Cost-effectiveness analysis of “ICT in Education” in developing countries

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Developing countries need to begin acquiring experience using ICT in educational purposes. Otherwise, educators of developing countries will be marginalized in the international dialogue of education world.
(World Bank, 1996)

Abstract

Even though, technology had been always matter about its high cost, today technological tools and software had been widely implemented in educational settings to enhance the teaching and learning. But, developing countries were always on the economic burden for the expensive technological tools and training cost.

The main purpose of this study is to recommend a few strategies, which focus on how to reduce the cost and increase the benefits of Information and Communication Technology (ICT) in education. The study has three main sections. In the first section, it provides background information about cost analysis and its four approaches. In the second, it highlights the significant role of cost-effectiveness analysis (CEA) of ICT in education, and also discusses the selected cases & studies about CEA of “ICT in Education” in developing countries. The final section contains the conclusion and recommendation of the study, which focus on the cost reduction strategies to optimize the utilization of ICT in education (to integrate technology in teaching and learning settings) with the available resources and budget.

Additionally, this study suggests the urgent demand of solid strategies for the “development of cost-effectiveness integration model” to integrate ICT in education for effective teaching and learning.

Cost Analysis

Cost analysis in educational settings refers to an evaluation process of using a broad set of techniques for evaluation and decision making process (Levin & McEwan, 2001, p.4). “The purpose of cost analysis is to assist in making decisions about the use of scarce resources” (Potashink & Adkins, 1996). There are four approaches of cost analysis:

1) Cost-effectiveness analysis (CEA)
2) Cost-benefit analysis (CBA)

3) Cost-utility analysis (CUA)
4) Cost-feasibility analysis (CFA)

Cost-effectiveness analysis. Cost-effectiveness analysis (CEA) refers to the consideration of most appropriate alternatives where both costs and consequences are considered in a systematic way (Levin, 1995). It had also been defined as a method of economic evaluation that allows task to be done with efficient consequences (Robinson, 1993, p.793). In order word CEA "is designed to compare the cost and effects of two or more alternatives with similar objectives" (Levin & McEwan, 2001, p.108). Considering these definitions, CEA could be defined as consideration of the alternatives by accomplishing most efficient result economically; where, those alternatives need to have similar goals and objectives.

The purpose of CEA is "to provide a method for choosing among alternatives in order to select those that are able to accomplish a given result most parsimoniously" (Levin & McEwan, 2001, p.1).

Cost-benefit analysis. The CBA is an analysis of the benefits in relation to the costs of a project or any educational programs (United Nations Educational, Scientific and Cultural Organization [UNESCO], 2011). CBA is one of the effective tools for proper functioning, growth and development of any organization (Jhamb & Pahuja, 2008). It "refers to the evaluation of alternatives according to their costs and benefits when each is measured in monetary terms" (p.11) and it determines all the alternatives in terms of monetary values of costs and benefits (Levin & McEwan, 2001). This approach helps to judge the overall size of net benefits of a program or policy which had been employed to develop a framework for tele-learning and employing ICT tools & software in Indian libraries (Cukier, 2006; Jhamb, 2008).

Cost-utility analysis. CUA "refers to the evaluation of alternatives according to a comparison of their costs and their utility or value" (p. 19), where utility focused on satisfaction of individual from one or more outcomes (Levin & McEwan, 2001). CUA could be considering as very nearby to the CEA based on the measure of effectiveness because; CEA is depends upon a single measure of effectiveness whereas CUA depends upon single or multiple measures of effectiveness.

Cost-feasibility analysis. Unlike CEA, CBA and CUA analysis, CFA "refers to the method of estimating only the costs of an alternative in order to ascertain whether or not it can be considered"(pp. 22-24) where budget is going to estimate before any further analysis (Levin & McEwan, 2001).

Cost-effectiveness ratio

Cost-effectiveness ratio (CER) is a ratio to identify the effectiveness of alternatives. It signifies level of effectiveness among alternatives for the given cost which can be calculated as: CER= C/E where C stands for cost of a given alternatives and E stands for effectiveness (Levin & McEwan, 2001, p.133).

In some case, effectiveness-cost ratio (ECR) is used to "choose the alternatives that provide the greatest effectiveness per unit cost" (p.137) which can be calculated as: ECR=E/C (Levin & McEwan, 2001). Nevertheless, CER and ECR are same if properly interpreted.

