Effectiveness of Using ICT in Education

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Abstract — *The globalization and the trend towards a knowledge-based economy emphasize the importance of using Information and Communications Technology (ICT) and e-learning concepts in education. Currently many countries are trying to adapt ICT in many aspects of their education systems. But in many cases, we hear that those attempts become failures due to various reasons such as poor infrastructure, lack of basic ICT knowledge, high cost in implementing the system for the first time in a country etc. This literature review focuses on how we can use ICT successfully in education.*

As our research topic is Effectiveness of using ICT in education, we studied some of the current systems used in various countries, the pros and cons of those available systems and the solutions they provided for the problems they have faced so far. Our view on those problems and solutions are discussed at the latter part of this paper.

Index Terms — ICT, education, e-learning, student centered classroom.

I. THE USES OF ICT IN EDUCATION

As ICT has become a more powerful tool in the 21st century, many people tried to integrate it for the learning environment. Developed countries use ICT in everywhere in their learning environments. However, most developing countries do not properly use ICT as a powerful tool.

Haaksma-Oostijen and Puper [1] emphasized that nowadays students in Netherlands use ICT as a source of information and a ways to contact world outside the school. The government of the Netherlands has founded a knowledge base called Kennisnet to interconnect Schools, Libraries, Universities, Museums and other knowledge centrals. Their student generation could use any knowledge resource using this network. The ICT infrastructure is not properly used in third world countries like Ghana. According to the Alfred Martey [2], the computer giant Microsoft agreed with the government of Ghana for skill training in ICT for teachers and students. The ICT authority of Ghana has created a learning network, which connects all the universities to help students to gain access to the learning materials island wide.

Some methodologies which used by Malaysian Mathematics teachers in the learning environment have identified by Chong, Sharaf and Jacob [3]. Most of them use Word processing packages, spreadsheet packages and presentation tools for teaching. Some teachers, who have access to the internet, use the internet to improve their knowledge. So in some countries like Malaysia, the ICT is playing a better role in education system.

Tinio, V. L. [4] has done a good analysis about uses of ICT in education on his research paper "ICT in education". He has emphasized that the television and radio broadcast is a key thing in education because almost all the people in a country have access to at least a radio. So radio and television broadcast have used as a powerful tool. That broadcast has used in education system in three ways. In school context, broadcast has used as a presenting tool for teachers or as a separate stream for extra education. In the community context, broadcast has used to broadcast educational programs. That helps to educate the whole community at once. China, India and Indonesia are the countries, which use effective television and radio broadcasters in Asia. In their universities, they use direct class teaching to reach their larger population. Some schools and institutes use offline-educating materials such as CD-ROMs, Cassettes and Tapes for their teaching process.

In addition, some education systems use teleconference for the education system. With teleconference, students and teachers use peer-to-peer learning to improve their knowledge. Tinio, V. L. [4] has divided current teleconferencing methods to four major parts.

1. Audio Conferencing
2. Audio – graphic conferencing
3. Video Conferencing
4. Web based conferencing

Audio conferencing refers to real-time telephone conferences. Audio-graphic conferencing refers to audio conferences with graphic, diagrams and pictures exchange. Video conferencing refers to conversations with both audio and video. That is a very powerful tool in the learning environment. Web based conferencing refers to the communication through the internet. Such as e-mail, web sites, etc.

Hennessy, S., Harrison, D., &Wamakote, L. [5] indicates two main reasons why teachers use ICT in education. First reason is teachers' own benefit and to improve their own knowledge. Second reason is to teach students. Students are more attractive to the ICT tools. Therefore, teachers can teach students via ICT tools without losing their attention.

We discussed the current uses of ICT in educations systems in various countries so far. Those people try to integrate ICT into their education system somehow or other, because there are many advantages in Using ICT, than using the ordinary

methods to teach the 21st century generation.

II. Advantages of Using ICT in Education

When we consider about our research topic-"Effectiveness of Using ICT in Education", advantages of using ICT in education is one of the important points to discuss. According to our research papers although it is difficult to establish, there are many advantages of using ICT in education.

One of the main advantage of using ICT in education is that learning process become very interactive thing and it make life easier both students and teachers. As mentioned in research paper Exploring the extent of ICT adoption among secondary school teachers in Malaysia[6] by using web sites like e-blackboard that can be hosted by school, can build an online learning environment. Teachers can upload assignments and other leaning materials. Students can refer those materials and if they have any problems, they can do online discussion with their teachers. Connection between teachers and students is increased because of this process. Not only that by establishing these kinds of connections through the web within schools, communication between teachers among different schools is developed and it is very important to improve their knowledge and to hold a good teaching process.

