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E-Learning versus Face-to-Face Learning: An Economic Analysis of Higher Educational Systems in Iran

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ABSTRACT

Traditional engineering educational system was compared with the e-learning engineering educational system on the economic dimension using hypothesis testing approach. The comparison involved trend analysis and prediction based on costs and benefits of the two systems. Interestingly, the analysis revealed that the traditional system had greater advantage on the economic dimension. Several factors support the e-learning system despite the associated economic disadvantage. The final analysis provided results in favor of a blended system which takes advantage of the traditional and e-learning systems.

Keywords: economic comparison, e-learning, statistical analysis, traditional educational system, virtual educational systems

INTRODUCTION

This paper compares e-learning with face-to-face learning on the economic dimension and demonstrates that a hybrid approach is the most efficient one. Internet has significantly impacted the establishment of Internet-based education, or e-learning. Internet technology evolution and e-business have affected all industrial and commercial activity and accelerated the growth of e-learning industry. This in turn has fostered the collaboration of education and Internet technology by increasing the volume and speed of

information transfer and simplifying knowledge management and exchange tasks (Lohmann & Corradini, 2002). E-learning could become an alternative way to deliver on-the-job training for many companies thereby saving money, employee transportation time, and other expenditures. In this way economy is the fundamental problem, and economic comparison should be discussed for solving this problem (Bifulco & Bretschneiderb, 2001). In general, many people who in a way are involved with educational systems accept that the existing system of education, which we call traditional system, is not effective anymore. It is now time to critically analyze the traditional system on the time dimension, for example, for the time wasted between classes or time for commuting between home and the place of learning. Racial diversity is one of the significant problems that cause some students away from college areas because of their skin color (Munenea, 2007).

Many researchers have focused on the acceptance and use of virtual learning environments to solve the problems mentioned above (Raaij & Schepersa, 2006). Each year, many computer-based devices are invented, produced, and thrown into the world markets to support e-learning. These devices are the inevitable parts of e-learning, because for any system we need some tools and the tools of e-learning are computer-based devices which are the fundamental items for the architecture of e-learning systems (Kambourakisa, Kontonib, Rouskasa, & Gritzalis, 2005). E-learning system supports external collaborative activity (i.e. domestic students can consult with foreign students) rather than internal collaborative activity (i.e. two domestic students consult each other in physical space), which makes it an effective web-based technology (Ngaia, Poonb, & Chana, 2005). E-learning system is a capable system for educational systems, especially for interactive activities which is increasing among students all over the world for improving their knowledge (Chen, Yu, & Chang, 2005). All researchers emphasize on the economic role of new technologies, and talking about cost and effectiveness is more relevant and important when a system of education is being discussed. Even some researchers argue it as a cost dilemma (Liao, 2004), while some other agree on the cost effectiveness of computer-based education (Duffy, Parry, & Ramakrishnan, 2004). The present study provides an economic analysis of varied systems implementation, and thus discovers the most effective and efficient system.

AN ANALYTICAL ECONOMIC EVALUATION

Many researchers in the past have evaluated traditional system and e-learning system on the economic dimension (Stark, Gruber, Renkl, & Mandl, 1998). For accomplishing that, they compared the systems in different ways; mostly they attempted to calculate the "Rate of Investment" for each system (Phillips, Trolley, & Cross, 2000). For economic comparison we need costs and benefits of educational systems under comparison. Cost is a substantial element and is divided into direct cost and indirect cost and pulsed by fix cost and marginal cost (Stratman, Roth, & Gilland, 2003). When the costs and benefits of each system have been obtained, we then can calculate the overall benefit by different methods, such as net present worth, rate of return, and equivalent uniform annual cost. Our study is derived from engineering educational systems in Iran. For economic comparison we need both costs and benefits. There is little economic benefit in traditional system, but for e-learning system we can mention several economic benefits. Some of these benefits are (1) opportunity benefit: E-learning system is time-boundless in the sense that students have enough time for other activities like working which can compensate a large amount of costs. This is the value added for e-learning system (Fletcher, D., 1990). (2) Benefit of accommodation: food, traveling or moving and transportation that are costs in face-to-face learning are benefits in e-learning system. Students would live in their own city and house that reduces costs and thus converts these costs into benefits. We won't take this into account as a separate benefit, but for e-learning system's equations and tables we assign zero instead of their costs. In e-learning, the cost of instructor's repeated teaching is omitted, because everything is recordable and there is no need for instructor to teach the same course for many times as the training simulator can be used. (3) Benefit of quality: Lessons in e-learning system ensure quality because of their repeatability (i.e. the lesson which is taught can be repeated) and the opportunity they provide for collaborative learning (i.e. a student can discuss a problem with other students all over Iran). Further analysis can be developed using the following terms.