Cost-effectiveness Analysis in Education

CEA has been considering as a key element of educational evaluation because this "can reduce the costs of reaching particular objectives" (p. 6) to achieve the educational goals with provided budget and resources (Levin & McEwan, 2001). Hence, CEA is considered as effective evaluation tools in educational settings which had been carried out in different educational fields as: teacher training (Tatto, Nielsen, & Cummings, 1991), computer-assigned instruction (Levin, Glass, & Meister, 1987), mathematics curriculum (Quinn, VAnMondfrans, & Worthen, 1984), educational television and radio (Jamienson, Kleees, & Wells, 1978).

To perform a CEA, following two criteria need to be considered: 1) Among the many alternatives, programs with similar goals need to be compared, and 2) common measure of effectiveness needs to be judge (Levin & McEwan, 2001, p. 11). CEA does have a many strengths. However its major obstacle: also exist; is that comparing CER, only among alternatives with similar goals. If an alternative with different goals: need to be compared then cost-benefit analysis will be employed.

There are several studies related with effectiveness of educational intervention, but very rare in cost-effectiveness. The clear framework for CEA of technology integrated educational settings and in comparison with other forms of learning is therefore critical for educational policy.

Application of cost-effectiveness analysis

CEA compares the cost of the interventions with their intended impact which has been widely used in the social sector. CEA techniques are very useful tool for project screening and ranking, whereas screening decreases the number of investment alternatives given budgetary constraints while ranking suggests about prioritization of the alternatives (World Bank, 2005). In some case, when rate of investment is not measurable with benefits then comparison is usually done with the CEA using qualitative and quantitative approach. Like increase of cost might be compared with different interventions, like as: increasing in test score, quantity of educational aids etc.

Importance of cost-effectiveness analysis

"Most effective approach is not always the most cost-effective" (Levin & McEwan, 2001, p.11). But, it would be impossible to know the ratio of cost and effectiveness without doing cost-effectiveness analysis. Furthermore, most effective alternative might be very expensive as well as most cost-effective one. That's why; CEA is a crucial tool to have an efficient output in low cost. Hollands, Bowden, Belfield, Levin, Sheng, Shand, & Hanisch-Cerda (2013) state that CEA aims to encourage policymakers to focus on effectiveness or productivity "of alternative educational intentions and to improve the efficiency with which public and private resources are employed in education" (p. 308). This analysis had been applied to several educational researches as; dropout prevention with the selection of appropriate educational programs to increase the completion rate (Rumberger, 2011), decision making process to invest educational budgets (Tsang, 1997).

ICT in education in developing countries

*Developing countries should not wait to introduce "ICT in Education" until a country has reached some economic and educational developmen*t.
(World Bank, 1996)

The world has been rapidly changing with the innovation of varieties of technological tools and software's/applications. YouTube (in 2005) and smart phone (in 2007) brought lots of dramatic changes in the entire world, with in few years. Indeed, today $1,000 laptop is much more powerful and efficient than a $10 million IBM computer of forty years ago (Potashink & Adkins, 1996).

Education has been dramatically influenced by the technologies whereas educational practice has changed very little (Osin, 1998). No doubtfully, ICT have been considered as the mandatory part of education in this 21st century including developed and developing countries of the world. Consequently, developing countries has been

also introducing different national plans and policies to foster “ICT in Education” since last couple of decade. Resulting, countries like Bangladesh, Pakistan and Nepal succeeds to have “Master Plan of ICT in Education” to enhance the technology in education.

World Bank (WB) reported that education is the only way to reach the long-term solution to increase the economic level of low socio-economic group (Osin, 1998), which also discuss: the key problems of education in developing countries as: overpopulated classroom which is beyond the capacity of teachers & physical classroom, insufficient number of teachers due to very low salary in remote areas, high dropouts because of engaging in income generating activates & unsatisfied teaching strategies.

Bajracharya (2014a) found that there are still many hidden and unhidden issues of education in developing countries like: reforming national curriculum (for both public and private schools), technological gap between private schools and public schools, perceptions of conservative teachers and parents, distribution of ICT tools, lack of trained teachers which were considered as hurdles of using technology in education, which needs extra time, fund and expert consultation. However, author suggests that hurdles like: technological gap between private and public schools, distribution of ICT tools and teacher training could be tackle with the implementation of cost-effectiveness framework to introduce “ICT in Education”.

In the context of Nepal, where budget allocation (in education) trend is always decreasing which is not likely to change in near future to expand physical educational institutions and implementation of technology tools (Ministry of Education [MOE], 2014). However, with the application of Open and distance learning (ODL) quality education might be provided with the limited budget in rural part of Nepal (Bajracharya, 2014b).

