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Adaptive Statistical Analysis on Higher Educational Systems

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Abstract: This study compared traditional system with virtual educational system statistically in Iran. In recent years e-learning has become a process which is changing the educational system from traditional to collaborative web-based activities in the widespread borderless world. For overcoming remoteness, distance learning and for prevailing time problem, a time boundless system of education is recommended. In this way, by the means of economical equations and statistical analysis we illustrated an in depth survey. Finally, by the means of hypothesis testing, we illustrated the best option for educational system is the combination of both systems.

Key words: E-learning, virtual educational systems, economic comparison, traditional educational system, statistical analysis

INTRODUCTION

Since the adoption of internet as the common channel for delivering teaching material in electronic form, the word e-learning, previously used for defining the teaching methodologies involving electronic aids, has been used as synonym of distance learning through Internet (Van Raaij and Schepers, 2008). Internet makes available resources (hardware, software, data and knowledge) distributed worldwide, reaching the students or workers at their homes with a minimum connection cost (Peretto *et al*., 2008).

The popularity of the internet as an information source has grown extensively. Its shear expanse and convenience is ideal to disperse information. More and more online services have now become available such as online banking, e-government, e-learning and e-commerce. Our interest lies with e-learning and in particular with the delivery of course material online. More specifically, we are interested in presenting online course material in interactive and stimulating ways for students and creating an online learning community similar to that which one might experience in an actual university. In this study, we present our experience of developing an innovative collaborative e-learning system and discuss an extension of this system for use on mobile devices (Monahan *et al*., 2008).

Internet has significantly impacted the establishment of Internet-based education, or e-learning. Internet technology evolution and e-business has affected all industrial and commercial activity and accelerated e-learning industry growth (Müller *et al*., 2007). It has also fostered the collaboration of education and Internet technology (Kong, 2008), by increasing the volume and speed of information transfer and simplifying knowledge management and exchange tasks (Padilla-Meléndez *et al*., 2008). E-learning could become an alternative way to deliver on-the-job training for many companies, saving money, employee transportation time and other expenditures. An e-learning platform is an emerging tool for corporate training, with many companies developing their own e-learning courses for employee on the- job training (Mangina and Kilbride, 2008). Employees can acquire competencies and problem solving abilities via internet learning for benefits among business enterprises, employees and societies while at work.

These days virtual education absorbed the attention of educational systems (Yang and Liu, 2007; Economou *et al*., 2000). The large numbers of educational systems are changing their method to distance learning. Working in virtual engineering education area (Reategui, 2008), provides an environment like modern information and communication technologies to transfer knowledge and education without time and boundary limitations (Mahdizadeh, 2008). In this way, economy is the fundamental problem, for solving this problem economic comparison should be discussed and technology many problems solved. Each year many computer-based devices are invented. By the means of economic comparison we also can compare two systems of education. In general, many people who in a way involve with educational systems accept that the existing system

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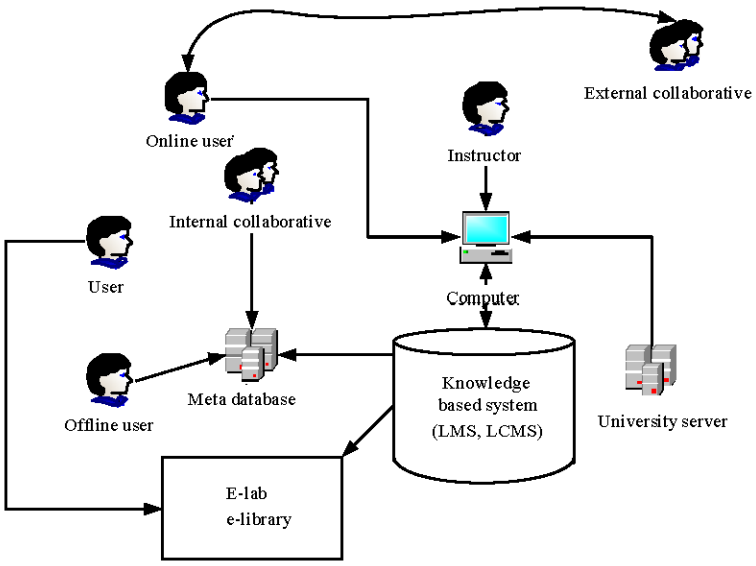

Fig. 1: Architecture of e-learning and collaborative activities

which we call it traditional system of education is not effective anymore. In the world we live time is really important, so, to criticize traditional system it is very time consuming, such as a migrated student to a campus or the wasted times between classes. Racial diversity is one of the significant problem that cause some students away from college areas because of their skin color (Munenea, 2007).