Notations:

C_M	Cost of moving	C_A	Cost of accommodation
C_R	Cost of registration	C_N	Cost of nutrition
C_M	Cost of maintenance	C_E	Cost of equipment
C_T	Total cost	C_{EF}	Cost of extra facility

B_W	Benefits of working	B_r	Benefit of omitting repetition
B_q	Benefits of quality	B_T	Total benefits

Now we can develop a linear formula for costs and benefits which help us to compare the two systems under review in this paper:

$$C_T = C_M + C_A + C_N + C_E + C_R + C_M + C_{EF} \quad ; \quad B_T = B_W + B_q + B_r$$

Assuming that all Iranian Universities implement an e-learning educational system, an economic comparison between the implemented e-learning educational system and the traditional system would provide the annual costs and benefits of the two systems for ten years as shown in Table 1. The numbers are arithmetic means based on interviews conducted on 10 Iranian Universities for traditional system and 5 Iranian Universities for e-learning. One of the authors conducted interviews with the administrators of these universities to obtain their assessments of costs and benefits. A null entry in the table for e-learning costs indicates that there is no cost for the related component.

Table 1 Mean Costs and Benefits of E-Learning and Traditional Systems of Education [1996, 2005] (in millions of US dollars)

Costs									
Traditional system	Year	C_M	C_A	C_N	C_E	C_R	$C_{M\&R}$	C_{EF}	C_T
	1996	55	300	250	55	150	10	45	865
	1997	60	450	270	60	200	15	50	1105
	1998	65	600	290	65	300	25	55	1400
	1999	70	700	300	70	400	30	65	1635
	2000	75	900	320	75	500	35	70	1975
	2001	80	1100	340	80	600	40	80	2320
	2002	85	1200	400	85	700	45	85	2600
	2003	90	1300	430	90	800	45	90	2845
	2004	95	1400	470	95	900	50	95	3105
	2005	100	1500	500	100	1000	55	100	3355

Table 1 Mean Costs and Benefits of E-Learning and Traditional Systems of Education [1996, 2005] (in millions of US dollars) (Continued)

Costs

E-learning system	Year	C_M	C_A	C_N	C_E	C_R	$C_{M\&R}$	C_{EF}	C_T
	1996	0	0	0	2500	850	20	30	3400
	1997	0	0	0	2450	900	25	45	3420
	1998	0	0	0	2400	950	30	55	3435
	1999	0	0	0	2300	1050	30	70	3450
	2000	0	0	0	2250	1100	35	80	3465
	2001	0	0	0	2200	1150	40	90	3480
	2002	0	0	0	2150	1200	45	100	3495
	2003	0	0	0	2050	1300	45	130	3525
	2004	0	0	0	2000	1500	50	150	3700
	2005	0	0	0	2000	1500	50	150	3700

Benefits

E-learning system	Year	B_W	B_q	B_R	B_T
	1996	450	88	50	588
	1997	530	115	68	713
	1998	580	135	80	795
	1999	610	150	87	847
	2000	650	180	90	920
	2001	700	200	95	995
	2002	800	230	110	1140
	2003	850	250	130	1230
	2004	900	270	180	1350
	2005	1000	300	200	1500

Economic Computations

Following equation provides the means for obtaining the economic comparison of the two educational systems.

