

Economics of E-Learning: Indicators of Comparative Cost Analysis in Higher Education

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Abstract:

Estimating cost function for technology based e-learning and face to face traditional learning is important to understand the economics of higher education. Universities are raising their tuition fees, especially for face to face learning to meet increasing cost of higher education. This study attempts to identify and compare the cost components of technology embodied higher education (e-learning) and face to face traditional system of higher education. Cost components are divided in terms of universities' cost of education, students' cost of education and social cost of education. This paper is a background work to initiate an empirical study of comparing cost of higher education. Hence it would clarify and explore the essential elements of cost associated with higher education.

1. Introduction

In the verge of increasing cost of face to face learning in higher academic institutions students are showing a tremendous interest on e-learning. E-education refers to a system in which learning materials are available to students in electronic form (Pegrum, Oakley & Faulkner, 2013), teach and support students via online and provide on-line administrative service, e.g. enrolment, billing, information and advice (Rumble, 2004). Littlejohn and Pegler (2014) defines e-learning as "... the process of learning and teaching using computers and other associated technologies, particularly through the use of the internet" (PP. 17). Technological development has initiated a new paradigm for e-education in higher academic institutes. As such, the concepts of education and learning have evolved beyond their traditional dimensions into a new system of independent space and time, which has potential to minimize costs of higher education. E-learning eliminates distance and time, thus facilitates fast and flexible learning opportunities in terms of financial and economic wellbeing of all stakeholders.

E-learning is used to deliver education and training using various electronic devices based on World Wide Web (www). E-learning facilitates to overcome many barriers associated with traditional face to face learning which include students' tardiness, schedule conflicts, unavailable courses, geographical isolation, demographic and economic disadvantage (Hijazi, 2004). This is why E-learning is becoming increasingly prominent, and more students are enrolling in tertiary education (OECD, 2005), especially in the on-line type of learning.

The economic history of e-education starts from the globalization process and has expended through the technological changes. Table 1 shows some of the major developments of the information and communication technologies over the last two globalization eras, which all help to support e-learning in different ways.

Table 1: Globalization, diffusion of new technology and higher education

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Date	Era of globalization	New technology	Old technology equivalent	Learning support function
1970's	Globalization 2.0 (Friedman 2007)	Interactive computers	Writing	New medium for articulating and engaging with ideas
		Local hard drives and floppy discs	Paper	Local storage with the user
1980's	Globalization 2.0 (Friedman 2007)	WIMP interfaces	Contents, indexes, page numbers	Devices for ease of access to content
		Internet	Printing	Mass production and distribution of content
		Multimedia	Photography, sound, and film	Elaborated forms of content presentation
1990's	Globalization 2.0 (Friedman 2007)	Worldwide Web	Libraries	Wide access to extensive content
		Laptops	Published books	Personal portable access to the medium
		Email	Postal services	Mass delivery of communications messages
		Search engines	Bibliographic services	Easier access to extensive content
		Broadband	Broadcasting, telephones	Choice of elaborated content and immediacy of communication
2000's	Globalization 3.0 (Friedman 2007)	3G Mobiles	Paperbacks	Low-cost access to elaborate content
2010's		Web 2.0	Pamphlets	Social network, Facebook.com, MySpace.com and Twitter

Source: Modified from Diana Laurillard (2006).

Globalization 2.0 compressed by the Great Depression and World Wars I and II, is only defined and led by companies globalizing, which brings interactive computers that start a new dimension and medium of interactive teaching and learning. As a result of these technological developments, telecommunication costs fall dramatically due to breakthroughs e.g. telegraphs, telephones, the web, satellites and fiber optic cables (Laurillard, 2006). Consequently, a global market for e-learning and online education has been established.

