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Evaluation of the Cost-Effectiveness of Virtual and Traditional Education Models in Higher Education: A Systematic Review

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Abstract

Context: Recent advances in information technology and electronic devices, as well as limitations in traditional education, have persuaded higher education systems to use the virtual model as an alternative. The present systematic review aimed at evaluating the cost-effectiveness of both the traditional and virtual education models.

Methods: In this systematic review, articles published in known English and Persian databases, such as MEDLINE (PubMed), Scopus, Science Direct, HTA, Cochrane, Irandoc, Magiran, and SID from 2007 to 2017 were retrieved. Studies on health technologies and economic were also reviewed. For this purpose, the hierarchical search algorithm and the keywords "e-Learning" and "traditional education" were used.

Results: Ten studies were included, and their results were slightly different. Most studies showed that the cost-effectiveness of virtual education alone or in combination with traditional education (blended model) was equal or greater than that of traditional education. The data analysis of the articles was performed by comparing cost, effectiveness (Min, SD, QASE), cost-effectiveness (ICER), and the average cost per student. Cost-effectiveness refers to achieve the highest output at the lowest cost. The results showed that due to the use of multimedia, lack of space and time limitations, admission of a large number of students, the increased student satisfaction, easy and fast access to information, and use of Sharable Content Object Reference model in producing content and instruction, distance higher education reduces education costs while compensating for the lack of human resources in the teaching-learning process.

Conclusion: One of the effective methods in the education of medical students seems to be Web-based teaching as traditional teaching. Considering the predominance of the web-based method, it is recommended to be used in educational programs in the universities.

Keywords: Electronic Learning-Virtual Education-Traditional; Blended Learning-Cost Effectiveness; Higher Education

1. Context

Recent advancements in information technology have considered all aspects of human life (1). Nowadays, universities, due to the limited budget as well as the increased number of students, require organizational changes and should be adapted to the new demands of the students (2). In 1990, the number of students in higher education was about 48 million worldwide, whereas it is estimated to reach about 160 million by 2025. Traditional universities with their facilities cannot respond to the increased demands of the students, and the need for an alternative is undeniable (3). Using information technology in education, especially the Internet, is one of the most appropriate solutions to solve educational concerns (4). Traditional methods of lecturing have been used by most schools and universities worldwide. They also are currently known as the most commonly used methods by schools and universities, of which memorizing and repeating, lecturing, question and answer, dramatic training, role-playing, scientific excursion, group discussion, and laboratory-based training are more considered. The traditional method is based on providing oral information by the lecturer and learning it through listening and taking notes by the student. In these methods, the lecturer is active, and the student is the receiver and inactive (5). In the recent decade, the replacement of traditional classrooms with virtual ones has raised, and initial experiences have begun; however, no desirable results have obtained. For example, according to the released information, 70% of virtual education institutions in the United States failed, and the first Open University of Britannia, despite its stupendous tuition, was less welcomed by students. However, the slow rate

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of replacement and also the unwillingness of universities to change their educational systems can be the reasons for this failure (6). E-learning is an extensive set of applicable software and IT-based teaching methods (computer, compact disk, network, internet, and virtual university), which provides a lifelong opportunity for training and learning in all fields with no limitation in time and place for every one (7, 8). Under such circumstances, students and lecturers are not limited to the time, place, or both, and also, the content is provided through the course management software, multimedia resources, the Internet, and video conferencing (9, 10). Some of the objectives and desires of e-learning are fulfilled. For example, the repeatability of the lesson, the cost of education, and the ability to access information anytime from everywhere; however, the improvement of the quality of education has not yet achieved. Based on the failures of the first experiences of e-learning, as well as the understanding of its prominent features, universities have shifted onto a blended approach, which relies on a combination of e-learning and traditional training and tried to design a learning model with high quality using the irreplaceable advantages of both methods (11, 12). Blended or integrated training is a combination of two or more methods, which in addition to traditional classes, also benefits from other educational approaches, such as multimedia lessons, seminars, and e-learning facilities. In the medical sciences universities in other countries, there is a growing trend toward shifting onto e-learning, particularly blended e-learning, rather than traditional models to provide students with the ease of access to information and other technological facilities. Recent studies have indicated that the integration of face-to-face or traditional training with e-learning provides a new and more flexible education model (12, 13). Considering the variety of higher education methods, the current systematic review aimed at evaluating the cost-effectiveness of both traditional and virtual education models and introducing the most cost-effective one to the relevant policymakers. The present systematic review aimed at evaluating the cost-effectiveness of traditional education compared with virtual education.