Assumptions:

- Benefits are with positive mark and costs are with negative mark.
- Interest rate in Iran is different in varied years.
- The system that has higher net present worth is economically more efficient.
- The formula is according to the factor of [P, F, A].

Notations:

P_{Net}	net present worth	P	present worth
I	interest rate	F	future worth
N	number of periods	A	annual cost or benefit

$$P_{Net} = F \times (P/F, I, N) + A \times (P/A, I, N) \qquad (1)$$

For calculus way we use the following equations:

$$P_1 = \frac{F}{(1+I)^N} \qquad (2)$$

$$P_2 = A \times \left(\frac{(1+I)^N - 1}{I \times (1+I)^N}\right) \qquad (3)$$

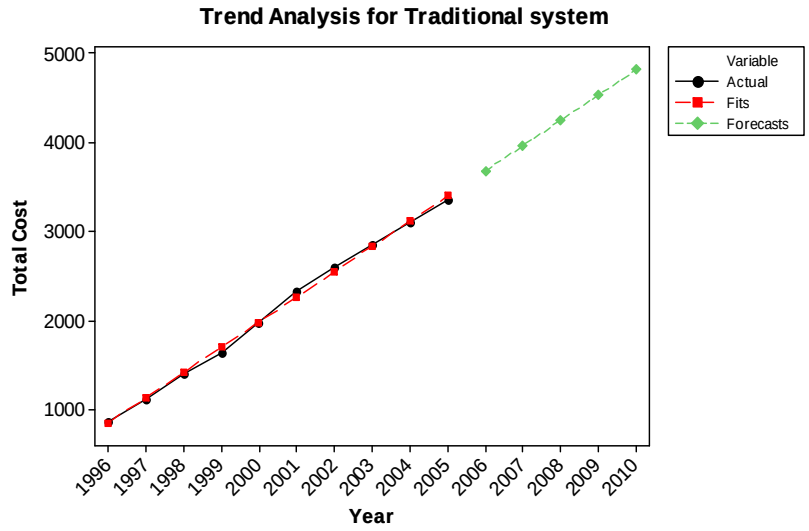
$$P_{Net} = P_1 + P_2 \qquad (4)$$

Trend Analysis

One of the most important bases of comparison is the future trend which is obtained by forecasting. In the following figures, the past trend and also the future trend for 5 years is presented by computing linear trend analysis using Minitab version 14. The total annual costs of traditional engineering educational system, from the year 2006 to 2010, as shown in Figure 1 are derived by means of the following equation:

$$Y_{t_{Traditional}} = 279.242 \times t + 549.667$$

In the above equation, t (the number of years) can take values from 1 to 10 for the study years (1996-2005) and 11 to 15 for the forecasting years (2006-2010).

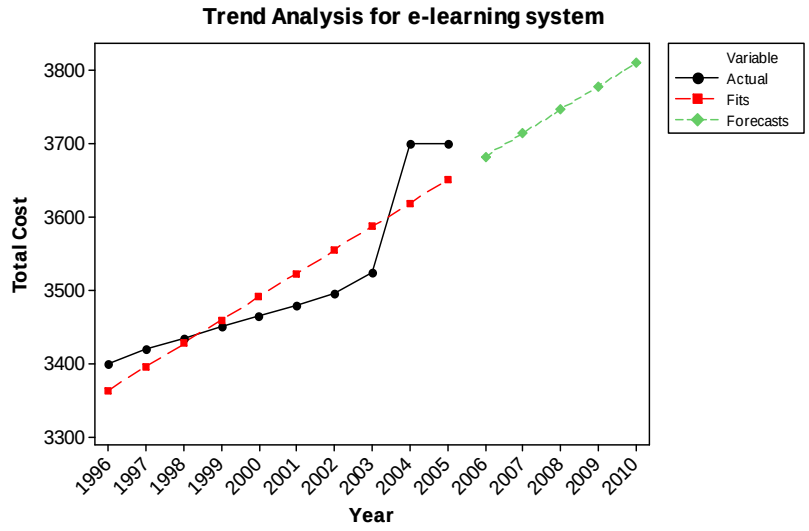


Year	Value (millions)
2006	3683$
2007	3967.09$
2008	4251.18$
2009	4535.27$
2010	4819.36$