Since the late 1990s, there has been enormous interest on e-learning both by practitioners and academics. We enter Globalization 3.0 in about 2000 to transform the world to a global village with high prospects of e-learning in higher education. Downes (2005) suggested that e-learning has entered into a new dimension of Web 2.0 technology (current development trend in e-learning). Along with the development of Web 2.0 technologies social networking sites like Facebook.com, MySpace.com and Twitter, have become more and more popular among the tertiary students, teenagers and young people, and connections are being established between social networking sites and e-learning. Social networking sites are being adopted as a way of studying communication between tertiary staff and students. It means that connections are being set up between social networking sites and e-learning. In the new phase of globalization mobile learning, or m-learning, is treated as the fastest growth area in the field of ICTs in education (Pegrum, Oakley & Faulkner, 2013).

There are various studies to investigate the impact of technology on education, several studies report positive impacts (O'Dwyer, Russell, Bebell, & Seeley, 2008; Goldberg, Russell, & Cook, 2003; Moran, Ferdig, Pearson, Wardrop, & Blomeyer, 2008; Warschauer & Matuchniak, 2010) and few others report negative impacts (Weston & Bain, 2010; Larkin & Finger, 2011). A recent study (Hätönen & Välimäki 2014) that investigates the impact of e-learning on nurses' and student nurses knowledge, skills, and satisfaction found no significant difference between e-learning and traditional learning. None of the research papers have identified comparative costs of e-learning and face to face traditional learning,

The importance of the paper lies to determine the indicators of costs of e-learning and compare those cost indicators against face to face traditional learning for different stakeholders (students, university and government) of higher education. The structure of this paper is as follows: section 2 gives a conceptual framework related to e-learning and cost of education. Section 3 describes cost elements of e-learning compared to face to face traditional learning from the point of view of universities, students and society. Section 4 briefly compares the cost of both systems, and finally section 5 concludes the paper.

2. Conceptual framework

This section deals with conceptual framework which is generally used in research to outline possible courses of action or to present a preferred approach to an idea or thought.

2.1. What is e-learning?

E-learning refers to learning with the use of information and communication technologies (HEFCE, 2005). This definition is broad enough to cover non-online technology, e.g. CD, media and is not confined to a narrow idea based on only “internet-enabled learning”. Because of its importance in tertiary education OECD (2005) refers to e-learning as the use of information and communications technology (ICT) to enhance and/or support learning in tertiary education.

Falch (2004) proposes four types of e-learning classifications: e-learning without presence and without communication, e-learning without presence but with communication, e-learning combined with occasional presence, and e-learning used as a tool in classroom teaching. Following Falch’s (2004) presence/communication classification, Negash and Wilcox (2008) have redefined the terms “presence” and “communication” and expanded the classifications into six dimensions in order to make a distinction between physical presence and virtual presence. These are shown in Table-2

Six e-learning classifications were made for e-learning with physical presence and without e-communication (face-to-face), where both teacher and student are physically present in the classroom, apply e-tools such as video clips, PowerPoint slides, and multimedia to deliver course contents. For e-learning without presence and without e-communication, this format of e-learning is a method of self –learning. For e-learning without presence and with e-communication (asynchronous), neither physical nor virtual presences are needed during studying contents delivery between the instructor and learner. The instructor prepares the course materials and lecture notes and assignments in advance, and then publishes online for students’ access.

Table 2: Different types of e-learning

Classification	Presence*	e-	Alias
Type A	Yes	No	Face-to-Face
Type B	No	No	Self-Learning
Type C	No	Yes	Asynchronous
Type D	Yes	Yes	Synchronous
Type E	Occasional	Yes	Blended/Hybrid-
Type F	Yes	Yes	Blended/Hybrid-synchronous

Source: (Negash & Wilcox, 2008)

* Presence is defined as real-time presence where both instructor and learner are present at the time of content delivery; it includes physical and virtual presence

** E-communication refers to whether the content delivery includes electronic communication or not.

For e-learning with virtual presence and with e-communication (synchronous), the teacher and student do not need to meet physically, however virtual meetings should take place during course content delivery. E-learning with occasional presence and with e-communication (blended/hybrid-asynchronous is a combination of asynchronous e-learning and face to face e-learning. In this format, course content is delivered by occasional

physical meetings that are face to face. E-learning with presence and with e-communication (blended/hybrid-synchronous), requires the instructor and learner meeting (physical or virtual) at the same time during the course content delivery. Some class sessions are held with physical presence (face to face); the rest of the class sessions are set with virtual presence. Overall, it is a combination of synchronous and face to face e-learning.