By the twentieth century and with the entrance of computer to technology many problems solved. Each year many computer-based devices invent, produce and enter to the world markets (Pazos-Arias *et al*., 2008). These equipments 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 *et al*., 2005). The architecture of an e-learning system is shown in Fig. 1. E-learning system as it is shown in Fig. 1 support external collaborative (Sun *et al*., 2008), activity (i.e., domestic student consult with foreign student) rather than internal collaborative activity (i.e., two domestic students consult), which make it an effective web-based item.

E-learning system is a capable system for educational systems (Chen, 2008), especially about interactive activities which is increasing among students all over the world for improving their knowledge (Chen *et al*., 2005). The existence of e-learning simulator systems, expert systems and advanced hardwares motivate to fundamental variations in technical implementation of educational systems that commonly force us to discuss cost in e-learning with more depth. Because of the huge attention to virtual learning in this study, it explore the economic aspects of an e-learning implementation.

In this study, we first discuss cost management in educational systems and then analyze e-learning and traditional systems by economic evaluations. After that rigorous statistical analysis are included to survey the most benefit method for education. That statistical analysis is done in different aspects for achieving more reliable results.

COST MANAGEMENT IN E-LEARNING

Definitely cost analysis and budget allocation is a complicated task for e-learning. Because, of the pace of thrive of technologies and innovations and also the increase of functionality and effectiveness for the time factors of new technologies in establishing e-learning has its own cost affects (Lenton, 2008). The budget of e-learning enforcement consists of performance and investment cost forecasting that is shown in Table 1.

Performable steps for determining costs:

- Identifying the elements that are fix in budget (facilities, maintenance of applicable softwares, database, infrastructure, …)
- Preparing a complete description for each cost item
- Predicting aggregation of fix costs

Table 1: Compound budget segments for e-learning enforcement

Segments	Description
Hardwares	Preparing budget for hardware cost items like buying a complete set of equipments, web cards, dependent equipments and hardware assets and their related costs like servers, hardwares security costs, high speed internet and wireless communication costs.
Softwares	Involve budget items which invest in software costs like applicable softwares, data base, audio, LMS (Learning Management System), LCMS (Learning Content Management System), graphic, video, text, …
Experts and efficient man power	Consist of wage and salary that are paid to employees for supplying softwares and hardwares.
External services	Consist of the costs of consult, communication and services organization that are being supplied from outside of the organization.
Communications	Involve costs for consuming internal and external organization webs and web management.
Other costs	Costs like installations, facilities, working area, rent, fix and variable cost of place and …

Table 2: General indexes for budget forecasting

Complicated infrastructure environment in e-learning system	The increase of complication within engineering education environment and its infrastructure cause the increase of operational costs The costs of providing multi purpose fields Risk evaluation information securing costs
Profit making enablers	The increase of income motivate the increase of costs that is substantial for offering better services like supporting policies, consuming new applicable softwares, renovating engineering educational systems and … The excessive growth of incomes that cause the more customer request for costly services
The changes of the number of employees	The increase or decrease of the number of employees, users and experts affect on the costs intensively
The cycle of economic procedures and the related crisis	Evaluating the economic crisis according to the procedures and cycles is a factor that affects on the increase or decrease of costs Providing some contracted budgets according to the primaries in economic crisis and stagnations Political crisis in countries like Iran

- Preparing essential documents for e-learning implementation committee to survey possibilities and capacity of cost reduction
- Preparing costs for external organization contractions and softwares license

After costs determination an initial budget is forecasted and provided for the implementation of systems. For preparing, an initial budget some indexes should be noticed. Some general indexes for budget forecasting are shown in Table 2.

