TITLE:

E-learning in the Science of Electricity in Higher Education in Turkey in terms of Environment and Energy

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ABSTRACT

The number of studies aimed to find out how to implement e-learning in Higher Education Institutions (HEI) is ever increasing due largely to the potential advantages of e-learning in education and training all around the world. While the Internet is filled with academic publications that mention the benefits of e-learning such as developing information skills/literacy, widening access, improving quality of teaching and learning, increasing flexibility, and reducing cost/improving cost-effectiveness, the number of studies focussing on the benefits of e-learning in terms of environment and energy is relatively few. This research study investigates the potential benefits of e-learning in the institutions providing education and training in the discipline of electricity in Turkey by considering several dimensions such as carbon footprint, recycling, traffic congestion, residential issues and energy. The number of institutions offering teaching and training in the science of electricity across Turkey is 417. At least 1496 teachers are currently working in these institutions. The Higher Education Council (HEC) in Turkey announced that the quotas of these institutions for the 2010-11 academic year is 20246 and 16,873 university applicants have already been placed in them. Noteworthy is that 138 of these institutions are based on evening classes because the number of university applicants is higher than the capacity of universities. Implementing e-learning in the institutions to deal with fast-changing knowledge is deemed a cost-effective means. Specifically, it has the important impact on environmental protection.

INTRODUCTION

The number of studies aimed to find out how to implement e-learning in Higher Education Institutions (HEI) is ever increasing due largely to the potential advantages of e-learning in education and training all around the world. E-learning offers opportunities for individuals to access to education and training anytime and anywhere when they are ready and for institutions to provide more cost-effective education and training all around the world (Yamamoto et al., 2010). The plurality of benefits for e-learning was classified by MacKeogh and Fox (2009) into seven broad categories, namely enhancing reputation, developing information skills, widening access, supporting disabled learners, improving the quality of teaching and learning, increasing flexibility, and reducing cost. While there are a number of other research studies discussing other benefits of e-learning, only a few of them focus on such benefits in terms of environment and energy. We attempt to bridge this gap by investigating the impact of e-learning on several dimensions such as carbon footprint, recycling, traffic congestion, residential issues and energy. Specifically, we study this issue in the context of the institutions that provide education and training in the discipline of electricity mainly departments of electrical and electronic engineering and departments of electricity in Turkey. Firstly, we review the literature to find out how using e-learning may save the planet and reduce the consumption of energy. Secondly, we analyse the quotas of the institutions providing education and training in electricity and the number of students who have been placed to study in those institutions in advance. Thirdly, we investigate the number of courses that must be completed for the graduation to find out how to save our forests by considering textbooks and notebooks. Fourthly, we map the location of university campuses to find

out whether they are out of towns and how they are far from town centres. Finally, we look at the numbers of course hours to investigate how using e-learning can save energy.

LITERATURE REVIEW

E-Learning or technology-enhanced learning (TEL) is generally considered as an approach to facilitate and enhance learning and training utilizing information and communication technologies (ICT) as a means of delivering and distributing educational content to participants whereas the Internet is the most popular way to implement e-learning (Woodall, 2009; Ulugtekin, 2005). Today, there has been an ever growing trend towards e-learning in HEIs and in organizations across the world because e-learning offers opportunities for individuals and organizations. It enables just-in-time learning, arranges courses to address to the specific needs of individuals, saves time without delaying learning benefits, minimizes travel costs and time away from work, and provides consistent course delivery (Ulugtekin, 2005; WSP, 2009). Additionally, it saves the planet by protecting our forests and reducing CO2 emission and energy. E-learning has the potential to reduce the amount of paper and printed materials such as textbooks and notebooks which are associated with traditional classroom instruction. A research carried out by the UK Open University Design Group (DIG) and Stockholm Environmental Institute (SEI) in 2005 points out that HEIs have influenced the environment; the usage of the Internet and e-learning consumes nearly 90% less energy and produces 85% fewer CO2 emissions than that generated on university campuses (India Environmental Portal, 2008). Universities are a large consumer of electricity and gas because of the usage of heating, hot water, lighting and all electrical equipment (University of Aberdeen, 2010).

Turkey is known officially as the Republic of Turkey - a Eurasian country bridging between Europe and Asia. There are 163 HEIs in Turkey with 102 and 52 of them being public and non-profit foundation (private) universities, respectively. We focus on the public and private universities in this article because they accommodate institutions and people, namely teachers and learners who are the target groups of our investigation.

