	FALSE
Students think that project requirement does not include subjects mentioned above.	☐	☐
Students think that subjects mentioned above are not relevant to their design projects.	☐	☐
Subjects mentioned above are relevant to many design projects, however students think that there is no time for those because of time spent for designing the product.	☐	☐
Students are not interested in the subjects mentioned above because the firms/companies that they work with do not ask them to do so.	☐	☐
Students think that they do not need to consider the subjects mentioned above as they are not professionals.	☐	☐
Students do not have necessary knowledge/facilities to implement the subjects mentioned above.	☐	☐
Other;		

APPENDIX E

ANALYSIS OF STUDENTS' REPORTS ON THEIR GRADUATION PROJECTS

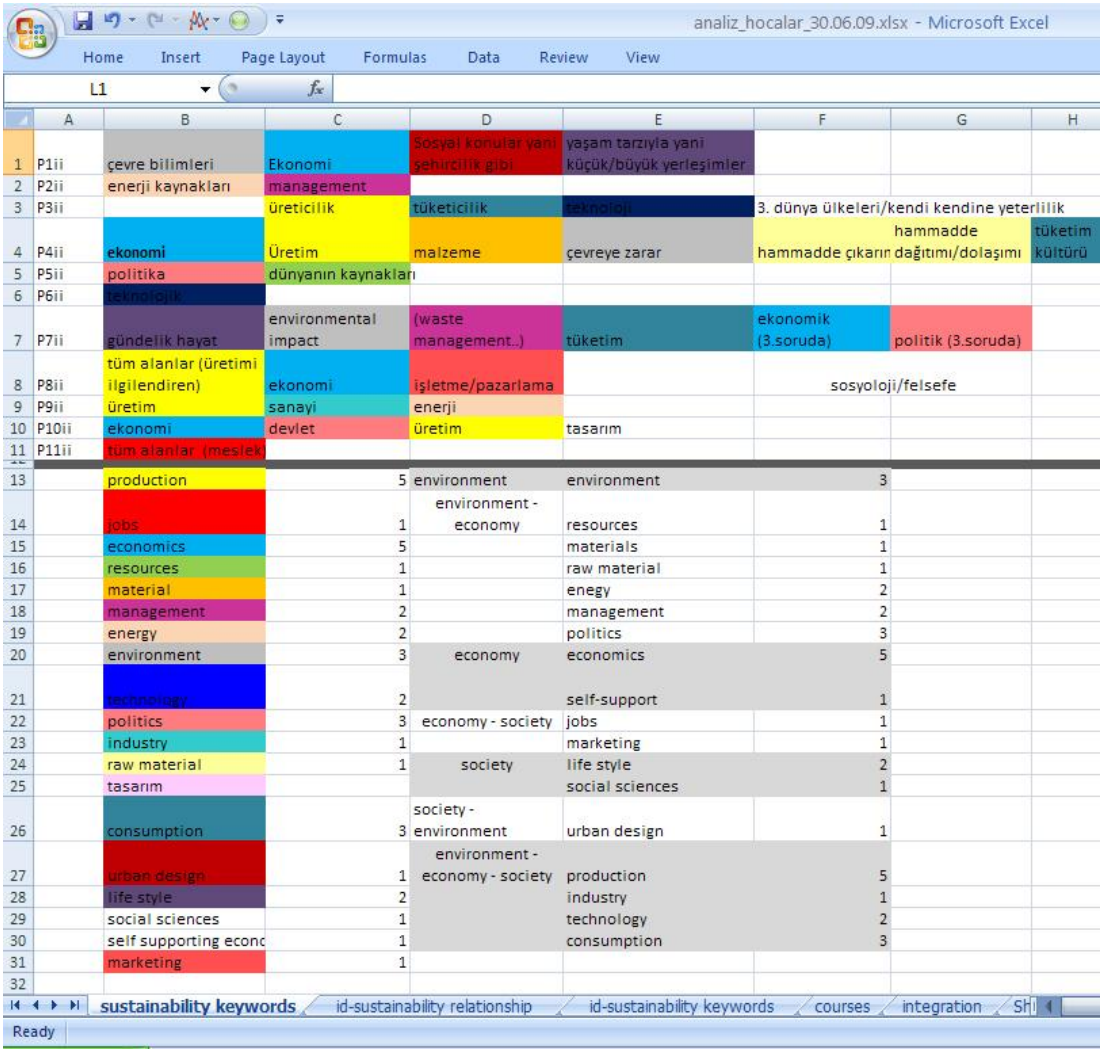
Table E.1

Constraints, objectives or directives mentioning sustainability related subjects in students' graduation projects (Frequencies)