When the budget is provided identifying the effective system is required. All researchers emphasize on the economic role of new technologies and talking about cost and effectiveness will be stronger when a system of education is being discussed. Even some researchers argue it as a cost dilemma and some other agreed on the cost effectiveness of computer-based education (Liao, 2004; Duffy *et al*., 2004). In this study economical analyzing of varied systems implementation considering the following ways:

- The equipments that are required in e-learning system.
- The useless time which is spent in colleges in traditional system.
- The money that students spend in traditional system.

In this way the most effective and efficient system is discovered.

ANALYTICAL ECONOMIC EVALUATION

Many researchers tried to evaluate traditional system and e-learning system economically. For accomplishing that, they compared them in different ways; mostly they attempted to calculate the Rate of Investment for each system.

For economic comparison we need costs and benefits of both educational systems. Cost is a substantial element and it is divided in to direct cost and indirect cost and plus by fix cost and marginal cost (Stratman *et al*., 2003). When the costs and benefits of each system have been got, we then can calculate it by different methods. Many methods such as: net present worth, rate of return and equivalent uniform annual cost are existed for analyzing.

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
F : Future worth
I : Interest rate
N : No. of period
A : Annual cost or benefit

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

For calculus way, it is use the following equations:

Table 3: Costs in traditional system of education

Costs	Description
Transportation	Each student would travel from the city that (s) he is studying to his or her home town time by time in any semester and also that traveling needs energy, …
Accommodation	The costs that students should pay for accommodation.
Equipments	Each student should provide some equipment which is required for his or her studying such as stationeries and ….
Nutrition	The costs that students should pay for their food.
Registration tuition	Students should pay tuition as their registry charge.
Maintenance	The costs which spent on university building, laboratories, …

Table 4: Costs of e-learning system of education

Costs	Description
Equipments	Some hardwares and softwares should be provided e.g., LMS (Learning Management System), LCMS, servers, …
Registration	The costs that students should pay for their registration.
Equipments maintenance	The equipments need periodic repair, part changing and updating.
Excessive facilities	E-library, digital LAB, digital thesis, …

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

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

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

As it is mentioned above educational systems in nowadays universe are basically divided to two groups, each of which has their cost and benefits. Present study is derived from engineering educational systems in Iran. As shown in Table 3 the costs of a traditional system of education are as follows:

And also, the costs of implementing e-learning engineering system of education are as shown in Table 4.

According to the former tables the costs in both systems are expressed. Hence the following notations could be defined.

Notations:

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

Of course, when we want to use this formula for e-learning system all costs except the cost of equipments, registration, maintenance and excessive facility are zero. For economic comparison, it also need the benefits. There is not any noticeable economic benefit in traditional system, but for e-learning system we can mention plenty of economic benefits as follows:

- **Opportunity benefit:** E-learning system is time boundless the students have enough time for other activities like working which can compensate a large amount of costs, it is the value added for e-learning system.
- **Benefit of accommodation:** Food, traveling or moving and transportation that were costs in e-learning system. Students would live in their own city and house that reduce the costs and alter them to benefits. We won't take it into account as a separate benefit but for e-learning system's equations and tables we put zero instead of their costs.
- **Omitting the cost of instructor's repeated teaching:** In this case because everything is recordable there is no need for instructor to teach a same course for many times and the training simulator is used.
- **Benefit of quality:** Because of being repeatable, i.e., the lesson which is taught can be repeated and the property of being collaborative, i.e., students can discuss a problem with other students in all over Iran. Additionally, just one good professor is required for supporting all the students and it is an important point especially in countries that the number of well skilled professors is too low. In traditional system students should pay more for such a situation.

Notations:

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

Now, it can develop a linear formula about costs and benefits which help us to compare two systems:

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

An implementation of an e-learning educational system throughout Iranian Universities is done. For achieving economic comparison between that e-learning educational system and the traditional system, the anniversary costs and benefits of two systems for ten years are shown in Table 5.