Table 1: Number of Higher Education Institutions in Turkey, (YÖK, 2010**)**

Higher Education Institutions	Number
Public University	102
Non-Profit Foundation University	52
Foundation Post-Secondary Vocational Schools	9
Military Higher Education Institutions	5
Public University with Special Status	2
Higher Education Institution affiliated with Law Enforcement Agency	1
Total	163

The number of applicants who have applied to study in HEIs in Turkey, North Cyprus and other countries is 1,588,624 for 2010-2011 academic year. Table 2 indicates the number of quotas of universities in Turkey and other countries and the number of applicants who have been placed or unplaced to study in an HEI for the 2010-11 academic year. It shows that the 48% (763,516) of 1,588,624 are placed whereas the rest of them should wait until next year because the quotas of HEIs are not sufficient for all applicants and Open University is not considered by individuals as a desired place for Higher Education and Training.

Table 2: Quotas of Higher Education Institutions for the 2010-11 Academic Year, (ÖSYM, 2010a)

HEIs	Quotas	Placed	Unplaced
Face-to-face Education	671.804	561.003	110801
Open University (OU)	Unlimited	202.513	-
Total	671804 + OU	**763516**	110801 + OU

METHODOLOGY

417 institutions of the universities in Turkey were selected for the study. The participating institutions in universities were determined by considering whether these institutions have provided education and training in the discipline of electricity in Higher Education according to the official data in 2010 provided by the ÖSYM, which stands for the Student Selection and Placement Centre in Turkey. Table 3 shows the number of programs offered by HEIs associated with the science of electricity in the academic year 2010-2011 and the number of quotas of the programs for general applicants and top-class applicants. Additionally, it gives the number of applicants who have been placed to start for studying in the respective HEIs in the coming academic year in Turkey.

Table 3: Number of Quotas in Institutions and Number of Students placed for the 2010-11 Academic Year, (ÖSYM, 2010b)

Higher Education Institutions	Period	No. of Institutions	Quotas of Institutions	No. Of Placed Students
Aircraft Electric and Electronics	4 Years	3	98	98
Avionics	4 Years	1	26	26
Electrical Education (*)	4 Years	10	781	-
Electrical Appliance Technology	2 Years	10	380	323
Electrical Engineering	4 Years	6	577	577
Electrical and Electronics Engineering (1) (**)	4 Years	140	5928	5452
Electrical and Electronics Engineering (2) (***)	4 Years	8	291	291
Electricity	2 Years	230	11770	9740
Electrical Energy Generation, Transmission and Distribution	2 Years	7	340	311
Rail Systems Electrical and Electronics Technology	2 Years	2	55	55
Total		**417**	20246	**16873**

(*) As Institutions provide education and training in Electrical Education were shut down on 13 November in 2009, the number of students placed for the 2009-2010 will be used through the research; (**) Institutions are located in Faculties of Engineering and Faculties of Engineering and Architecture; (***) Institutions are located in Faculties of Technology

The number of quotas of the institutions and the number of students who are placed in those institutions are highly relevant for the research because the Student Selection and Placement Centre in Turkey will offer new students the remaining places after the registration of the placed ones. Implementing e-learning in the above mentioned institutions to deal with fast-changing knowledge is deemed a cost-effective means and has the important impact on environmental protection.

REDUCING CO_2 EMISSONS WITH E-LEARNING

E-learning is clearly considered as means of reducing CO_2 emissions and minimizing travel costs. We calculated the distance between campuses and towns by considering the exact location of the respective institutions and town centres to find out how e-learning can save travel costs and reduce CO2 emissions in the respective institutions. For the calculation, the exact location of the institutions was obtained by the official web sites and then Google Maps was used. Table 4 shows the number of the university campuses which are located out of the town centre or inside of the town centre. While we could classify the location of 226 institutions, due to various reasons we could not identify the others'. It shows that 148 of the institutions are located outside of the towns in Turkey.

Table 4: Locations of Institutions in and out of towns in Turkey

	Total	Outside of a Town	Inside of a Town	Total Towns	Not Found
Aircraft Electric and Electronics	3	3	0	3	0
Avionics	1	1	0	1	0
Electrical Education	10	4	2	6	4
Electrical Appliance Technology	10	6	2	8	2
Electrical Engineering	6	0	2	2	4
Electrical and Electronics Engineering (1)	140	69	33	102	38
Electrical and Electronics Engineering (2)	8	6	2	8	0
Electricity	230	58	36	94	136
Electrical Energy Generation, Transmission and Distribution	7	1	0	1	6
Rail Systems Electrical and Electronics Technology	2	0	1	1	1
Total	417	148	78	226	191

Table 5 shows the average distance between the exact location of the institutions and town centres. As 226 of the institutions, individuals have to travel from the towns to the respective university twice per a day. For example, an individual, who is studying in a department of electrical and electronics engineering and prefers to walk from the town to the campus, has to walk at least 6.74 km and at most 7.28 km. For an individual who prefers to use a vehicle should drive at least 7.89 km and at most 9.04 km on average.