In 1995 meta-analysis report of “The Costs and Effectiveness of Educational Technology” shows mileage of technology in educations does have characteristics like efficiency and engagement. This report had concluded that computer-based instruction (CBI) could act as a positive catalyst to increase the performance level and cost effective (Melmed, 1995). To conclude this statement, report investigates two different cases (K-12 and aircraft raining) where they had calculated the performance and cost issue.

Firstly, In the case of K-12 education, they had compared with the conventional approaches like: lecture, textbooks and workbooks to know the effectiveness of using technology. They had introduced the multimedia (videodisc approach: using video in classroom) and found that performance percentile had been increased from 50^{th} to 75^{th}.

Similarly, they compared the costs with the different approaches (like: tutors, reducing class size, increasing instructional time and providing CBI) to increase the comprehensive mathematics scores. Author had calculated the cost of different approach (where tutoring cost was 1612 $, reduced class size ranges from 983 $ to 1195 $, increased instructional time reached 2667 $, CBI ranged from 192 $ to 490 $) and concluded that CBI is cheaper approach. Thus evidence shows that, technology integration is a cost-effectiveness approach.

Secondly, In the case of aircraft training, they had compared with the actual aircraft and simulation (by using multimedia) and found that performance percentile had been increased from 50^{th} to 65^{th} via simulation. Regarding the cost issue, difference between the actual aircraft training time with simulation and without simulation had been calculated and concluded that aircraft training with simulation cause low cost. Statistical data shows that an hour of simulation time saves an hour of actual aircraft, where cost of an hour of simulator training is less than the cost of an aircraft hour. Hence this case also proved that technology integrated trainings could increase the performance with in low cost.

Thus the evidence of this report clarifies that how technology integrated course could be a cost-effectiveness comparing with the non-technology integrated courses.

Report prepared by UNESCO also focused on using technology to create an "Open School" considering an alternative schooling usually to remote children (in Latin America, African countries), who could not get to school education (Perraton & Creed, 2000). Commonwealth of Learning (COL) states that Open Schools are urgently needed to provide education for millions of children who does not have access to formal schooling (COL, 2013). In 2010, 71 million children were out of school (UNESCO, 2012). COL defined Open school as; involvement of learning process if there is physical separation between school-learner and teacher, with the implementation of different technologies to provide the education (COL, 2013). Moreover, COL states: addition or expansion of conventional school will be a priority; however they (COL) argues: even if one new secondary school were to be built every month for the next ten year, the demand of conventional school will not be met. Thus COL concluded that open schooling with appropriate technology integration need to be implement to provide education rather than not providing education (because of lack of conventional school). Moreover, technology is an important key stakeholder of open schooling. Later the concepts of open school had been widely accepted and have been implementing in South Asian countries like: Nepal, India and Bangladesh. Presently, Nepal is running open school for primary education (grade one to five) targeting mountainous students

and drop out issues (MOE, 2007).

Cost-effectiveness analysis in ICT in education

This part provides the few studies and case studies which employed CEA to enhance the technology integrated teaching and learning.

Despite significantly reduction of cost of ICT tools in recent years, most countries and school were still not able to afford, which makes them to rely on international agencies and donors. In 1996, "Education and Technology" team of WB had calculated major cost that occurred during implementation of "educational computer applications in developing countries" are as: 1) equipment cost (which is about 25-40% of the project budget), 2) market differentiation (Educational institution of developing countries consider to invest its limited budget for less capable inputs (cheaper one but still educationally effective) rather than high capable inputs (expensive with many functions). This phenomenon of the educational technology industry creates a differentiation in hardware which creates a market differentiation), 3) software, 4) professional development, and 5) property protection (to provide a safe place and necessary security place for technological tools to prevent from being robbery) (Potashnik & Adkins, 1996).

Yet one more, empirical research did by the WB concerning ICT in primary and secondary education in Latin America and Caribbean countries (Belize, Chile, Costa Rica, Jamaica & Mexico) which suggest two major alternatives for cost-effectiveness. In the first alternative; contracting instructor in a school as a private tutor could be consider to reduce the technology training cost of professional development (teachers) of educational institution. Similarly, the second alternative is: assigning the private training institutions for teaching school students rather than having schools purchase equipment and assume responsibility for maintenance, Moreover, second alternative could save high investment to buy educational technological equipment and software in school because private training institution already does have that equipment on advance.