2. Evidence Acquisition

First, MEDLINE (PubMed), Scopus, Science Direct, HTA, Cochrane, Irandoc, Magiran, and SID were searched as the most important electronic databases from the beginning of 2007 to 2017. A special and proper search strategy was used for each database using the keywords and the structured questions by “AND” and “OR” operators. Persian and English keywords were Electronic Learning, virtual education, traditional education, blended learning, higher education, cost-effectiveness.

2.1. Inclusion and Exclusion Criteria

All RCT and CCT studies were included in the study, and due to the limited research on simultaneous evaluation of outcome, cost, and cost-effectiveness, papers only conducted on each of traditional or virtual education models were enrolled in the current review study. In terms of Persian studies, only the articles that compared virtual and traditional training models in higher education were included, and the studies that did not compare e-learning with traditional education were excluded. Articles published in languages other than Persian and English and articles published before 2008 were also excluded.

2.2. Selection of the Study

The present study was performed in accordance with the principles of PRISMA. In this study, first, titles and abstracts part of the various articles were studied; then, the full texts of the articles were studied. In all steps, two researchers independently worked on studies, and discrepancies were resolved by conversation. In the next step, the eligible articles were selected and qualitatively evaluated.

2.3. Data Extraction

The collected data were transferred to a researcher-designed form containing the author’s name, year of study, education model, outcomes, costs, and cost-effectiveness.

2.4. Qualitative Assessment of Studies

The quality of studies was assessed according to the consensus on the health economics (CHEC) checklist. This checklist includes 20 items that examine studies based on population description, the cost-efficacy of the study, the validity of the methods and the model, with the physical unit, study results, cost-effectiveness, follow-up, and ethical considerations and then the score of each study ranges from 1 to 20, according to the items. According to the predetermined criteria, a score was allocated to each of the studies to show its quality (14).

2.5. Data Analysis

Because of the heterogeneity in the obtained results and methods of economic evaluation, the meta-analysis was impractical; so, the qualitative data analyzing method was used.

3. Results

3.1. Study Selection

A systematic review of databases was accomplished, according to the inclusion and exclusion criteria, of which 1,460 studies were obtained. After the exclusion of duplicates (397 articles), the remaining 1,063 articles were categorized by titles. The title and abstracts were

reviewed. The abstracts were reviewed again, in which 1,014 articles were excluded, and finally, 49 remaining articles were entered into the abstract screening process for final evaluation. The full texts of these articles were examined by the first author based on the inclusion and exclusion criteria. In case of uncertainty, the second author intervened. Finally, ten articles were entered into the final step of the study. The selection process of the present study was based on the PRISMA protocol (Figure1).

3.2. Data Extraction

Four out of 10 studies had been accomplished in 2015. Among the reviewed articles, three articles were randomized controlled trials, and two studies belonged to the same author, although there was no sign of bias, since one had been conducted in 2010 and the other in 2015. Four studies had examined both outcomes and costs and six studies only compared costs (Tables 1 and 2).

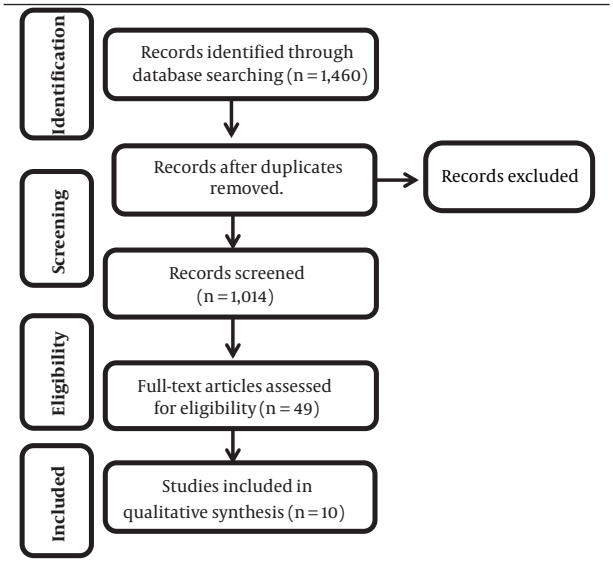

Figure 1. The flowchart of the study selection, according to the PRISMA protocol

Table 1. Comparison of Virtual Education with Traditional Education in the Selected Articles[a]