2.2 Cost of education

The cost function approach is an important tool for higher education policy research. Universities can compare their different modes of education by using cost function. Cost functions also provide an opportunity to evaluate the cost of providing higher education to domestic and international students for online and face to face learning methods. So this section deals with the cost function of education and associated relationship between total, average and marginal costs; it also provides information on the economies of scale and the optimum size of the institution in terms of its cost components.

2.2.1 Total cost of education

The sum of individual cost, institutional cost and social cost is called the total cost of education.

$$TC = UC + SC + EC \quad \dots (1)$$

where,

TC = Total cost of education

UC = Universities' cost of education (fixed and variable)

SC = Students' cost of education (fixed and variable)

EC = Social cost of education (fixed and variable)

While estimating the total costs of education, it is necessary to avoid any type of double counting. If there is transfer in terms of student fee, it is important that private costs of education takes into account only the net of private payment.

2.2.2 Unit cost of education

Unit cost of education generally means cost per unit. Unit cost is important for measuring effective cost of education, when it ignores drop-outs and considers only the learners who are actually attending the classes. The difference between the effective costs and the normal costs of education reveals the efficiency/inefficiency of the given level of educational system.

$$AC = \frac{TC}{TN} \quad \dots (2)$$

By decomposing equation (2) we could write

$$AC = \frac{UC}{TN} + \frac{SC}{TN} + \frac{EC}{TN} \quad \dots (3)$$

There are different types of unit cost measurement:

$$CL = \frac{TC}{TN} \quad \dots (4)$$

$$CA = \frac{TC}{NS} \quad \dots (5)$$

$$CS = \frac{TC}{NP} \quad \dots (6)$$

Where, CL = Cost per learner including drop out students
 CA = Cost per learner who actually attending school
 CS = Cost per successful learner
 TC = Total cost of education
 TN = Total number of enrolled students
 NS = Number of students attending class
 NP = Number of successful students

The selection of unit cost measurement depends largely on the objective. Measuring effective unit cost (CS in equation-6) is important for manpower planning and related purpose.

2.2.3 Cost function and economies of scale

In strategic planning average cost is used to measure economic sustainability of teaching and learning methods. Economic sustainability of e-learning refers to the ability of all stakeholders to finance an ICT-enabled environment over the long term. Therefore cost-effectiveness through economies of scale is important. Most studies considered economies of scale by quantifying the reduction in average cost of product as level of output expands (Lewis & Dundar, 1999). Economies of Scale exist when long-run average cost declines as output is increased, i.e. each additional unit can be produced for less additional cost than the previous unit.

If a technology, for example ICT, exhibits decreasing returns to scale in education, then average cost of education will be increasing as the enrolment increases. If ICT exhibits constant returns to scale, then average cost will be constant in output. If ICT exhibits increasing return to scale then average cost falls due to increase in the enrolment rate. This increasing returns to scale in education sector is desirable as it increases welfare for all stakeholders. The cubic form of the average cost function indicates rising costs of teaching at low student numbers, while the growth rate of average cost gradually diminishes as student numbers rise for higher level of economies of scale.

2.2.4 Econometric estimation of cost function

Traditionally a basic cost function is defined as:

$$C = f(y, p_i, x_i, e_i) \quad (7)$$

Where C is the cost of education, y is the student numbers enrolled in face to face and online courses of study, p_i represents the price of input i for producing y , x_i represents input i , e_i represents error term and f represents the functional relationship relating costs to the level of output. The function f is defined by the underlying education technology that is converting different inputs into the final output. A number of specifications for f are possible, although expressions involving third degree polynomials are preferred because they are capable of capturing total cost movements along production stages of increasing and declining average costs (Creedy, Johnson & Valenzuela, 2002).