According to the Kumiko Aoki [7], ICT play an important role in higher education in Japan. In his research paper, he explained how ICT helps to overcome limitations in higher education. He mentioned with the percentages how e-learning is spread in Japan higher education institutions. He recognizes three main reasons that are directly affected to this spread of e-learning. Those reasons are

1. To offer effective instruction to students (81.6%)
2. To offer education efficiently (60.7%)
3. To respond to diverse needs in learning styles (60.4%)

According to his explanation, we can identify the advantages of using ICT in higher education.

Students' interest to learning is also increased because of using ICT [8]. Learning is become a boring activity to most of the students. However, using ICT it can convert to an interesting and active work. Because of that, students' passion in education is increased and they participate to the learning process actively.

Computers can be effectively used to support students talk and improve their discussion when they work in small groups [9]. Computers that are connected within small groups help to improve students' these collaborative tasks. Because of that, effective learning process can be established and students understanding and their knowledge can share among small groups.

Another main advantage of the ICT is interactive white boards (IWD) [10]. They explain how the structure of the classroom and learning process are changed because of this IWB concept. Because of these types of concepts, learning process becomes more interesting and interactive.

In the research paper Teacher Factors Influencing Classroom Use of ICT in Sub-Saharan Africa [5], authors recognized specific ways that ICT use enhances teachers' professional knowledge and capabilities. Those are,

- Extending subject knowledge
- Enabling planning and preparation for teaching to be more efficient
- Developing the range of teachers' existing pedagogic practices

In addition to that this paper mentioned another important fact that workload not only students but also teachers is reduced because of using computers and web. Teachers can use ICT effectively to reduce their workload in many things such as preparing papers, assignments etc. because of the workload reduction in other activities, teachers can increase their attentiveness in teaching process.

Liu and Bacon [11] discussed in their research paper about using ICT to enable people who have significant difficulties to experience better learning in an educational setting such as a college, home or social community. In addition to that, they recognize necessity of the vocational trainings for people who have special educational needs.

III. Drawbacks, Issues and Key Challenges in the Use of ICT in Education

So far we have discussed about the usage of ICT in education process and the advantages of using ICT in education than using the ordinary teaching and learning methods. Prof. Ghosh et al. has listed few of the drawbacks of using ICT in education as follows. "

1. It may create a digital divide within the class as students who are more familiar with ICT will reap more benefits and learn faster than those who are not as technology savvy.
2. It may shift the attention from the primary goal of the learning process to developing ICT skills, which is the secondary goal.
3. It can affect the bonding process between the teacher and the student as ICT becomes a communication tool rather than face to face conversation and thus the transactional distance is increased.
4. Since not all teachers are experts with ICT they may be lax in updating the course content online which can slow down the learning among students.
5. The potential of plagiarism is high as student can copy information rather than learning and developing his or her own skills.
6. There is a need for training all stakeholders in ICT." [12 pg. 10]

Although it is easy to imagine a world - full of ICT equipment and productive usage of them, it is very difficult to realize that dream in real world, due to lots of constraints.

As the resources in this world are not equally distributed to

the entire population, we cannot even think of a world where the every student is living a luxurious life and using ICT to his learning process. So, the main issue we find here is lack of infrastructure for implementing an ICT based education system [13], [5], [4]. We can find this issue in any country when introducing ICT into education. Ashish Hattangdi and Prof. Atanu Ghosh also have identified that issue in Indian education system during their research on enhancing the quality and accessibility of higher education using ICT [12]. Even in a developed country like Japan, they had to face this problem [7]. Although it is not very difficult for the developed countries to provide relevant ICT infrastructure to the institutions, teachers and students, it is very difficult for the poor and developing countries. Effectiveness of using ICT in school education largely depends upon the availability and accessibility of ICT resources such as hardware, software and communication infrastructure. If those things cannot be accessed by the teachers and students, ICT will never be used in schools mainly in developing countries. In many Sub-Saharan African countries, the process is affected by lack of reliable access to electricity, internet access and extreme poverty of people [5]. Those resources are more available in urban areas than rural areas in any country. Therefore, the rural population will miss the chance of getting the education in an enhanced manner, using ICT.