Author's Name	Effective			Total cost, $			The Average Cost per Student, $			Cost-Effectiveness (ICER), $	
	Traditional	Blended	Virtual	Traditional	Blended	Virtual	Traditional	Blended	Virtual	Traditional	Virtual
Battaglino et al. (15)	-	-	-	10000	8900	6400	-	10200	7700	-	-
Abeysinghe et al. (16)	-	-	-	22835	3955	1672	21034	3697	15063	-	-
Maloney et al. (17)	Min = 81/6%; QASE = 38/98	-	Min = 83/2%; QASE = 35/78	3060	-	1590	-	-	-	Total incremental cost = 78/50	Total incremental cost = 44/43
Fazlollahtabar and Sharma (18)	-	-	-	3355	-	3700	-	-	-	ICER per participant = -407/43	ICER per participant = -407/43
Kumpu et al. (19)	64/3 ± 5.8	67/3 ± 7.6	-	10718 (78)	43888 (64)	-	13699	68059		ICER per participant = 788, total incremental cost = 15776	
Maloney et al. (20)	7/94 ± 3/35	67/67 ± 2/96	-	30011	-	24520	-	-	-	ICERf2f-ICER BL = -1/10, ICER BL20% > ICER F2F	
Nigam et al. (21)	-	-	-	3564	-	2358	-	-	-	-	-
Vasilakis et al. (22)	-	-	-	27236020	-	2910140	1513	-	1213	-	-
Bandla et al. (23)	Min = 25/92	-	Min = 26/94	21640	-	21752	-	-	-	-	-
Olakulehin and (24)	-	-	-	128650	-	81000	-	-	-	-	-

[z]Abbreviations: BL, blended learning; F2F, face to face education; ICER, incremental cost-effectiveness ratio; QASE, number of students educated x the group's average rating; SD, standard deviation.
[a]Values are expressed as mean ± SD or No. (%).

Table 2. Comparison of Virtual, Traditional, and Blended Education in the Selected Articles

References	Year of Publication	Results
Battaglino et al. (15)	2015	Virtual education was more cost-effective with lower costs than blended education, and virtual education was more effective than blended education.
Abeysinghe et al. (16)	2013	Findings demonstrated that the costs incurred for blended learning were higher than traditional courses. Because of the high delivery costs in online learning, blended learning provides more profits to students by reduction of opportunity and travel costs.
Maloney et al. (17)	2012	Web-based learning is more cost-effective.
Fazlollahtabar and Sharma (18)	2008	Total cost of virtual education was higher than traditional education and the cost of blended training was more than traditional method. The traditional system is economically more effective. The final analysis performed the results in favor of a blended system, which takes the benefit of traditional and e-learning systems.
Kumpu et al. (19)	2015	The evaluation demonstrated that the costs of BL were substantially higher than the traditional CL and there was a slight difference between the groups in learning outcomes.
Maloney et al. (20)	2015	The BL method was more affordable and more effective to work than the face to face approach.
Nigam et al (21)	2015	Traditional education costs higher compared with virtual education, and virtual training was economically more costly than traditional education.
Vasilakis et al. (22)	2014	E-learning was more effective to operate than the traditional education.
Bandla et al. (23)	2012	Cost-effectiveness of online education was higher than traditional education.
Olakulehin et al. (24)	2011	Cost-effectiveness of distance education was higher than that of traditional education.

[z]Abbreviations: BL, blended learning; CL, classroom learning;F2F, face to face education; ICER, incremental cost-effectiveness ratio.

3.3. Quality Control

The CHEC checklist was utilized to examine the quality of the studies. According to the checklists completed for each paper. Based on the checklists completed for each paper, of which three studies obtained a score of 18, two studies scored 15, two studies obtained a score of 16, and three studies scored 17, 13, and 12, respectively (Table 3).

Table 3. Quality Analysis of the Included Studies

Q	1	2	3	4	5	6	7	8	9	10
1	No	No	No	Yes	Yes	No	Yes	No	Yes	Yes
2	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
4	No	Yes	Yes	Yes	Yes	No	Yes	No	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
6	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
7	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
8	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
9	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
10	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
11	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	No	Yes
12	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
13	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
14	No	No	Yes	Yes	Yes	No	Yes	No	No	No
15	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	Yes
16	No	No	Yes	Yes	Yes	No	Yes	No	No	No
17	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
18	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	No	Yes
19	No	No	No	Yes	No	No	No	Yes	Yes	No
20	No	No	No	No	No	No	No	Yes	Yes	No
Total	13	15	17	18	18	12	18	16	15	16

[z]Abbreviation: Q, question.