For a single-output cost function (equation-7), one method of estimating economies of scale is to examine the ratio between marginal and average costs (Cohn & Cooper, 2004). In this context, marginal costs (MC) and average costs (AC) are defined as

$$MC = \frac{dC(y)}{dy} \text{ and } AC = C(y)/y$$

If $\frac{MC}{AC} < 1$, then there is economies of scale (Brinkman, 1990), in this case university is operating to the left of the minimum point of its average cost curve. Average costs could be reduced by expanding output up to the point where $MC=AC$. Diseconomies of scale can also exist, when $\frac{MC}{AC} > 1$, in which case a university is operating to the right of the minimum point of its average cost curve. Average costs could be reduced by reducing output up to the point where $MC=AC$.

A further graphical illustration of the of the features of costing model in higher education with a possible economies of scale over a wide range of output is presented in Figure-1; this means that the average cost of production of education continues to fall as the chosen level of output increases until that level becomes large. Figure 1 illustrates the average (AC) and marginal (MC) costs, when the output capacity has to be increased it usually involves construction of a large university which has the capacity to produce more students subject to an increased demand. This means that the university may be operating on the declining portion of its average and marginal cost curves, as illustrated in Figure 1.

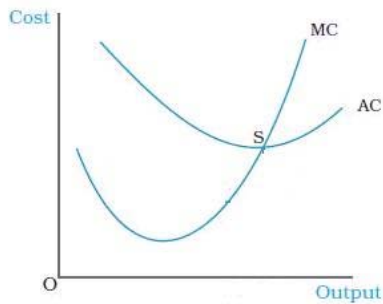


Figure1: Cost of higher education with possible economies of scale

The above theoretical discussion provides a general guidance for data analysis. However, the transition from theory to statistical analysis is difficult as cost functions are dependent on the underlying production function (Creedy, Johnson & Valenzuela, 2002). A possible endogeneity for measuring cost function lies to the fact that cost might defines quality of education. In addition, identifying proxy measures for variables to be included in an educational cost function are also difficult and challenging that we are going to discuss in the next section.

3. Cost elements of e-learning compared to face to face traditional learning

As we mentioned earlier, total expenditure on traditional education rose sharply; therefore, all stakeholders related to education are more interested in whether or not technology could reduce educational costs. It is difficult to compare the costs of distance/online and traditional systems of learning. They might have different objectives; they could teach different subjects or the same subjects in different ways; the prerequisite or educational qualifications of the students entering into the systems may be different, and this could affect their success in producing graduates; and the quality of the teaching might be different (Rumble, 2004). Any one of these variables could affect costs and the way we view them. Generally, however, cost comparisons are confined to institutions teaching at the same level (primary, secondary or tertiary) and the assumption is made that the quality of the education offered is similar. The sub-sections below compare the cost of e-learning with traditional learning considering the key stakeholders (universities, students and governments).

3.1 Universities' Cost of Education

Traditionally universities are labour intensive; substituting IT technology for labour could increase productivity by reducing costs while maintaining same outcomes relative to the traditional ways of handling day to day activities.

The total costs of learning are divided into fixed and variable costs. Fixed costs are defined as those that do not change with a change in the number of students. Fixed costs do not vary continuously, although they may change if activities are ended or if there are very significant changes in volumes. Variable costs tend to change directly (linearly) with the change in activity. Rumble (2004) proposed the basic cost function for any educational system is

$$UC = S\alpha + C\beta + P\gamma + F \quad \dots (7)$$

In equation (7), UC is the Universities' cost of education, S is the number of students, C is the number of courses which are being developed, P is the number of courses being presented to students, F is fixed cost of the system (administrative costs and other overheads), α is the direct cost of teaching per student, β is the direct cost of developing a course, and γ is the direct course-related cost of presenting a course. The direct costs comprises labour costs (payments to authors, editors, designers, broadcast producers) as well as the development and production costs of producing 'master copies' or prototypes of course materials (for example, payments to consultants, payments for rights, cost of editing broadcasts and preparing master tapes, etc.). The total direct cost of teaching students is $S\alpha$, the total direct cost of courses in development is $C\beta$, and the total direct cost of courses in presentation is $P\gamma$. All the costs on the right hand side of the equation are dependent on providers' choice on S, C and P.