Another issue we identified in these projects is lack of general ICT knowledge of teachers and students. For many people still ICT is a strange thing. They fear to use ICT and to change the general way they have followed so far. That is actually a psychological fear that some people have in their minds. Their fear for getting into a changed path is a big constraint in the process of introducing ICT into education. Andrew E. Fluck [14] examined that the teachers would not accept computers to the teaching environment unless reliability and usefulness of them are proven. Before introducing computers to the learning environment, the teachers should have an excellent awareness of the use of computers. But nowadays students have better awareness than teachers. The teachers need to have a sufficient ICT knowledge and skills when integrating ICT in new student-centered learning approaches [5]. The student also should have basic computer literacy. If they do not have such knowledge, they should be given a proper basic computer education. Both the teachers and students need to be familiarized to the new concepts, new applications etc. and to adjust to the situations [13].

A main question that rose in this scenario is that "Will ICTs replace the teacher?" [4] The answer will be definitely "NO". There are many tasks and activities in a classroom that should be done by a teacher and a computer cannot do. This is not related to the case of distant learning. Even 100% perfect computer software only provides an additional experience. That experience should be taken by both the students and the teachers together. There are many valuable,

important and enjoyable activities in a classroom, which can never be replaced by a technology. Usage of ICT along with those values makes the education process more effective [8]. Trying to change the classroom based education system is not a good solution. We just try to change the teacher-centered classroom into a student-centered classroom and to increase the percentage of self-learning of the students with the help of ICT tools in integrating ICT into education system.

Cost will be another barrier in integrating ICT into education. It can be considered as the reason for the previously mentioned issue of lack of ICT facilities. It is true that it costs a lot of money to change an existing system into a new system, which needs more infrastructures. According to Tinio V.L., "for computer-based approaches the total cost of ownership therefore includes:

FIXED COSTS
  • Retrofitting of physical facilities
  • Hardware and networking
  • Software
  • Upgrades and replacement (in about five years)
VARIABLE OR RECURRENT COSTS
  • Professional development
  • Connectivity, including Internet access and telephone time
  • Maintenance and support, including utilities and supplies"

Joseph Intsiful, Dr. Philip Fosu Okyere, Dr. Shiloh Osae [15] recognize brain drain which has resulted in the lack of the critical mass of ICT-engineers and scientists relevant for undertaking ICT-related project professionally as the major challenge for the development of ICT education in Ghana and they suggest to build an aggressive human capacity in ICT through training workshops, seminars and courses as a solution above challenge. It is also a huge problem for other poor countries. But luckily, a country like Sri Lanka does not have such a problem, as there are a plenty of professionals who are capable of handle such big ICT projects.

In order to successfully integrate ICT into the education system we have to somehow or other addresses these issues.

IV. INNOVATIVE SOLUTIONS GIVEN BY THE PREVIOUS RESEARCHES

According to the reviewed research papers, lack of teachers' knowledge in ICT is a huge barrier for using ICT in education. So this problem must be addressed first to get the maximum use of ICT to make education effective.

According to the paper Teacher Factors Influencing Classroom Use of ICT in Sub-Saharan Africa [5] UNESCO has identified three approaches to solve this problem. Those are technological literacy, knowledge deepening, and knowledge creation. Therefore, this research must be concentrated on above factors.

Next and may be the most important factor is students.

Students also have to have a good understanding about using ICT. Otherwise, all the effort of introducing ICT to education may go in vain. There is another side of this. Though students have good understanding about how to use ICT, they may not aware about the tools, which can be used for their education. This fact is highlighted as "Introduction to ICT" before the questionnaire. As the result, the researchers found that most of the students, who use computers and internet, do not use wikis properly. But most of the students had good ICT capabilities and searching abilities." [16] As a solution to overcome these problems the research A study on the use of ICT in mathematics teaching[3] propose to introduce e portals as everyone can share their experiences and knowledge. In this research, it will be furthermore analyzed on this solution and how the implementation should be. Also in this research, it should be considered on how the training programs for the student should be launched.

Most of these problems cannot be solved easy without government influences. With the help of the governments, some countries are already uses ICT effectively in education [2], [3]. However, in poor countries, government cannot expend lot of money for developing an ICT infrastructure in education [6]. So introducing cost effective ways, which can be used by governments to increase the effectiveness of ICT in education, must be a part of this research.

Effective use of ICT education does not means only information sharing. It also includes "multimedia visualizations and representations, online production, commenting and networking tools and didactical and methodological tools" [17]. So each of these methodologies and tools must be analyzed and used to effectively use ICT in education. Also, there are some fields of education, which will be more benefited by using ICT in the teaching and learning process. A study on the use of ICT in mathematics teaching [3] and Adoption of ICT in science education: a case study of communication channels in a teachers [18] proves this. Therefore, more attention must be placed on these areas.