Table 5: Average distance in km between town centres and institutions

Higher Education Institutions	Ins.	Stu.	Walk		Vehicle	
			Min	Max	Min	Max
Aircraft Electric and Electronics	3	98	8	8.77	8.07	9.93
Avionics	1	26	4.6	4.6	5	6.9
Electrical Education	6	389	5.1	5.2	5.2	5.65
Electrical Appliance Technology	8	306	5.16	5.21	5.36	5.89
Electrical Engineering	2	268	1.5	1.6	2	2.9
Electrical and Electronics Engineering (1)	102	3758	6.74	7.28	7.89	9.04
Electrical and Electronics Engineering (2)	8	291	6.5	7.88	7.4	8.3
Electricity	94	3678	5.13	5.34	5.54	6.03
Electrical Energy Generation, Transmission and Distribution	1	30	5	5	5.3	5.3
Rail Systems Electrical and Electronics Technology	1	25	2.8	3.6	3.2	4.2
Overall Average	**226**	**8869**	**5.89**	**6.30**	**6.64**	**7.47**

Note: Ins. = number of institutions; Stu.= number of students.

A carbon footprint is known as the amount of greenhouse gases produced directly or indirectly by individuals, which is also considered as the amount of CO_2. There are many variables influencing the amount of $C0_2$ emission produced by cars or buses such as engine size, brand and the number of passengers. The statistics given by the UK Motoring Search Engine (2010) indicates that the CO_2 emission rate varies between 86 g/km and 470 g/km whereas the average amount of CO_2 emission generated by cars is 167 grams of carbon dioxide per kilometre. A research carried out by the Department for Environment, Food and Rural Affairs in the UK found that the estimated amount of CO_2 emission per passenger km produced by a bus journey was calculated as 0.1025 g/km per passenger. We will use the 0.1025 g/km and the statistics given in Table 5 to calculate how e-learning can help to reduce the CO_2 emission. Table 6 shows the amount of $C0_2$ emission which may be produced by students in 226 institutions by their bus journeys. We calculated the respective CO_2 emission rates as follows: CO_2 Emission = Distance x Student Number x 0.1025. This calculation was implemented by considering every institution's distance and their student numbers separately.

Table 6: The amount of CO2 Emission produced by Bus Journeys from towns to campuses

Higher Education Institutions	CO_2 per 1 Journey (gram)		CO_2 per a Year (Kilogram)		CO_2 per Graduation (Kilogram)	
	Min	Max	Min	Max	Min	Max
Aircraft Electric and Electronics	75.15	92.12	21.04	25.80	42.08	51.6
Avionics	4.6	4.6	2.73	5.15	5.46	10.3
Electrical Education	200	215.67	56.02	60.39	224.08	241.56
Electrical Appliance Technology	176.71	193.93	49.48	54.30	98.96	108.6
Electrical Engineering	27.47	39.83	15.38	22.31	61.52	89.24
Electrical and Electronics Engineering (1)	3262	3705	913.37	1037.52	3653.5	4150.08
Electrical and Electronics Engineering (2)	217.04	30.75	60.77	68.89	243.08	275.56
Electricity	2196.98	2404.14	614.96	673.16	1229.9	1346.32
Electrical Energy Generation, Transmission and Distribution	16.30	16.30	4.56	4.56	9.12	9.12
Rail Systems Electrical and Electronics Technology	8.2	10.76	2.30	3.01	4.6	6.02
Overall Average	**6220**	**6982**	**174.61**	1955.09	5572.3	6288.4

