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Evaluation of Enhancement of the E-learning Model for Research and Innovation Development

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Abstract
The internet has become the vehicle for success for many organizations including the education sector, although at the expense of the work force which has continuously reduced due to many activities initially performed by human beings done over the net. The e-learning mode is currently being adopted by many institutions of learning particularly where the classrooms are large and/or the distances to the institution of choice are long. Many lecturers are resistant to this method since they believe it will render them redundant. This paper has evaluated the e-learning method and how it could be used to support research development by reducing the time and enormous finances spent on face-to-face mode of teaching and redistribute them to research development at no extra cost. This will lead to plenty of innovation and increased research output, economic and social development.

Keywords: E-learning, Full Time, Part Time, School Based

1. Introduction

A variety of factors including the increased use of on-line educational technology has pushed Australian universities in recent years to extend the ways in which they deliver learning and teaching (Smith, Ling, & Hill, 2006) [5]. But many Universities are not yet ready for this change and governments have been slow to take the lead (Vassiliou, 2014) [6]. While there are instances of innovation, the landscape is fragmented, various barriers prevent widespread uptake, and fully fledged institutional or national strategies for adopting new modes of learning and teaching are few and far between (Vassiliou, 2014) [6]. Bate, (2015) [1] indicates that there is an important development within blended learning that deserves special mention, and that is the total re-design of campus-based classes that takes greater advantage of the potential of technology, which he calls hybrid learning, with online learning combined with focused small group face-to-face interactions or mixing online and physical lab experiences. In such designs, the amount of face-to-face contact time is usually reduced, for instance from three classes a week to one, to allow more time for students to study online. Jackline K. A. Nyerere, (2012) [2] in their study established that efficient and optimal delivery of ODeL in Kenya faces both economic and infrastructural challenges. However, strengthening the existing relevant structures would address some of the challenges. For many teachers in higher education, the current context of course delivery mode decisions appear to be that "no input is requested or taken," and no research could be found that has addressed the question of optimizing delivery mode decisions. It appears that decisions about whether to teach a course as ace-to-face (F2F), hybrid, or online are often externally imposed onto teachers or are driven by non-pedagogical considerations (Jenkins, 2013). Thus, this research delves into the optimization of the e-learning mode of teaching in line with other modes with a need to determine the limiting factors of the implementation of the mode despite its benefits enlisted or enjoyed by other sectors if adopted. With the lack of research time for many lecturers due to the lack of personnel and thus more teaching and administrative responsibilities as well as large class sizes to attend to the e-learning mode's adoption could reduce times spent on teaching in particular by for example the lecturers not having to move to a particular venue to teach. The lecturers could also record their lessons either visually and/or orally and thus send them to learners who would still undertake their course even in the absence of the lecturers who could be then engaged in a research or innovation brainstorming session.

1.1 Introduction

E-learning has gained popularity in the recent past due to its easy access, low undertaking costs, time saving and wide coverage. Many institutions of higher learning are pursuing the model or are in the process of pursuing it. Despite the

effectiveness of the e-learning mode its effect and impact have not been widespread and full-time mode of learning is still the preferred mode of learning. While full time is an effective mode of learning particularly for the youth since it also acts as a way of socializing and character development, it can be boring for those who have been in school for long as well as those who are working. With the increase in the number of students in school and the high costs of putting up quality facilities for learning as well as personnel and administrative costs it would save the country enormous funds if e- learning was expanded to accommodate in particular the courses that are easy to grasp. Some institutions of higher learning lack required personnel and with limited budgets for the same this could be a solution. Also, this could enable academics personnel save ample time needed for undertaking research since they could be able to teach larger classes with learners attending the classes at their own chosen venues.

1.2 Problem statement
Institutions of higher learning were traditionally designed to be centers of research. The undergraduate students would have a short session with a professor after which a tutorial fellow would then attend to facilitate the students as they undertook the practical assignments given by the professors mark them and forward the marks gained. Post graduate students would only undertake research that led to an enormous number of new findings and innovations which is evidenced by the many books and findings determined in the early 20th century which most of us use currently. Most will attest to the fact that most of the materials used to teach currently were written in the nineteenth and early twentieth centuries. This research was able to determine by comparative analysis and optimization method how to combine different modes of learning to minimize cost and thus by implication maximize returns.

1.3 Objectives
The general objective of this study was to determine the number of e-learning students per course that would minimize cost of higher education under certain limiting factors

Specific Objectives

1. To model the cost of respective modes of learning
2. To determine an objective function that would minimize the cost of learning
3. To model the limiting factors of e- learning
4. To determine the optimal mode mix that would minimize cost of higher education

2. Literature review
2.1 Theoretical frame work
Linear programming, sometimes known as linear optimization, is the problem of maximizing or minimizing a linear function over a convex polyhedron specified by linear and non-negativity constraints. Simplistically, linear programming is the optimization of an outcome based on some set of constraints using a linear mathematical model. Linear programming theory falls within convex optimization theory and is also considered to be an important part of operations research. The general problem of convex optimization is to find the minimum of a convex (or quasiconvex) function f on a finite-dimensional convex body A. Methods of solution include Levin's algorithm and the method of circumscribed ellipsoids, also called the Nemirovsky-Yudin-Shor method.

