EFFECTIVENESS ASSESSMENT STUDY OF THE USE OF ICT TOOLS IN E-LEARNING SYSTEM

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Abstract

The learning system is currently in the transition phase from classic learning system which rely on hard copies of text materials and whiteboard to the modern learning system which is often denoted as E-learning system. This new learning methodology strongly rely on technology in delivering the information to the students. This paper aims to evaluate the efficiency of the use of ICT tools in today's learning system. This is done by firstly identifying the technical tools which are of great benefits in improving the content delivered to the students and then by emphasizing on their efficient usage. Through survey study, we validate that ICT tools should be integrated in the learning system in a more efficient way than just using slides that summarize the content presented in the book. Besides, we have studied the importance of practicing other modern technical tools as mainly simulation software which is able to support the text material by dynamic models that can help the student to in-depth his/her understanding and better clarify the textual presentation of the course materials provided to the students in the slides and textbooks.

Keywords: Learning, ICT tools, Simulation

1. Introduction

Nowadays, one way to investigate the learning system is by considering it as a socio-technical system holding social components (e.g., teacher, student) and technical components (e.g., PowerPoint slides, Simulator) that are well organized to achieve efficient learning. The objective of this research is to investigate the quality delivered by today's learning systems. This is done by identifying the critical practices for improving its success and by emphasizing on the efficient usage of the existing technical tools.

The gradual transition of the learning system towards E-Learning provides the student more flexibility in accessing the information. Basically, the student becomes able to attend only part of the classes (i.e., blended

learning) or never attend the classes (i.e., distance learning) due to the technical facilities which permit him/her (i) to download the slides (i.e., containing summary of the materials presented in the textbook), (ii) to attend the lecture (i.e., tutor explanation of the slides) online from anywhere through real-time video streaming and offline from anywhere and (iii) at any-time through recorded video streaming. The evolution of network access technologies (e.g., Fiber optics technologies, broadband wireless technologies) makes this task possible without any difficulty in the developed countries. Of course, this is not as easy in the developing countries where the network infrastructure suffers from performance limitation that affect considerably the broadcasting of multimedia content.

The starting point of this work is the realization that most of efforts done in this transition phase focus in facilitating to the students the access to the lecture slides at any-time and from everywhere without taking full advantage of the existing technical tools in providing the student deep knowledge. We have proceeded by firstly wondering if the usage of slides absolutely achieve this purpose. Then, we identify the technical tools which are of great benefits in improving the content delivered to the students.

Basically, the ICT technology changes the learning style by making the complex subject and dry units more clear. But, we have realized that most of tutors and students rely completely on textual presentation of the materials presented in slides for both teaching and standalone study. The survey study that we present in this paper shows that slideware and any other potential ICT tool should be used carefully in class in order to avoid presenting just a textual display of the materials but for supporting the content by additional means of information that help the student to better understand the course materials in less time and mind effort.

Then, we proceed in the paper by providing guidelines about the best learning practices. Basically, to enhance the student retention, tutor should apply special teaching practices (e.g., rhetorical questioning, group working, brainstorming, examinations, multimedia display, simulation scenarios) after a number of slides that requires some period of explanation time. Moreover, to achieve successful learning system, other modern technical tools should also be practiced as mainly simulation software which is able to support the text material by dynamic models that can help the student to improve his/her understanding and better clarify the textual display of the course materials presented in the slides and textbooks. Real measurement tools could be also of great benefit for the students to achieve the same purpose when practicality allows.

On the other hand, the paper emphasizes on the role of teachers as critical components in the learning system. The teacher should have the competency for mediating the technical tools, integrating the software (e.g.,

simulator) into the subject aims of the lesson and using the interactive whiteboard appropriately to apply the best teaching practices. Therefore, specific technical and pedagogical competencies need to be instructed for effective usage of the different technical tools and for applying the relevant codes of practice in teaching.

The paper is organized as follows. The next section presents through a survey study the common inefficient practices applied nowadays in learning. Then, Section 3 emphasizes on the best teaching practices that should be applied by tutors in class. Besides, we present in Section 4, the importance of integrating software tools for strengthening learning in the domain of ICT. Finally, the conclusion is presented in Section 5.

2. Inefficient learning practices

Nowadays, blended learning and distance learning become possible due to the technical facilities which permit the student (i) to download the slides, (ii) to attend the lecture online from anywhere through real-time video streaming and offline from anywhere and (iii) at any-time through recorded video streaming. The evolution of network access technologies (e.g., Fiber optics technologies, broadband wireless technologies) makes this task possible without any difficulty in the developed countries. Of course, this is not as easy in the developing countries where the network infrastructure suffers from performance limitation that affect considerably the broadcasting of multimedia content.

Nevertheless, we have realized that most of efforts done in current learning system focus in facilitating to the students the access to the lecture slides at any-time and from everywhere. We are wondering if this learning approach provides also the students deep knowledge. Therefore, we have conducted a survey regarding the efficiency of the slideware usage in learning. The survey is conducted during the semester of spring 2013 involving 205 students from three study majors (i.e., technology, business, education), and different university levels (undergraduate and graduate).