Figure 1 Trend analysis for traditional system

Also, for e-learning engineering educational system the trend is shown in Figure 2. Forecast for the e-learning system for the next 5 years is done by means of the following equation:

$$Y_{t_{e-learning}} = 31.8788 \times t + 3331.67$$



Year	Value (millions)
2006	3682.33$
2007	3714.21$
2008	3746.09$
2009	3777.97$
2010	3809.85$

Figure 2 Trend analysis for e-learning system

Significant Factors Effect in Forecasting

We can choose more important cost factors of e-learning and traditional system and identify their importance for forecasting the total cost as follows:

Notations:

C_A	Cost of accommodation	C_R	Cost of registration
C_{EF}	Cost of excessive facility	C_T	Total costs
α_j	j=0,1,2,3 coefficient	T	Number of years

$$\sum_{i=1}^{10} C_{Ti} = \alpha_0 t + \alpha_1 \sum_{i=1}^{10} C_{Ai} + \alpha_2 \sum_{i=1}^{10} C_{Ri} + \alpha_3 \sum_{i=1}^{10} C_{EFi} \quad (6)$$

$$\sum_{i=1}^{10} C_{Ai} C_{Ti} = \alpha_0 \sum_{i=1}^{10} C_{Ai} + \alpha_1 \sum_{i=1}^{10} C_{Ai}^2 + \alpha_2 \sum_{i=1}^{10} C_{Ai} C_{Ri} + \alpha_3 \sum_{i=1}^{10} C_{Ai} C_{EFi} \quad (7)$$

$$\sum_{i=1}^{10} C_{Ri} C_{Ti} = \alpha_0 \sum_{i=1}^{10} C_{Ri} + \alpha_1 \sum_{i=1}^{10} C_{Ri} C_{Ai} + \alpha_2 \sum_{i=1}^{10} C_{Ri}^2 + \alpha_3 \sum_{i=1}^{10} C_{Ri} C_{EFi} \quad (8)$$

$$\sum_{i=1}^{10} C_{EFi} C_{Ti} = \alpha_0 \sum_{i=1}^{10} C_{EFi} + \alpha_1 \sum_{i=1}^{10} C_{EFi} C_{Ai} + \alpha_2 \sum_{i=1}^{10} C_{EFi} C_{Ri} + \alpha_3 \sum_{i=1}^{10} C_{EFi}^2 \quad (9)$$

The result should be an equation as follows:

$$C_T = \alpha_0 + \alpha_1 C_A + \alpha_2 C_R + \alpha_3 C_{EF} \quad (10)$$

After putting the related information in the above equation, the following equations are derived:

Regression equation for traditional system:

$$Y_{\text{Traditional}} = 486 + 0.961\ X_1 + 1.78\ X_2 - 4.03\ X_3$$

Regression equation for e-learning system:

$$Y_{\text{e-learning}} = 2451 + 1.27\ X_2 - 4.45\ X_3$$

The above equations can be used to obtain the forecasting of total cost of each system according to special cost factors.

STATISTICAL ANALYSIS FOR HYPOTHESIS TESTING

In this part a hypothesis testing is affordable for discovering more economic systems of education as follows:

$H_0: \mu_{e-learning} - \mu_{traditional} = \delta \leq 0$; $H_1: \mu_{e-learning} - \mu_{traditional} = \delta > 0$

Where H_0 states that the mean total cost of e-learning is less than or equal to traditional system against H1 which means the mean total cost of e-learning is more than the traditional system. For this hypothesis testing one-tailed student-t distribution is used. The value of t statistic obtained in the present analysis is 5.051.