Overhead costs are related to management functions (personnel, finance, management services, administration, institutional planning and evaluation, etc.). Overhead costs may also include an allowance for the

replacement of capital (studio and transmission equipment, computers, etc.), all of which will in due course wear out and need to be replaced.

Rumble states "As a general rule, the fixed costs of distance education systems are high when compared to traditional education, but the variable costs per student are low. The result is that (...) the average cost per student falls as student numbers increase. However, whereas the rate of decline in average costs is relatively large to begin with, it quickly falls off."

Table 3 Universities' cost of education: a comparison between face to face and online learning

Cost elements		Face to face cost elements	Online learning elements
Fixed Costs	Capital costs	Construction of building, rental/lease, utilities, insurance, cleaning, power etc.	Learning platform (servers, intranet, software licenses, maintenance, infrastructure, support staff)
		Equipment (furniture, PCs, flip charts, boards, overheads displays, training systems/servers, etc.)	PCs, laptops, networks, intranets, software etc.
		Administration (registration and tracking systems, invitations, reminders, evaluations, etc.)	Administration (registration and tracking systems, invitations, reminders, evaluations, etc.)
Variable Costs		Supplies (printing, workbooks, refreshments, meals, pens, markers, etc.)	Supplies (CDs, supplemental workbooks, supporting Knowledge Management (KM) sites)
		Course development (designers, subject matter experts, editors, etc.)	Course development (web development, designers, subject matter experts, editors, etc.)
		Course delivery (instructors, facilitators, support staff overhead)	Support (Facilitators or coaches, help desk, training customer service, overhead)

Source: modified from Berge, Z. & Donaldson, C. (2008).

3.2 Students' Cost of Education

Students' cost of education (SC) largely depend on the tuition fee per student per course (δ) will follow the following equation, modified from Rumble, 2004.

$$\delta = \alpha + \frac{P\gamma + (C\beta/E_{12}) + F}{\eta} \quad \dots (8)$$

In equation (8), α is the direct cost of teaching per student, $P\gamma$ is the direct costs of presenting the courses, $C\beta$ is the development and production costs of the courses, E_{12} is the elasticity of substitution between e-learning and

face to face learning; and F is the fixed costs of the enterprise, including an allowance for the replacement of capital. The more is the student numbers in the course (η), the lower the fee (δ) for economies of scale.

Table 4 Students' cost of education: a comparison between face to face and online learning

Cost elements	Face to face cost elements	Online learning cost elements
Fixed costs (domestic students)	Direct cost (fees) minus government student benefit Purchasing books, computers and related materials	Direct cost (fees) minus government student benefit Purchasing computer, related technologies and high speed internet
Fixed costs (international students)	International students fee, visa and travel costs, living costs (accommodation and food), insurance costs, Purchasing books, computers and related materials	Direct cost (fees) minus government student benefit (if any) Purchasing computers and related technologies (mandatory purchase) including internet.
Variable costs (domestic students)	Educational loan, foregone income from labour market activity/ other non-market activity during period of education (opportunity cost).	Educational loan, foregone income from labour market activity / other non-market activity during period of education (opportunity cost). Health related problem due to use of technology (eye problem, obesity)
Variable costs (international students)	Educational loan, opportunity cost i.e. foregone income from labour market activity (where they could legally work) / other non-market activity during period of education.	Educational loan, opportunity cost i.e. foregone income from labour market activity (where they could legally work) / other non-market activity during period of education, Health related problem due to use of technology (eye problem, obesity)

Direct costs are the most visible costs; include all money expenditure incurred on different items: expenditure on tuition fees, other fees and charges, purchase of books, stationary, uniforms, hostel accommodation expenses and transport. In e-learning, student related costs include the volume and mode of distribution of reference materials supplied to students, the costs of tutors for marking students' assignments/examination scripts. The variable costs for students depend on the stated indicators and will vary, sometimes depend on the management decision.