A percentage of students equal to 87.32% find that the slides do not contribute in helping them to stay more focused during the whole study time. Moreover, 88.29% of the students find that the usage of this ICT tool in class does not play a role to make them more motivated to participate in class discussion. This could be explained by the fact that more than 78% of the students find that the teaching slides creates in class lethargic atmosphere that makes them sleepy. The rest of students (22%) think that this factor may exist but it depends more on the teaching style of the tutor than on the used teaching tool.

Besides, 89.27% of the students rely only on the slides in their stand-alone study, and only 10.73% of the students use the textbook. More than

95% of the students that rely on textbook have GPA greater than 2.7. This means that students with relatively lower GPA rely more on the slides to minimize the study materials presented in the textbook. After discussing this issue with more than ten coordinators from different university majors, they have all agreed that in the various courses that they coordinate, the usage of slides require more time and mind effort to acquire the structure of the materials and deep understanding of the content.

Thus, the solution to present more comprehensive lecture, provide deep knowledge, and create more interactive class could not be achieved by just presenting items of text in the slides projected on the board of a low-lighting class or streamed through the Internet. We believe that slideware and any other potential ICT tool should be used carefully for learning by not just presenting a textual presentation of the materials but by supporting the content by additional means of information that help the student to better understand the course materials and in less time and mind effort. As we will describe in the following sections, this can be achieved by relying on special practices and using modern ICT tools to better clarify the textual presentation of the course materials. Thus, slides should not be considered as the main study materials but only as review or summary materials of the textbook.

3. Best learning practices

In this part, we discuss how to use efficiently the technical tools for achieving the best learning practices. Nowadays, most of lectures rely on the oral presentation of the slides to present information to passive listening students whether they are attending the lecture in class or online. But research (e.g., as stated by Anand (2007)) has shown that after 10 to 20 minutes of continuous lecture, assimilation falls off rapidly. To enhance the student retention, tutor should pause and apply special activity after a number of slides that requires this amount of explanation time. The following most common best teaching practices could help the tutor to fill the pausing time by activities that are able to help the students to better understand the presented material and facilitate the learning process:

- *Rhetorical Questions:* asking pre-planned rhetorical questions that are posted in the slides.
- *Surveys with Exemplifier:* integrate in the slides examples on the presented information or challenge the students to provide such examples.
- *Group work*: challenge the students to solve exercises related to the point just made in a group work basis.

- *Brainstorm:* motivate the students to provide alternative possibilities which could be useful to generate ideas, encourage creativity, and involve the whole class.
- *Examinations*: ending the slides by a quiz stimulates students to concentrate in class and study at home. While the usage of multiple choice, true-false, and completion questions help the students the memorization of facts and statements, essay examinations facilitate the understanding of the overall general concept of the material.
- *Dynamic models:* to provide deeper understanding to the students, display dynamic behavior of the theory presented in the text materials using preferably modern technologies.

The underlined practices should be clearly integrated, posted or flagged in their proper placement in the slides for reminding the tutor to apply them and also for imposing a common practice in all the sections of the lecture. Obviously, it is more easy and efficient to introduce these practices when using an interactive white board instead of static slides. While an interactive whiteboard is a touch-sensitive screen that works in conjunction with a computer and a projector, traditional PowerPoint slides are presented on the white board through the projector without being able to be edited. Interactive whiteboard is an efficient tool for being adopted in the class to interact with digital content and multimedia. Learning facilities with an interactive whiteboard may include the following as stated in SmartTech (2004):

- Manipulating text and images.
- Taking notes in digital ink.
- Viewing websites as a group.
- Demonstrating or using software at the front of the class without being locked behind a computer.
- Creating digital lesson activities with templates and images.
- Showing and writing notes over educational video clips.
- Using presentation tools built into the interactive whiteboard software to enhance learning materials.

Thus, relying on slides projection whether on a whiteboard or interactive whiteboard does not lead to successful lectures unless the practices presented in this section have been well applied by the teacher in the whole lecture session. This is necessary for enhancing the student retention and improving his/her understanding. In the rest of paper, we emphasize particularly on the importance of the ICT software tools in improving students' learning.

4. Case study: Integrating software tools for strengthening learning in ICT domain

In the special case of ICT domain, it is important to determine the software tools that could be useful to provide deeper understanding to the students by displaying dynamic behavior of the theory presented in the text materials. In this domain, there are large number of network protocols that should be understood by the students with so many specifications. The difficulty in understanding such theories could be solved by illustrating the protocols in action and by editing their parameters. This helps the student to observe the sequence of messages exchanged between the different protocol entities, enquiring into the details of protocol operation, and customizing the behaviour of the protocols and then observing the consequences of every customization. This can be done in simulated scenarios or in a real network environment.