2.2 Empirical Literature
Linear programming can be solved using the simplex method (Wood and Dantzig 1949) [7] which runs along polytope edges of the visualization solid to find the best answer. Khachian (1979) [3] discovered a polynomial-time algorithm in which the number of computational steps grows as a power of the number of variables rather than exponentially thereby allowing the solution of hitherto inaccessible problems. A much more efficient polynomial time algorithm was found by Karmarkar (1984) [4]. This method goes through the middle of the solid (making it a so-called interior point method), and then transforms and warps. Arguably, interior point methods were known as early as the 1960s in the form of the barrier function methods, but the media hype accompanying Karmarkar's announcement led to these methods receiving a great deal of attention. This study thus uses the simplex method to optimize the suitable methods for learning as per the research's objectives.

3. Methodology
3.1 Formulation of the optimization equations
The number of courses and learning modes anticipated include respectively;

- Courses: Certificate, Diploma, Bachelors, Masters
- Learning Modes Full time, Part time, School Based, E-learning

Let i represent the mode of learning, j the course in the mode, then $\times_{ij}$ represent the number of students in course j of mode i and $y_1, y_2, y_3, y_4 =$ Total number of students in the full-time mode, part time mode, school-based mode, and e-learning mode respectively, Then

$$\times_{11}+\times_{12}+\times_{13}+\times_{14}= y_1$$

$$\times_{21}+\times_{22}+\times_{23}+\times_{24}= y_2$$

$$\times_{31}+\times_{32}+\times_{33}+\times_{34}= y_3$$

$$\times_{41}+\times_{42}+\times_{43}+\times_{44}= y_4$$

and C_{ij} is the cost of course $j$of the mode i, Thus total cost per mode is given by

$$c_{11}\times_{11}+c_{12}\times_{12}+c_{13}\times_{13}+c_{14}\times_{14}=m_1y_1$$

$$c_{21}\times_{21}+c_{22}\times_{22}+c_{23}\times_{23}+c_{24}\times_{24}=m_2y_2$$

$$c_{31}\times_{31}+c_{32}\times_{32}+c_{33}\times_{33}+c_{34}\times_{34}=m_3y_3$$

$$c_{41}\times_{41}+c_{42}\times_{42}+c_{43}\times_{43}+c_{44}\times_{44}=m_4y_4$$

Where m_i is equal to total cost of mode i divide by y_i
Thus, the objective function is to minimize total cost

$$m_1y_1+m_2y_2+m_3y_3+m_4y_4$$

Subject to Cost of changing lecturers attitude (L) on adopting the e-learning mode

$$L_1y_1 + L_2y_2 + L_3y_3 + L_4y_4$$

Ease of Technological access (T) needed for e-learning mode

$$T_1y_1 + T_2y_2 + T_3y_3 + T_4y_4$$

Duration of government policy formulation (P) to empower e-learning mode

$$P_1y_1 + P_2y_2 + P_3y_3 + P_4y_4$$

3.2 Assumptions in the determination of L, T and P

3.2.1 Assumptions made in the determination of L

- Workshops and seminars will build confidence in the use of e-learning by lecturers
- The cost of holding a seminar or workshop does not depend on the course level

3.2.2 Assumptions made in the determination of T

- The assumption is that every student has a laptop and cost of access to internet
- Internet will be availed at the institutions of higher learning
- Access cost is based on duration of course and hours per unit of the course
- Limiting Cost is the vote on internet provision

3.2.3 Assumptions made in the determination of P

- The government will be willing to change its policy on e-learning to enhance the mode of training

4. Results

Data from an institution of higher learning that has the 4 modes and the four sources is tabled below

Table 1: A table of the number of students and the cost per student

	x_{1j}	x_{2j}	x_{3j}	x_{4j}	**Total**
C_{i1}	1000;22000 22000000	3300;30000 99000000	4200;39000 163800000	320;65000 20800000	8820
C_{i2}	500;28000 14000000	1640;32000 524800000	2620;45000 117900000	2100;72000 151200000	6860
C_{i3}	3000;20000 60000000	4000;28000 112000000	3500;33000 115500000	500;55000 27500000	11000
C_{i4}	2000;14000 28000000	3200;21000 67200000	5000;32000 160000000	750;44000 33000000	10950
Total	124000000	803000000	557200000	232500000	37630

Cost is calculated by multiplying number of students per cost per mode and fees per course per mode

Table 2: A table of the cost of a mode j per student

m_i	m_1	m_2	m_3	m_4
	3295	21339	14807	21233
m_i (000)	m_1 (000)	m_2 (000)	m_3 (000)	m_4 (000)
	3.295	21.339	14.807	21.233

This is calculated by dividing the total cost per mode by the total students in the courses

Table 3: A table of the cost limiting factors

Number of units per course	7	21	102	34	Total	Cost per student
Cost of limiting factor per semester						
L_i (15000)	105000	315000	1530000	510000	2460000	65
T_i (3000)	21000	63000	306000	102000	492000	13
P_i (45000)	315000	945000	4590000	1530000	7380000	20

The cost of the limiting factors is a product of units offered per course and an estimated cost of the limiting factor per unit.