Table 6 shows the amount of CO_2 emission which will be produced by 8869 students in 226 institutions per a bus journey, per year and until they graduate. The statistics in the table tell us that 8869 students will cause the 6288.4 kilogram CO_2 emission. Using e-learning in those institutions can set the amount of CO_2 emissions by students' bus journey to zero. It is significant to note that the amount of CO_2 emission calculated in the research may be different because it was calculated according to the average bus CO_2 emission. The amount is highly dependent on the activities of students. There may be several students who prefer cycling, walking from the town to campuses or using their own cars. As the distances between campuses and towns are relatively long, walking or using bicycle may not be possible. In summary, the above calculations are only rough estimations, given there are a host of contributing factors whose values are not accessible to us. Nonetheless, the figures can somehow convey a general impression how e-learning can help improve the environmental protection

SAVING ENERGY WITH E-LEARNING

Table 7 indicates the number of courses in institutions associated with the science of electricity, which must be completed by students in order to graduate. It also shows the number of practical and theoretical hours of courses to be completed for graduation. For example, individuals who are going to study in Department of Avionics must complete 53 courses and should participate in 1960-hour theoretical and 1064-hour practical sessions in 4 years (i.e. compulsory course credits as graduation requirements). In HEIs in Turkey, each term consists of 14 weeks. Descriptive statistics in the Table 7 will be used throughout the article to indicate the number of institutions and number of students in those institutions.

Table 7: Number of courses with compulsory theoretical and practical hours as graduation requirements

Items	Number of Institutions	Number of Courses	A Student		All Institutions	
			T	P	T	P
Aircraft Electric and Electronics	3	53	2170	952	6510	2856
Avionics	1	59	1960	1064	1960	1064
Electrical Education	10	50	1624	798	16240	7980
Electrical Appliance Technology	10	39	1036	504	10360	5040
Electrical Engineering	6	56	1918	434	11508	2604
Electrical and Electronics Engineering (1)	140	62	2016	490	282240	68600
Electrical and Electronics Engineering (2)	8	72	2072	602	16576	4816
Electricity	230	38	1190	434	273700	99820
Electrical Energy Generation, Transmission and Distribution	7	37	1204	364	8428	2548
Rail Systems Electrical and Electronics Technology	2	35	1134	336	2268	672
Total	**417**	**501**	**16324**	**5978**	**629790**	**196000**

Note: N = Number of Courses; T and P = Theoretical and Practical hours

Table 7 also indicates the total number of theoretical and practical hours given by institutions across Turkey. For example, three institutions provide education and training in aircraft electric and electronics across Turkey. To enable all their students to meet the graduation requirement, they must arrange 6510-hour theoretical and 2856-hour practical sessions in 4 years. What Table 7 tells us that 417 institutions associated with the science of electricity: in order to enable their students complete their studies and graduate in 2 or 4 years, 629,790-hour electrical energy needs to be consumed for lighting up their classrooms and 196,000-hour electrical energy to light up their labs. In addition to lighting, the more or less same amount energy should be spent to operate electrical equipment in classrooms and labs. Due largely to the location of Turkey, half of education and training is implemented in winter. Hence, 417 institutions should heat their labs and classrooms at least 825790/2 = 412,895 hours by consuming energy namely natural gas, electricity or woods.

SAVING THE PLANET WITH E-LEARNING

Paper is not only a significant source for writing and drawing but also is used for the production of textbooks, notebooks, magazines, newspapers and buildings. Textbooks and notebooks are the main element of education and training in a traditional way. Paper is mainly made of trees and water with the use of other ingredients. An average tree inhales 12 kilograms of CO_2 and exhales enough O_2 to keep a family of four breathing for a year (Ecokid). Forests do not only produce O_2 but also have social, communal and environmental benefits for humanity. Forests create an open non-priced recreation, landscape amenity and biodiversity for societies. They also generate large amount of oxygen and absorb large amount of carbon dioxide, helping regulate the gases in Earth's atmosphere (Ecokids). These findings indicate that implementing e-learning will not only save forests but also save humanity.

Table 8 shows the number of institutions associated with the science of electricity, number of students placed by the Turkish Higher Education Council for the academic year 2010-2011, and the number of courses that they have to complete for graduation. The number of courses can be referred to Table 7. Table 8 shows that the 16873 students who are going to study in institutions associated with the science of electricity between 2010-11 and 2013-14 academic years will have to study 833,215 textbooks. Fraser (2007) says that the average length of textbooks is 715 pages. He also says that a 40-feet dead tree is used to produce 11.6 textbooks. As 11.6 textbooks are equal to a 40-feet dead tree, we used the following calculation to find out how e-learning can save our forests: “Number of Trees = Number of Textbooks / 11.6 = 833,215 / 11.6 = 71.829**”.** Additionally, the more or less the same amount of notebooks is also necessary for drawing and writing. These findings indicate that individuals in institutions associated with the science of electricity would have opportunity to save 71,829 x 2 = 143,658 trees by using e-learning