Table 5: Costs and benefits of e-learning and traditional systems of education (1996, 2005)

Costs	Year	C_m	C_A	C_N	C_E	C_R	$C_{M\text{ and }R}$	C_{FF}	C_t
Traditional	1996	55	300	250	55	150	10	45	8650
system	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
E-learning	1996	0	0	0	2500	850	20	30	3400
system	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	Year	B_W	B_q	B_R	B_T
E-learning	1996	450	88	50	588
system	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

Now by the stated equations the economic comparison is accessible. In this way, it is possible to identify the more economic educational system. The efficiency of this approach is understood while strategic planners and policy makers are planning for long run in a country.

STATISTICAL ANALYSIS BY HYPOTHESIS TESTING

In this research, a hypothesis testing is affordable for discovering more economic system of education as follows:

$$H_0 : \mu_{\text{e-learning}} - \mu_{\text{traditional}} = \delta < 0$$
$$H_1 : \mu_{\text{e-learning}} - \mu_{\text{traditional}} = \delta \geq 0$$

where, H_0 means the mean total cost of e-learning is less than traditional system against H_1 which means the mean total cost of e-learning is more than traditional system. For this hypothesis testing the t-student distribution is used.

Assumption:

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

Notations:

μ : The mean of the population
$\bar{X}$: The mean of the sample (data)
n : No. of samples
σ : The variance
S : The standard deviation
δ : Difference between the mean of the populations

$$T = \frac{\bar{x}_e - \bar{x}_t - \delta}{sp\sqrt{\frac{1}{n_e} + \frac{1}{n_t}}} \quad (5)$$

$$sp^2 = \frac{(n_e - 1)s_e^2 + (n_t - 1)s_t^2}{n_e + n_t - 2} \quad (6)$$

$$t_{\alpha, n_e + n_t - 2} = t_{0.05, 10+10-2} = 1.734 \quad (7)$$

$$T = \frac{3507 - 2121 - 0}{613.59\sqrt{\frac{1}{10} + \frac{1}{10}}} = 5.051$$

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

So, the result shows that the mean total cost of e-learning system is more than traditional. Now, what makes e-learning system to have its fans, that are too many, despite the former calculations, is the future trend of the world toward virtual education based on computer-based elements (Johnson *et al*., 2002) and the quality of engineering education in e-learning system and also the substantial reason which is the economical benefits of e-learning engineering educational system (Fresena and Boydb, 2005)

BLENDED APPROACH

Here, two different hypothesis testing are being used each of which illustrates a result. It choose 3 cost factors of each system to fulfill the hypothesis testing. For traditional system, it choose the cost of accommodation, the cost of equipment and the cost of registration as cost factors for the supposed testing. The rules which used here are as same as described earlier. The test would be as follows:

$$H_0 : \mu_{\text{e-learning}} - \mu_{\text{traditional}} = \delta < 0$$
$$H_1 : \mu_{\text{e-learning}} - \mu_{\text{traditional}} = \delta \geq 0$$

where, H_0 means the mean total costs of e-learning cost factors are less than traditional system against H_1 which means the mean total cost of e-learning factors are more than traditional system.

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

If $T > t_{\alpha, n_{e-learning}+n_{traditional}-2}$ 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.

Another experiment is done as a blended approach. In this case, a combination of two systems i.e., traditional system and e-learning system is used simultaneously. Now we select another 3 cost factor in blended situation i.e., costs of the same parameters in two systems are added to each other, that summation 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:

$$H_0 : \mu_{hybrid} - \mu_{traditional} - \delta < 0$$
$$H_1 : \mu_{hybrid} - \mu_{traditional} - \delta \geq 0$$

where, H_0 means the mean total cost of blended cost factors are less than 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 this result that the blended approach i.e., parallel consuming of both systems, is more cost effective. Nonetheless, in blended approach a student would be at the environment of university time by time which ensues to a better interactive relationship between students.

CONCLUSIONS

Economic comparison is a substantial factor 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 it can realize which system is suitable economically and it helps us to a better decision making and implementation. By finding out varied costs and benefits according to above mentioned formulas economic comparison and also future trend is achievable. As it was illustrated the blended approach provide a more economic situation in the future, the reasons would be lack of environment in traditional system and infinite capacity of e-learning system.

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