Logically, suggested option seems to be very effective on that time (1996), where most of the government and key stakeholder prioritize to provide knowledge about using hardware and software (MS Office, programming) itself. However, present world is different. Now most of the infants were digital natives (mobile user were everywhere). Most of the old software has been outdated, also very few peoples were using that. That's why, today's world need to consider about "integration of technology in education" rather than technological knowledge (TK) only. Today's necessity is application of technological tools and software's/applications in the content knowledge;

which is widely known as technology integration. Here the purpose of technology integration in education means active engagement, participation in groups, frequent interaction, and connection to the real-world experts that make classroom more interesting and diverse, and also enhancing the teacher-student relationships for better teaching and learning (Euthopia, 2008).

Hence, the option which had been highly recommended by WB in 1996 might not be influential in today's world because it only concentrates on TK. In order to provide the skills and knowledge about technology integration to today's students/children, teacher/instructor need to be a confident to handle and apply technological tools and software's/applications. Orr, Westbrook, Pryor, Durrani, Sebba, and Adu-Yeboah (2013) conducted a systematic review and concluded that there is a positive correlation between teachers confident and motivation of students to learn. Another point made by Orr et al. was: teachers need to have a confident with technology integration in classroom otherwise student's motivation might be negative toward acceptance of technology for education. Authors had also pointed that trained teachers could be effective comparing to untrained or semi-trained teachers and concluded that teachers professional development is very important to increase the performance of students. However, there is still a cost issue for the teacher training trainings. Tatto et al. (1991) noted that implementation of distance education could reduce the financial burden up to some extent: to provide the teacher training comparing to the conventional way.

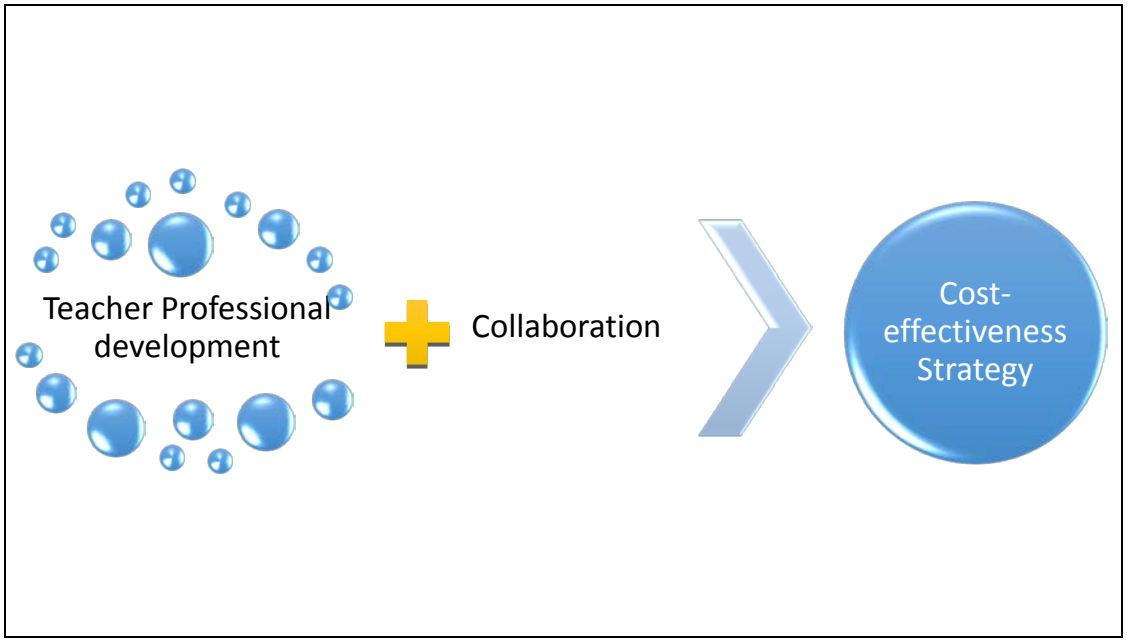
Conclusions and Recommendations

This part will discuss: few strategies represented by table 1, to reduce the cost and increase the benefits of technology integrated program. Based on the above discussions following two points could be considered for effective and efficient to integrate ICT in education.

1) Teacher Professional development
2) Collaboration

Table 1

Cost-effectiveness Strategies



Teacher professional development

"The purpose of teacher training is to equip individuals with the personal and professional skills needed in schools and other learning contents" (UNESCO, 2011, p.11). With the rapid development of ICT and implementation of technology in today's educational system, teacher professional development (TPD) program is also not far from the technological influences.