Table 8: Number of textbooks will be used by students in institutions associated with the Science of Electricity

Items	Number of Students	Number of Courses	Number of Textbooks	Number of Trees
Aircraft Electric and Electronics	98	53	5194	**448**
Avionics	26	59	1534	**132**
Electrical Education	781	50	39050	**3,366**
Electrical Appliance Technology	323	39	12597	**1,086**
Electrical Engineering	577	56	32312	**2,786**
Electrical and Electronics Engineering (1)	5452	62	338024	**29,140**
Electrical and Electronics Engineering (2)	291	72	20952	**1,806**
Electricity	9740	38	370120	**31,907**
Electrical Energy Generation, Transmission and Distribution	311	37	11507	**992**
Rail Systems Electrical and Electronics Technology	55	35	1925	**166**
Total	16873	501	833215	**71,829**

What is more, textbooks and notebooks are not only made of woods but the usage of some water and electrical energy in the process are essential. Öztürk (2005) says that 2400 kilogram woods (17 pine trees), 440,000 kilogram water and 7600 kwh electrical energy are consumed to produce 1000 kilogram paper.

CONCLUSION

This study focused on the potential benefits of e-learning in the institutions providing education and training in the discipline of electricity, which are mainly departments of electrical and electronic engineering and departments of electricity in Turkey. The aim is to investigate whether e-learning can save energy on campuses, reduce CO_2 emissions and save the planet. The research was conducted in the context of the Turkish Higher Education Institutions (HEIs) providing education and training in the science of electricity. Specifically, 417 of these HEIs have been identified where 16873 students are going to study in the academic year 2010-11 in Turkey. Based on the findings of this research, several important key points can be inferred and they are listed as follows:

Firstly, this research found that the 16873 students who are going to study in 417 institutions associated with the science of electricity between 2010-11 and 2013-14 academic years will have to study 833,215 textbooks. Additionally, the more or less the same amount of notebooks is also necessary for drawing and writing. These findings indicate that individuals in institutions associated with the science of electricity would have the opportunity to save **143,658** trees by using e-learning. This is a highly significant finding to show how e-learning can save the cost associated with printing materials and how it saves the planet but it also shows that fast-changing information with e-learning can be updated efficiently, which saves the foreseeable costs in advance.

Secondly, the findings reveal that the majority of HEIs are located in the outside of towns, which require students to drive between 6.64 and 7.47 kilometres to arrive in campuses and creates 6,288 kilograms of CO_2. This shows that using e-learning is also a fight with global warming which is a threat for the future of humanity.

Thirdly, the findings discover that education and training on campuses significantly consume electrical and natural gas energy. We found that education and training of 16873 students in 417 institutions until they graduate in 2 or 4 years entail the consumption of 826,790-hour electrical energy for lighting and at least 412,896-hour electrical energy, natural gas for heating. The energy used to educate and train students may be even more than we have calculated, because there may be several electrical equipments in classrooms and labs. Additionally, for the labs, students in the science of electricity carry out several experiences such as setting up electrical circuits or operating engines. They are also additional extra cost for the universities.

In general, using e-learning in the institutions associated with the science of electricity can save the planet, reduce the amount of CO2 emission by the students' activities and save the energy consumed on the campuses. We could not calculate the distance between several campuses and towns for two reasons: firstly, the number of the institutions is high and we do not have access to all the required data. Secondly, the maps we used to calculate the distance between campuses and towns such as Google Maps are not sufficiently detailed for Turkey.

The research reveals some significant findings that may potentially influence the policies of HEIs. Firstly, the quotas of those HEIs are not sufficient for all applicants. The 52% of the applicants in 2010 have to wait until next year. E-learning clearly can help to solve the residential issues in HEIs and help universities to provide education and training in the science of electricity for the all applicants. This research can change the perspective of students and teachers in the institutions associated with the science of electricity. We can provide some clear statistics to them, showing how they have the opportunities to save the planet and reduce the amount of energy on campuses and prevent further CO2 emission.

However, the savings mentioned for the environment and energy could be meaningless if e-learning did not bring any learning and teaching values in higher education in Turkey. For this reason, we must understand how the institutions associated with the science of electricity are ready for e-learning and how e-learning can provide education and training efficiently in these institutions. Investigating the impact of e-learning in this specific domain is one of the major research objectives we plan to pursue in our future work.

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