Indirect costs (opportunity costs) are those costs which are not directly visible. Students who could be doing productive work rather than spending time in education have opportunity cost. This refers to the value of students' time often measured by the earning forgone for any productive work to continue the study. Any opportunity cost comparison depends on student's time invested on education and related wage of that time.

3.3 Social Cost of Education

Social costs are comprised by environment costs and public costs which include financing by the government on the basis of taxes, loans and other public revenues.

Table 5 Social cost of education: a comparison between face to face and online learning

Sector	Cost elements	Face to face cost elements	Online learning cost elements
Government	Fixed Costs	Subsidizing facilities (building, amortization, rental/lease, utilities, insurance, cleaning, etc.)	Subsidizing learning platform (servers, intranet, software licenses, maintenance, infrastructure, support staff)
	Variable Costs	Students benefit (transfer payment), scholarship	Students benefit (transfer payment), scholarship
		Loss of output (displacement effect), tax forgone	Loss of output (displacement effect), tax forgone (if any)
	Fixed Costs	Co2 and other greenhouse gas emission for fixed establishment costs	Co2 and other greenhouse gas emission for fixed establishment costs
Environment	Variable Costs	Co2 and other greenhouse gas emission for per student learning.	Co2 and other greenhouse gas emission for per student learning.

Both face to face and on-line educations have anthropogenic impact on the environment, which includes carbon dioxide emissions in the production process. Research shows that offering a lower-division class of 100 students with an online format leads to reduce CO₂ emission of 5-10 tons per semester than that of face to face learning (Campbell & Campbell, 2011). Offering online course could result in less carbon footprints compare to online learning as fewer students commute trips to campus. However, online learning is not free from carbon emission because of its establishment cost and other variable cost of using machine and computers per student.

4. Comparing e-education costs with face to face learning

Many countries of the world are emphasising on supply of digitally literate, technologically able graduates who are employable in the digital global economy (Buchanan, 2011). However, there is almost no research on the cost elements of comparing traditional face to face education with e-learning.

The use of media and the problems of managing online students mean that the overhead costs of the institution, the costs of developing a course, and the course related costs of presenting courses are in general higher in distance teaching institutions than in traditional institutions with comparable student numbers. However, cost per student is lower. This is because the relatively limited amount of support given to students means that the direct cost per student is lower, but overhead cost is higher because much of the managerial and academic effort of the institution is being put into the development and maintenance of educational materials and administrative systems for the control of distance students (Rumble, 2004).

In an Australian study Inglis (1999) found if the communication costs are borne by the student rather than by the institution, then there may be some circumstances in which online delivery is less expensive, otherwise not. Battaglino, Haldeman & Laurans (2012) compared financial costs of blended learning and fulltime virtual school with face to face learning and found that average overall per-pupil costs of both models are significantly lower than the \$10,000 national average for tradition-al brick-and-mortar schools—and that virtual schools are cheaper on average than blended schools.

5. Conclusion

In this study we have presented the determinants of comparative costs for both e-learning and face to face learning to provide a more comprehensive picture of the cost components in higher education. While both types of education have similar cost components, we find that the various cost components have somewhat different implications for different mode of education and different resource allocation at both the social and individual level. Basically, economies of scale determine and differentiate the extent of economic costs for e-learning and face to face education.

Thus, one may argue that the high economies of scale to invest in e-learning go a long way toward justifying the society's faith in education, and individuals can minimize their costs. However, we need to know much more about the empirical relationship between economies of scale and cost components of e-learning vs. face to face education. This would justify the importance of e-learning, if any, and its significance for the individual, household and society.

Literature that estimates financial cost functions of higher education both for e-learning and face to face learning is very limited. However, financial estimation is incomplete for educational cost, because education is being treated as a merit good; we need extensive economic study for measuring the true cost of education, where social and environmental costs have to be considered. There is almost no comprehensive empirical study on comparing e-education and face to face learning in terms of their overall cost components. This study has constructed basic elements of the cost indicators in a theoretical way to estimate comparative costs of online and face to face learning. The novelty of this study is that it sheds some lights on various aspects of cost functions including social and environmental aspects which are often neglected but useful for economic analysis.

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