Table 4: A table of Limiting cost per student

Number of units per course	7	21	102	34	Total
Cost of limiting factor per semester per student					
L_i (15000)	12	46	139	47	2460000
T_i (3000)	2.4	9.2	27.8	9,3	492000
P_i (45000)	36	138	417	140	7380000

This is determined by dividing the cost per limiting factor by the total number of students per mode

Table 5

Number of units per course	7	21	102	34	Total
Cost of limiting factor per semester per student					
L_i (15000)	105	95	364	1594	2460000
T_i (3000)	42	38	117	40	492000
P_i (45000)	105	236	1311	3060	7380000

The objective function is:

$$3.295y_1 + 21.339y_2 + 14.807y_3 + 21.233y_4$$

Subject to the following limiting functions:

$$105y_1 + 95y_2 + 364y_3 + 1594y_4 \geq 2460000$$

$$42y_1 + 38y_2 + 117y_3 + 40y_4 \geq 492000$$

$$105y_1 + 236y_2 + 1311y_3 + 3060y_4 \geq 7380000$$

The first stage is to formulate the inverse or dual of the formulation above as follows:

Minimize $2460000\,y_1 + 492000\,y_2 + 7380000\,y_3$

Subject to: $105y_1 + 42y_2 + 105y_3 \leq 3.295$

$$95y_1 + 38y_2 + 236y_3 \leq 21.339$$

$$364y_1 + 117y_2 + 1311y_3 \leq 14.807$$

$$1594y_1 + 40y_2 + 3060y_3 \leq 21.233$$

The first iteration of the simplex equation above results into the following:

Step: 1

659/200	0	x3	105	42	105	1	0	0	0
21339/1000	0	x4	95	38	236	0	1	0	0
14807/1000	0	x5	364	117	1311	0	0	1	0
2187/103	0	x2	1594	40	3060	0	0	0	1
		zj-cj->	-2460000	-492000	-7380000	0	0	0	0

Status: Waiting for next Iteration

Pivot 3060

Step 1

Optimal 0

Elapsed 0.0 segs

Solution y_2=659/200, y_5=21339/1000, y_6=14807/1000, y_1=2187/103

and the optimal finite solution is found in Step: 3

55/226	0	y_3	49514/275	0 0 1 0 -131/322	202/1443
3541/2000		y_4	27661/331	0 0 0 1 -93/266	21/289
43/752	492000	y_1	-3283/1028	1 0 0 0 7/699	-1/233
2/323	7380000	y_2	211/375	0 1 0 0 -1/7639	1/2611
		zj-cj->	53569671/442	0 0 0 0 1263473/319	319544/447

Status: Optimal finite solution found

Pivot 99.86274509803921

Step 3

Optimal 73825.23275083448

Elapsed 0.001 segs.

Solution y3=55/226, y4=3541/200, y1=43/752, y2=2/323

5. Conclusion

The optimal solution indicates that the only mode of delivery with more than one student is y_4 which is the e-learning mode thus indicating its viability. The optimal solutions could be improved with the improvement of the limiting factors which have been modeled in line with the e-learning mode thus favoring it and perpetuating its offer. Thus, there is need for consultations among service deliverers who are the lecturers and policy makers on the need to develop a mode of learning that embraces e-learning or adopt the e-learning mode with a view to create time and resources saved from using the mode for research and innovation activities that will boost creativity and lead to economic and social development

6. References

1. Bate T. Deciding on Modes of delivery. In T. Bate, Teaching in a Digital age. Online Learning and Distance education, 2015. https://www.tonybates.ca/.
2. Jackline KA, Nyerere FQ. Delivery of Open, Distance, and E-Learning in Kenya. The International Review of Research in open and Distributed learning, 2012.
3. Khachian LG. A Polynomial Algorithm in Linear Programming. Dokl. Akad. Nauk SSSR. 1979; 244:1093-1096.
4. Karmarkar N. A New Polynomial-Time Algorithm for Linear Programming. Combinatorica. 1984; 4:373-395.
5. Smith A, Ling P, Hill D. The Adoption of Multiple Modes of Delivery in Australian Universities. Journal of University teaching and Learning Practice, 2006.
6. Vassiliou A. New Modes of Learning and Teaching in Higher Education. European Commission for Education, Culture, Multilingualism and Youth, 2014.
7. Wood MK, Dantzig GB. Programming of interdependent Activities, I. General Discussion. Econometrica. 1949; 17:193-199.
8. Tokhomirov VM. The Evolution of Methods of Convex Optimization. Amer. Math. Monthly. 1996; 103:65-71.