ICT can be used to change the teacher centric education in to a student centric education. Research by Kumiko Aoki [7] explains how the use of ICT did this in Japan. So it should be adapted and used in all other countries because student centric education is more effective than teacher centric education.

There are some arguments related to this topic saying new methods like ICT cannot replace traditional educational methods. That is true to some extent. However, the approach should not to replace traditional methods but to use ICT alongside with the current methods. Important of this is emphasized in the research by Jones [19]. This is a good topic to do further researchers.

Some under developed countries are afraid to invest money to introduce ICT because they think country will not get any profit from it. But researches [2] have proven by doing that it will help the development of country. So authorities must be informed about the benefits of this. Results from previous researches will help to do this.

Above facts are some given solutions to some of existing problems. But some of this are less practical and should be optimized. Also still, there are many problems without solutions. So this research will concentrate on doing those things.

V. HOW CAN WE USE ICT IN OUR EDUCATION SYSTEM?

A. *The Solutions we proposed for the identified problems for making the system more effective*

Up to now, we discussed about the issues of the current ICT system and then we discussed about some solutions suggested by some renowned researchers. In this section, we are going to present out viewpoint about this solutions. Furthermore, we will suggest some new solutions and some improvements to the discussed solutions for making the use of ICT in education effective as much as possible.

The major issue identified was the lack of resources. Under that lack of computers, poor internet connectivity is identified. The high cost to develop ICT infrastructure causes this problem. Specially underdeveloped or developing countries suffer this problem. As a solution for this, a low prize computers should be introduces to these countries at an affordable prize. In order to get the benefits of the ICT one need not to have very high performing computers. A computer with basic functionalities can fulfill the basic needs. Therefore, the use of low prize computers should be popularized among general public. As we all know if we use commercial software, the software cost for a computer is much higher than the hardware cost. But there open source software is freely available. They may not be as user friendly as the commercial software. However, this software is more than adequate to fulfill the basic ICT needs. Therefore, the use of free and open source software should be encouraged. More attention should be given to develop the usability of this free and open source software. It is not possible to give computers to everybody. But the government of the developing countries should invest money to develop ICT infrastructure. Public computer centers would be a best way address this issue. These public computer centers should be like public libraries. Where people can use the computers access the internet freely or at a minimal prize. This kind of a center can facilitate many people very cost effectively.

Another issue we identified in these projects is lack of general ICT knowledge of teachers and students. Today we see even the students who have computers do not use them properly. They use computers for gaming and various other activities that generally involves with entertainment. But using computers for entertainment purposes only is not going to help the learning process. Main reason for this is the lack of general knowledge about and in ICT. To address these issue students should be taught to use a computer effectively.

ICT should be made a compulsory subject in basic education system alone with language and mathematics. To implement this properly a good set of teachers is needed. Teacher training process should be properly designed to create good and confident teacher to help the students in the learning process. Furthermore, ICT should be used as a tool to teach and the other subjects as well. However, the approach should not to replace traditional methods but to use ICT alongside with the current methods. Importance of this is emphasized in the research by Jones [19] As suggested in Chongs study introducing e portals[3] where everyone can share their experiences is also very effective. But sharing individual experiences in these portals should be encouraged. In Sri Lanka currently, ICT is taught in schools as a separate subject, which is optional. But as Sara Hennessy, David Harrison and Leonard Wamakote suggests in their research paper [4] thorough pedagogically, we can integrate ICT use into subject teaching rather than as a discrete subject in school. As in the research paper "Introducing ICT Supported Education for Sustainable Rural Development in Ethiopia" [20] if integrating of ICT into education become a success, we can move onto the other sections like health, agriculture etc.

VI. Conclusion

It appears that the adapting ICT and e-learning in education is not an easy task even for the developed countries. But it is not a difficult task either. These days younger generation is very familiar with the new technologies even though they are not studying technical things. We need to change the attitudes of the students and teachers in order to use ICT in education. In addition, we can use innovative methods with ICT in education as well. Then the adapting ICT in education will become a success.

As every problem has solutions, the identified problems should be address in order to use ICT in teaching and learning process effectively. It will take time and budget to make this a success. But thinking about the long term investment we do via this, everyone can be happy because it will effect largely for the country's academic sector. Development of the education system of a country will effect for the development of the country directly. So we hope that it is essential for a developing country like Sri Lanka to try this in order to improve the quality of the free education. We can go far beyond by starting with the education sector and move on to the other sectors like health, agriculture so that those sectors also improved with the help of ICT.