3.4. Data Analysis

Battaglino et al. (15) claimed that virtual education costs less than the blended model. They also showed that the productivity of virtual education was significantly higher than that of the blended model. The average cost of virtual schools was 5,000 to US$7,700 and to US$7,600 10,000 for blended training (15). The results of their study were consistent with those of Maloney et al. (17) and Vasilakis et al. (22) studies, indicating that virtual and web-based education is less costly than traditional education. Also, virtual education is more cost-effective than other training model.

Abeysinghe et al. (16) showed that blended training was more cost-effective than traditional and virtual educations, which is consistent with the results of the Maloney et al.'s study (20). Maloney et al. (20) concluded that the blended training is more cost-effective than the traditional model and saves US$1/10 per student in comparison with traditional education. The cost-effectiveness of the blended model was 24% more than the traditional method. These findings are inconsistent with the findings of studies by Fazlollahtabar and Sharma (18) and Kumpu et al. (19). Fazlullahtabar and Sharma (18) reported that the total cost of virtual and blended educations is higher than traditional training, while traditional education regarding economic efficiency. Kumpu et al. (19) also concluded that the cost of blended training was considerably higher than traditional education and reported a slight difference in the effectiveness of the two methods. Nigam et al. (21) showed that traditional education is more costly compared with virtual education. Bandla (23) showed that the cost-effectiveness of online learning is more than traditional education, and provided a more reliable educational platform for medical students during internship. These results are in agreement with the findings of a study by Olakulehin and Panda (24) indicating that the cost spent by students on distance education is less than that of traditional education.

4. Discussion

The current research aimed at investigating the efficiency of e-learning and traditional education in terms of health technology assessment. The current study compared the cost-effectiveness of traditional education versus virtual education in a systematic review. To compare these studies, a systematic review was conducted using the cost-effectiveness as the measurement. For example, Maloney et al. (17) study entitled "breakeven, cost-benefit, cost-effectiveness, and willingness to pay for web-based versus face-to-face education delivery for health professionals" can be noted. Randomized results controlled trials demonstrated that there were no significant differences in outcomes between groups, except for Web-based education group that reported spending significantly more time (median and interquartile range of 1/0 and 0.8 – 2/0 h compared with 0/0 and 0/0 – 1/0 h, respectively) engaged with the additional learning materials than the face-to-face group (rank-sum test: P = 0/002). The mean (SD) mark (used for calculating QASE in the cost-effectiveness analysis) of the integrated examination and practical assignment for Web-based and face-to-face methods was 83.2% (9/9) and 81.6%, respectively. This finding is also consistent with the results of Olakulehin et al. (24), Vasilakis et al. (22), and Nigam et al. (21). Olakulehin et al. (24) demonstrated that significant private costs learners incur both at the pre-entry and during the course of their studies for higher education in Nigeria also It was found that the private costs for students using the distance learning mode (like NOUN) were significantly lower than those occupied in pursuing university education via the conventional education model, like the University of Lagos. In the end, the paper concluded by advocating more importance and emphasis on open and distance learning methods for university education and training in Nigeria and other developing countries. It also recommended that funding agencies and scholarship granting organizations would access a larger number of interested grantees using the exploration of distance learning approach, whose costs are lower and entails a much lower private contribution from learners. Also, Vasilakis (22) concluded that the cost for implementing an e-learning system for 2,050 students through one year was about €2,925,800. In contrast, at the same time and for the same number of students, it was €4,100,456 for a traditional system of learning. That means that we can save about more than €500 per student per year. Also, the cost of implementing a traditional learning system for 17,500 students through one year was about €27,179,500, and at the same time and for the same number of students, it was estimated €17,489,700 for an e-learning system. That means that about €10,000,000 can be saved, which is about €554 per student per year. Nigam et al.'s study (21) in 2013 entitled "digitizing education: a cost-benefit analysis" revealed that wonders in digitization could be observed with a greater impact on development in the education sector and innovation in technology. Moreover, virtual training was economically more costly than traditional education. Bandla et al. (23) study indicated that because short-term and long-term learner performance outcomes were roughly equivalent, according to the delivery method, the cost-effectiveness of online learning was a viable instruction platform for clinical clerkships economically and educationally. Results of these articles are completely in contrast with those of Fazlollahtabar and Sharma's study (18). He demonstrated that the traditional system was more cost-effective. In addition to the associated economic disadvantages, several factors support the e-learning system. The final analysis performed findings to the benefits of a blended system, which takes advantage of both traditional and e-learning systems. Kumpu et al. (19) in 2015 indicated that blended learning (BL) costs were substantially higher than the traditional classroom learning (CL) approach. This study also demonstrated