		Total number	constraints	objectives	directives
New ways of doing it	*item 1*	0	0	0	0
	item 2	3	2	1	0
	item 3	10	2	7	1
	item 4	5	1	2	2
Material selection / usage	*item 5*	26	15	4	7
	item 6	2	0	0	2
	item 7	1	0	1	0
	item 8	1	0	1	0
Distribution	*item 9*	3	2	1	0
	item 10	1	1	0	0
	item 11	4	2	1	1
	item 12	2	1	0	1
Product use	*item 13*	4	2	1	1
	item 14	3	0	2	1
	item 15	0	0	0	0
	item 16	0	0	0	0
	item 17	2	1	1	0
Optimal life	*item 18*	8	7	0	1
	item 19	5	2	1	2
	item 20	3	0	2	1
	item 21	1	0	0	1
End of life	*item 22*	0	0	0	0
	item 23	0	0	0	0

APPENDIX F

EXAMPLE OF A DATA ANALYSIS DOCUMENT



analiz_hocalar_30.06.09.xlsx - Microsoft Excel

Home | Insert | Page Layout | Formulas | Data | Review | View

L1

	A	B	C	D	E	F	G	H
1	P1ii	çevre bilimleri	Ekonomi	Sosyal konular yani şehircilik gibi	yaşam tarzıyla yani küçük/büyük yerleşimler			
2	P2ii	enerji kaynakları	management					
3	P3ii		üreticilik	tüketicilik	teknoloji	3. dünya ülkeleri/kendi kendine yeterlilik		
4	P4ii	ekonomi	Üretim	malzeme	çevreye zarar	hammadde çıkarın	hammadde dağıtımı/dolaşımı	tüketim kültürü
5	P5ii	politika	dünyanın kaynakları					
6	P6ii	teknolojik						
7	P7ii	gündelik hayat	environmental impact	(waste management..)	tüketim	ekonomik (3.soruda)	politik (3.soruda)	
8	P8ii	tüm alanlar (üretimi ilgilendiren)	ekonomi	işletme/pazarlama		sosyoloji/felsefe		
9	P9ii	üretim	sanayi	enerji				
10	P10ii	ekonomi	devlet	üretim	tasarım			
11	P11ii	tüm alanlar (meslek)						
13		production	5	environment	environment	3		
14		jobs	1	environment - economy	resources	1		
15		economics	5		materials	1		
16		resources	1		raw material	1		
17		material	1		enegy	2		
18		management	2		management	2		
19		energy	2		politics	3		
20		environment	3	economy	economics	5		
21		technology	2		self-support	1		
22		politics	3	economy - society	jobs	1		
23		industry	1		marketing	1		
24		raw material	1	society	life style	2		
25		tasarım			social sciences	1		
26		consumption	3	society - environment	urban design	1		
27		urban design	1	environment - economy - society	production	5		
28		life style	2		industry	1		
29		social sciences	1		technology	2		
30		self supporting econc	1		consumption	3		
31		marketing	1					
32								

sustainability keywords | id-sustainability relationship | id-sustainability keywords | courses | integration | SH

Ready

Figure F.1 Excel sheet of data analysis of the educators' responses to Question 1

APPENDIX G

CATEGORIZATION OF THE KEYWORDS MENTIONED BY PARTICIPANTS

Table G.1

Keywords mentioned by the participants about sustainability related areas according to the sustainability aspects

	Keywords of students	**Keywords of educators**
environment	environment	environment
	re-use	
	biology	
	water	
	transportation	
environment - economy	resources	resources
	materials	materials
	raw material	raw material
	enegy	enegy
	re-cycle	management
	management	politics
	agriculture	
	politics	
	product service systems	
economy	economics	economics
		self-support
economy - society	jobs	jobs
	labor	marketing
society	community	life style
	education	social sciences
	communication	
	life style	
	morality	
society - environment	architecture	urban design
	urban design	
environment - economy - society	production	production
	industry	industry
	technology	technology
	consumption	consumption

APPENDIX H

ANALYSIS OF INDEPENDENT SAMPLE T-TESTS

Table H.1

Independent sample T-test results of items

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Item 1	Equal variances assumed	2,020	,162	,058	43	,954	,016	,276	-,540	,572
	Equal variances not assumed			,042	11,705	,967	,016	,381	-,816	,848
Item 2	Equal variances assumed	,451	,505	-2,030	43	,049*	-,626	,308	-1,247	-,004
	Equal variances not assumed			-2,199	19,594	,040	-,626	,285	-1,220	-,031
Item 3	Equal variances assumed	,000	,994	,376	43	,709	,152	,405	-,664	,969
	Equal variances not assumed			,397	18,598	,696	,152	,384	-,653	,958
Item 4	Equal variances assumed	3,959	,053	-1,139	43	,261	-,286	,251	-,793	,221
	Equal variances not assumed			-1,468	29,266	,153	-,286	,195	-,685	,112
Item 5	Equal variances assumed	2,970	,092	-1,569	43	,124	-,433	,276	-,990	,124
	Equal variances not assumed			-1,790	21,803	,087	-,433	,242	-,935	,069
Item 6	Equal variances assumed	1,582	,215	-1,669	43	,102	-,567	,340	-1,252	,118
	Equal variances not assumed			-1,917	22,138	,068	-,567	,296	-1,180	,046
Item 7	Equal variances assumed	,285	,596	-,987	43	,329	-,388	,393	-1,180	,405
	Equal variances not assumed			-1,083	20,109	,292	-,388	,358	-1,134	,359
Item 8	Equal variances assumed	1,515	,225	-2,516	43	,016*	-,893	,355	-1,609	-,177
	Equal variances not assumed			-2,916	22,573	,008	-,893	,306	-1,527	-,259
Item 9	Equal variances assumed	1,220	,276	-,675	43	,503	-,254	,376	-1,013	,505
	Equal variances not assumed			-,749	20,523	,463	-,254	,339	-,961	,453
Item 10	Equal variances assumed	,237	,629	-1,629	43	,111	-,583	,358	-1,304	,139
	Equal variances not assumed			-1,579	16,170	,134	-,583	,369	-1,365	,199
Item 11	Equal variances assumed	1,217	,276	-,538	43	,593	-,249	,462	-1,180	,683