References

[1] T.G. Haaksma-Oostijen, and J. Puper, "ICT and the New Roles of the Teacher in Dutch Secondary Education," An article published in CRPIT '03 Proceedings of the 3.1 and 3.3 working groups conference on International federation for information processing: ICT and the teacher of the future, vol. 23, p. 1.

[2] Alfred Martey, "ICT in Distance Education in Ghana," Library Hi Tech News, vol. 21 no. 5, pp. 16 – 18, 2004.

[3] C.K. Chong, H. Sharaf, and D. Jacob, "A study on the use of ICT in mathematics teaching," Malaysian Online Journal of Instructional Technology, vol. 2, no. 3, pp. 43-51, 2005.

[4] V.L. Tinio, "ICT in education." Bangkok: UNDP-Asia Pacific Development Information Programme (APDIP), 2003.

[5] S. Hennessy, D. Harrison, and L. Wamakote, "Teacher factors influencing class room use of ICT in sub-Saharan Africa," Itupale Online Journal of African Studies (Education in Africa: Developments in the 21st Century), vol. 2, pp.39-54, 2010.

[6] B.T. Lau, and C.H. Sim, "Exploring the extent of ICT adoption among secondary school teachers in Malaysia," International Journal of Computing and IT Research, vol. 2, no. 2, pp 19-36, 2008.

[7] Kuniko Aoki, "The Use of ICT and e-Learning in Higher Education in Japan"

[8] W. Ki, A. L. S. Chung, and H. C. Lam, "Teacher Empowerment and Minimalist Design," An article published in CRPIT '03 Proceedings of the 3.1 and 3.3 working groups conference on International federation for information processing: ICT and the teacher of the future, vol. 23.

[9] Steve. Higgins, "Does ICT Improve Learning and Teaching in Schools?," UK: British Educational Research Organization, 2003.

[10] A. Balanskat, R. Blamire, and S. Kefala, "The ICT Impact Report, A review of studies of ICT impact on schools in Europe, European School net for the European Commission," (march 2007), p. 75, 2006.

[11] Ying Liu, and Jean Bacon, "Innovation or diffusion?: three scenarios of vocational education settings in ICT practices for people with learning difficulties in China." iCREATe '10 Proceedings of the 4th International Convention on Rehabilitation Engineering & Assistive Technology, ISBN: 978-981-08-6199-5.

[12] A. Hattangdi, and Prof. A. Ghosh, "Enhancing the quality and accessibility of higher education through the use of Information and Communication Technology," Strategy Learning 01.

[13] A.K. Jager, and A.H. Lokman, "Impacts of ICT in education. The role of the teacher and teacher training." Stoas Research, Wageningen, The Netherlands, Paper Presented at the European Conference on Educational Research, Lahti, Finland, pp. 22 – 25, September 1999.

[14] A. Fluck, "Why Isn't ICT as Effective as it Ought To Be in School Education," ICT and the Teacher of the Future. International Federation for Information Processing Working Groups 3.1 and 3.3 Working Conference, 26-31 January 2003, Melbourne, Australia, pp. 39-41, ISBN 1-920682-02-3, 2003.

[15] J. Insitful, P. Okyere, and S. Osae "Use of ICT for Education, Research and Development in Ghana," Literacy Information and Computer Education Journal (LICEJ), vol. 2, no. 4, December 2011.

[16] Nikolaos Tselios, Panagiota Altanopoulou, and Vassilis Komis. "Don't leave me alone: effectiveness of a framed wiki-based learning activity," WikiSym '11 Proceedings of the 7th International Symposium on Wikis and Open Collaboration New York, NY, ISBN: 978-1-4503-0909-7.

[17] K. Ala-Mutka, Y. Punie, and C. Redecker, "ICT for learning, Innovation and Creativity. Institute for Prospective Technological Studies," JRC, European Commission, 2008.

[18] K. Juuti, J. Lavonen, M. Aksela, and V. Meisalo, "Adoption of ICT in science education: a case study of communication channels in a teachers' professional development project," Eurasia J Math Sci Technol Educ, vol. 5, pp.103-118, 2009.

[19] A.J. Jones, "Infusing ICT Use within the Early Years of Elementary Education," CRPIT '03 Proceedings of the international federation for information processing working group 3.5 open conference on Young children and learning technologies, vol. 3, 2003.

[20] Berhanu Beyene, P.F. Dietmar Möller, Jochen Wittmann, "Introducing ICT Supported Education for Sustainable Rural Development in Ethiopia," SCSC Proceedings of the 2007 summer computer simulation conference. Society for Computer Simulation International San Diego, CA, ISBN:1-56555-316-0.