that delivering the course as BL incurred more than double the costs that were examined for the CL approach of the course at the Stellenbosch University that also had the highest number of participating students. No notable difference was found in students' learning outcomes. The result of this research was consistent with that of Fazlollahtabar research. Maloney et al. (20) research in 2015 came to this conclusion that BL method was affordable and more effective to perform than the face to face (F2F) approach. The ICER value comparing F2F to BL was -$1.10, showing that to operate the BL model, there is a saving. The findings of this research are similar to the research by Abeysinghe et al. (16), showing that the overall total costs of the course augmented with the introduction of the online component; which consists of 101% augmentation in course development, 6% augmentation in course material production, and 124% increase in course delivery that indicates online tutoring as the most costly component of this blended course. So, prioritizing of the most crucial elements of learning is very critical and evaluating the ratio of print, F2F, and online components accordingly. The results of the present study were in contrast to the results of Battaglino et al.'s research (15) who realized that the average overall per-pupil costs of both models were significantly lower than the $10,000 national average for traditional brick and mortar school settings and virtual schools on average were inexpensive than blended schools. These ranges are lightening from $5,100 to $7,700 for virtual schools and $7,600 to $10,200 for the blended version. Economic analysis of Web-based versus F2F training to improve the student's performance differed based on the sort of analysis and stakeholder perspective undertaken. The Web-based educational approach from the perspective of the education providers. In the existence of equivocal findings for comparisons from other stakeholder perspectives, it seems that providers will try to deliver education in a web-based medium than an alternative F2F approach.

5. Conclusions

In general, this study was done to find varied aspects of choosing a system for implementation. Based on the results, the blended approach provides a more acceptable economic condition in the future, because of the lack of environment for incorporation in the traditional system and infinite capacity of the e-learning system. Also, a transmission from traditional to the blended system will elude the shock created by a sudden substitution of the educational system with e-learning. Therefore, considering the importance of education, this model should be provided for students by governmental resources. The importance of teaching-learning and the increasing demand for education from one side and the emphasis on the effectiveness of education, while reducing its costs, on the other side, are the challenges that all educational organizations are facing. Undoubtedly, the emergence of new educational technologies as well as e-learning help to provide such opportunities, but they do not lead to profound and effective learning. Virtual education, despite all its advantages, has its limitations such as relatively high initial costs, limited access to the exploitation, limited access to a computer and its accessories, limited management and monitoring of computer resources, as well as educational services and their systematic guidance, depriving students of the benefits of ethical and educational relationships with teachers, and bandwidth shortage in multimedia courseware. On the other hand, traditional education, along with its constraints, has some advantages such as helping the lecturers in teaching the contents and encouraging the students to learn, linking past and present experiences of learners, accelerating and facilitating getting information, receiving feedback from others, which cannot be completely ignored and only use virtual education. Therefore, due to the advantages and limitations of both traditional and virtual education, the blended model was created. Since most of the articles emphasized the cost-effectiveness of virtual education and blended training, using the blended approach provides the opportunity to benefit from both educational models; this approach can be effective in learning and teaching processes in different manners including quick feedback from the lecturer to the student, increased human interactions, and flexibility in education. In addition, the blended learning approach in terms of cost and expenses has a priority in all educational organizations; for example, some of the practical activities have a great deal of complexity and cannot be taught face-to-face in the classroom; therefore, blended learning provides the opportunity to simulate such activities in a computer environment to teach learners with less cost, time, and risk. Therefore, it can be concluded that the use of this emerging approach in education is not merely a fashion. Still, it is also necessary to increase the effectiveness of training courses and, on the other hand, reduce the direct and indirect costs of education. Also, it should be noted that blended traditional-virtual method requires the prerequisites that preparing the virtual university website and empowering professors and students to use new technologies, as well as culture-building and shifting the scientific attitude toward e-learning, are of the most important ones.

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