Jung (2005a) argued that cost effective teachers training approaches increase the quantity of ICT use in teaching and learning. Author suggest: open computer labs to public with low fee, negotiating of equipment cost with vendors, share web based resources for trainings could be a cost-effective strategy for teacher training. Hence, ICT need to be integrate in the TPD program where, initial focus could be centered on 1) how to use ICT tools and software/applications (like: MS Office, Programming etc.) in the classroom and 2) At the same time; Need to emphasis on technology integration to perform educational task, like: presentation skill using PowerPoint, collaboration among teachers and students using wikis, moodle system for communication and report making using Word are few examples where to use TK to perform educational works.

Additionally: many studies had been done about mode of TPD trainings as: 1) face-to-face training, and 2) online training. Jung (2005b) strongly believed that online teacher training is more cost-effective than face-to-face teacher training (p.131), where author had analyzed various qualitative and quantitative data. In this study, author had compared cost and effectiveness of face-to-face and online training course separately and concluded that, total cost of online training were approximately 59% of those of

face-to-face training, whereas cost per enrolled student and cost per completed student of online training course were 43% and 56% of that of the face-to-face training respectively. This shows that face-to-face training is expensive than online training. Regarding effectiveness, teachers who received the training from both modes (face-to-face and online) were trying to use ICT more frequently than before, additionally: online trainees were using internet too. Thus this evidence shows that online teacher training could be providing effectively in low cost.

In 2000, UNESCO reported that teachers training via distance education are cost-effectiveness because establishment of physical school might be very expensive in rural part of Latin America where numbers of enrollment students were not constant in every year which varies based on climate and migration (Perraton & Creed, 2000).

Jimoyiannis (2010) state that pre-service teachers are willing to learn and develop new skills related to their instruction through design authentic activities it is reasonable to engage them in solving meaningful instruction problems through authentic ICT-based learning activities with a sound background (Beyervach et al 2001; Mcdougall, 2008).

In addition to mode of TPD program, pre-service teacher training helps to foster teacher's ability to integrate ICT in teaching once they became a teacher (Chang, Chien, Chang, & Lin, 2012). Presently, developing countries like Nepal has been only employing 10-days in-service teacher training programs, to provide trainings about "ICT in education" (MOE, 2014). It was found that, this type of "in-service training" is not effective because: 1) Many teachers were not able to have a "training leave" because of lack of teachers in school 2) in-service teacher were not willing to adopt those technology due to lack of enough knowledge and fear to use advance technology (Tap Raj Pant, Personal Communication, September 20, 2014).

Among, TPD program via 1) in-service teacher training & 2) pre-service teacher training, pre-service is much more cost-effectiveness and effective to teach and integrate ICT in education because pre-service teachers almost spend three to four years of using technological tools and software's/applications which makes them confidence to teach TK and way of integration to future students (Lopes & Tormenta, 2010; Moore, 2003).

Berhe, Dowling and Nigatu (2014) had implemented two types of training program: pre-service and in-service for pharmaceuticals technicians. Regarding cost, authors had considered different cost issues as: per diem, transport, meals, trainer costs, and costs from removing trainees for their workplace. Thus the result shows that cost for in-service trainee was six times that of a pre-service. Moreover, evidence shows that pre-service trainees do not have transport and pre diem costs. Additionally, effectiveness of training was equally effective which was measured after the graduation

for pre-service trainee. Similar evidences were also found in teacher's ability to integrate ICT in teaching once they became a teacher (Chang, Chien, Chang, & Lin, 2012). Hence, pre-service teacher training could be considering as effective strategy for cost-effective approach.

Collaboration

Many evidences had been found where authorized ICT agencies and international agencies like: IBM, Microsoft, UN, World bank and many more organizations has been doing many projects and investing on long-term educational programs to introduce and integrate ICT in education. Like: IBM in Chile, Costa Rica & Mexico, World Bank in South Asian countries, One Laptop per child (OLE) project in many developing countries, OLE Nepal in remote district areas of Nepal, Microsoft Nepal in higher educational institution in Nepal (Potashnik & Adkins, 1996; Dinesh Khanal, personal communication, September 20, 2014) are some examples for collaboration.

In the context of Microsoft Nepal, which has been doing many technologies, based project work: collaborating with the government and many educational institutions. Its aim is to provide the basic and advance computer trainings about ICT itself and technology integrated program for university students (Microsoft Ventures, 2015). In this program, trainees have been receiving trainings for free of cost after passing certain exam (A. Bailochan, personal communication, August 10, 2015). Bailochan added that after completion of the training and graduation from university, trainee will be asked to do a job as a trainer in their company. Thus, this type of collaboration would help to provide the advance technological skill needed for this 21st century.

Hence, collaboration with 1) authorized ICT agencies, and 2) international agencies & local NGOs could be also consider as cost-effectiveness strategy to introduce and integrate ICT in education in developing countries.

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