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
	Equal variances not assumed			-,493	14,913	,629	-,249	,504	-1,324	,827
Item 12	Equal variances assumed	,214	,646	-1,098	43	,278	-,385	,351	-1,092	,322
	Equal variances not assumed			-1,149	18,376	,265	-,385	,335	-1,088	,318
Item 13	Equal variances assumed	,230	,634	-,937	43	,354	-,356	,380	-1,121	,410
	Equal variances not assumed			-,913	16,301	,375	-,356	,390	-1,180	,469
Item 14	Equal variances assumed	,022	,883	-,992	43	,327	-,302	,305	-,916	,312
	Equal variances not assumed			-1,067	19,313	,299	-,302	,283	-,894	,290
Item 15	Equal variances assumed	,036	,851	-,852	43	,399	-,243	,286	-,819	,333
	Equal variances not assumed			-,879	17,893	,391	-,243	,277	-,825	,339
Item 16	Equal variances assumed	,007	,933	-,672	43	,505	-,209	,310	-,835	,417
	Equal variances not assumed			-,706	18,484	,489	-,209	,296	-,828	,411
Item 17	Equal variances assumed	,471	,496	,324	43	,748	,104	,322	-,546	,754
	Equal variances not assumed			,300	15,137	,768	,104	,348	-,637	,845
Item 18	Equal variances assumed	,023	,881	-,776	43	,442	-,273	,352	-,982	,436
	Equal variances not assumed			-,836	19,395	,413	-,273	,326	-,955	,409
Item 19	Equal variances assumed	,113	,739	-1,890	43	,065	-,543	,287	-1,122	,036
	Equal variances not assumed			-2,129	21,201	,045	-,543	,255	-1,073	-,013
Item 20	Equal variances assumed	1,188	,282	-1,202	43	,236	-,390	,325	-1,045	,265
	Equal variances not assumed			-1,498	26,869	,146	-,390	,261	-,925	,144
Item 21	Equal variances assumed	1,312	,258	-2,048	43	**,047***	-,578	,282	-1,146	-,009
	Equal variances not assumed			-2,687	30,646	,012	-,578	,215	-1,016	-,139
Item 22	Equal variances assumed	1,784	,189	-1,125	43	,267	-,447	,397	-1,247	,354
	Equal variances not assumed			-1,330	23,594	,196	-,447	,336	-1,140	,247
Item 23	Equal variances assumed	1,860	,180	-,567	43	,574	-,203	,359	-,926	,520
	Equal variances not assumed			-,650	22,099	,522	-,203	,312	-,851	,445

*$p < .05$

Table H. 2

Independent sample T-test results of design areas

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
new ways of doing it	Equal variances assumed	,048	,827	-1,119	178	,265	-,186	,166	-,514	,142
	Equal variances not assumed			-1,118	72,760	,267	-,186	,166	-,517	,145
material	Equal variances assumed	2,613	,108	-3,244	178	**,001***	-,570	,176	-,917	-,223
	Equal variances not assumed			-3,724	95,108	,000	-,570	,153	-,874	-,266
distribution	Equal variances assumed	,015	,902	-1,888	178	,061	-,368	,195	-,752	,017
	Equal variances not assumed			-1,888	72,857	,063	-,368	,195	-,756	,021
product use	Equal variances assumed	,199	,656	-1,370	223	,172	-,201	,147	-,490	,088
	Equal variances not assumed			-1,414	96,701	,160	-,201	,142	-,483	,081
optimal life	Equal variances assumed	1,009	,317	-2,884	178	**,004***	-,446	,155	-,751	-,141
	Equal variances not assumed			-3,372	99,052	,001	-,446	,132	-,708	-,183
end of life	Equal variances assumed	3,851	,053	-1,226	88	,223	-,325	,265	-,851	,202
	Equal variances not assumed			-1,430	48,072	,159	-,325	,227	-,782	,132

*$p < .05$