Assumption:

$\sigma^2_{e-learning} = \sigma^2_{Traditional}$

Notations:

μ	The mean of the population	$\bar{X}$	The mean of the sample (data)
n	Number of samples	σ	The variance
δ	Difference between the mean of the populations	S	The standard deviation

$$t_{\alpha, n_e + n_t - 2} = t_{0.05, 10+10-2} = 1.734 \qquad (11)$$

If $t > t_{\alpha, n_{e-learning} + n_{traditional} - 2}$ then H_0 is rejected: 5.051 > 1.734

This result shows that the mean total cost of e-learning system is more than that for the traditional system. So what makes e-learning system to have its fans that are too many, despite the former calculations? There are several reasons: (1) The future trend of the world toward virtual education based on computer-based elements; (2) The quality of engineering education in e-learning system; and (3) The economic benefits of e-learning engineering educational system, which is the most important reason (Fresena & Boydb, 2005).

Blended Approach

In this section, two different hypothesis testing approaches are used, each of which illustrates a result. We choose three cost factors of each system to fulfill the hypothesis testing. For traditional system, we choose the cost of accommodation, the cost of equipment, and the cost of registration as cost factors for the proposed testing. Rules used here are the same as in section 3. The test would be as follows:

$H_0: \mu_{e-learning} - \mu_{traditional} = \delta \leq 0$; $H_1: \mu_{e-learning} - \mu_{traditional} = \delta > 0$

Here H_0 means the mean total costs of e-learning cost factors are less than or equal to those for the traditional system against H1 which means the mean total cost of e-learning factors are more than those for the traditional system.

$$t_{\alpha,n_e+n_t-2} = t_{0.05,10+10-2} = 1.734$$

For the given data we obtain t = 7.81.

If $t > t_{\alpha, n_{e-learning} + n_{traditional} - 2}$ then H_0 is rejected: 7.81> 1.734. As a result, H_0 is rejected. It means that even if some of the cost factors are being selected, the result is same i.e. the mean total cost of e-learning system is more than traditional system.

The following analysis is done for a blended approach. In this case a combination of two systems i.e. traditional system and e-learning system is used. Now we select another set of three cost factors in blended situation i.e. costs of the same parameters in two systems are added to each other, and that sum is multiplied by 1/4 as a share coefficient. Those factors are the cost of moving, the cost of accommodation, and the cost of nutrition. Therefore, we set another hypothesis testing as follows:

$H_0: \mu_{hybrid} - \mu_{traditional} = \delta \leq 0$; $H_1: \mu_{hybrid} - \mu_{traditional} = \delta > 0$

Where H_0 means the mean total cost of blended cost factors are less than or equal to traditional system against H_1 that means the mean total cost of blended cost factors are more than traditional system.

$$t_{\alpha,n_e+n_t-2} = t_{0.05,10+10-2} = 1.734$$

If $t > t_{\alpha, n_{hybrid} + n_{traditional} - 2}$ then H_0 is rejected: -1.184< 1.734. As a result H_0 is not rejected.

Corresponding to the above hypothesis tests we come to the result that the blended approach i.e. parallel consuming of both systems, is more cost effective. Nonetheless, in blended approach a student would be in the university environment from time to time which ensures a better interactive relationship between students.

CONCLUSION

Economic comparison is a practical and substantially effective approach for implementing projects, especially when we want to discuss an engineering educational system. By the means of economic comparison between e-learning engineering educational system and traditional engineering educational system we can realize which

system is more suitable economically and it helps us in a better decision making and implementation. By finding out varied costs and benefits according to above mentioned formulae, economic comparison, an effective method of forecasting based on specified cost elements and also the future trend is achievable. By the means of hypothesis tests an overall study has been accomplished for finding varied aspects of deciding which system to choose for implementation. As illustrated above, the blended approach provides a more acceptable economic situation in the future, the reasons would be lack of environment for and accommodation in traditional system and infinite capacity of e-learning system. Further, transition from traditional to blended system will avoid the shock of a sudden replacement of educational system to e-learning.

In future work we will insert the fixed and variable costs in our economic comparison separately and the depreciation rate will be taken into account.

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