In both cases, the student can learn networking concepts using a computer on his/her desk, at home, or in a lab. He/she can observe the network protocols using software illustrating the protocol "in action". Thus, such software provides the student the flexibility to work on a live lab everywhere and anytime. It also allows the student to learn more deeply the theory presented in the text materials by involving him/her in the learning process instead of studying passively through reading and memorising. In the following two subsections, we present the advantages of integrating in the study resources real measurement software, and simulation software respectively.

4.1. Real measurement software

The basic tool for observing the messages exchanged between executing protocol entities is called a packet sniffer. As the name suggests, a packet sniffer captures (i.e., sniffs) messages being sent/received from/by the student's computer. It will also typically store and/or display the contents of the various protocol fields in these captured messages. A packet sniffer itself is passive. It observes messages being sent and received by applications and protocols running on the computer, but never sends packets itself. Similarly, received packets are never explicitly addressed to the packet sniffer. Instead, a packet sniffer receives a *copy* of packets that are sent/received from/by application and protocols executing on your machine.

Wireshark packet sniffer (official website: http://www. wireshark.org/) allows the student to display the contents of messages being sent/received from/by protocols at different levels of the protocol stack. Technically speaking, Wireshark is a packet analyzer that uses a packet capture library in the computer. It operates in computers using different network access technologies. Then, the measurement collected by Wireshark

can be used for showing the students network traffic in real-time or for analyzing the traffic offline after saving the measured data.

We have integrated the passive measurement tool Wireshark in the assignment of a level-three course in the first semester of the academic year 2013 2014. This course focuses on the fundamentals of wireless communication and the tool is requested to be used for experimenting the communication in a wireless local area network working on IEEE 802.11 which is the WLAN protocol studied in a vast part of the course materials.

This assignment was proposed for 7 branches in 7 different countries in the Middle East. The total number of students who did the assignment is 490. The grade of this assignment has a 20% percentage of the total course grade. A percentage of 40% of this assignment was dedicated for answering questions related to this software tool, 35% was focusing on analytical system approach, and 25% was requesting to write an essay related to new innovations in IEEE 802.11.

The questions of the software tool problem were focusing on exploring and finding the addresses of communicating nodes, the types of exchanges control messages, and the values of some parameters related to the quality of service. The result of the students in this part of the assignment show that they did very well on such category of questions. The average grade was 16.8 over 20 and 82% of the students have grades greater than 16 over 20.

Besides, the feedback collected from 50 students distributed in two sections of one country was as the following. First, we have observed that a positive correlation equal to 0.4 exists between the assignment grade and the student's GPA. This means that more competent students have higher abilities to explore the software tool and to apply their theoretical knowledge. Besides, the students having grades greater than 16 over 20 affirm that they have more motivation and enthusiasm in working on such type of questions than on the other questions. Moreover, the students confirm that by solving such exercises, which are based on hands-on experimentation, they are able to learn the study concepts more deeply and in less time with relative to the other type of questions requested in the assignment.

The major difficulty encountered by the students that have lower grades was discovering the environment of the software and starting work in it. This can be caused by the fact that the students have not enough trained in the past courses to work on ICT tools and so they lack confidence in solving such problems. Once this initial phase is completed, the students find themselves able to work on such system more fluently. Thus, this also proves that such ICT tools should occupy an interesting part of the courses so that

the students can reach the final year project with more experience and confidence to work on such tools.

4.2. Simulation software

By creating conditions that are approximately real, students can practice coping with complex problems. Simulations could be applied in the physical reality as for example simulating the role of a manager in a meeting. Simulations could be also applied in the virtual reality through software as for example simulating a wide area computer network for testing its performance which is relatively more difficult for the student to apply it using real measurement. In the following subsections, we present an overview on the domain of simulation, its importance for learning, and the major features of network simulators.

4.2.1. Overview

The commonly used definition of Simulation is, as stated in Banks (2001), the imitation of the operation of a real-world process or system over time. For simulating, a model has to be developed in a first stage for describing the key characteristics or behaviors of the selected physical or abstract system or process. The model is necessary for representing the system under study so that its operation over time represents the simulation; the generic sequence of such work is presented in Figure 1.

Simulation is an interesting research tool that is used in different fields, as for example simulation of technology for performance optimization, testing, and training. Training simulators include for example clinical simulator and flight simulators for training staff to provide them with a lifelike experience. Thus, the simulation has different conceptual structure depending on the field under study. For example, the conceptual structure of a simulation in the field of economy is usually mathematical. In other terms, it requires the characterization of a mathematical model that is iterated many times with different parameters to reveal relationships and illustrate concepts. More examples and details about simulation can be illustrated in Smith (1998).

In this section, we focus on the positive role of simulation in learning. To be more specific, we emphasize on the simulators which are dedicated for the domain of communication networks since this field fits with our domain of expertise. Basically, Network Simulator provides a virtual environment for modeling, analyzing, and predicting the performance of IT infrastructures, including applications, servers, routers, switches, and protocols (as defined by Aboelela (2007)). Basically, it is designed for being used in research or industry for diagnosing difficult problems, planning for

future scenarios (e.g., growth, failure), and validate changes before they are implemented.

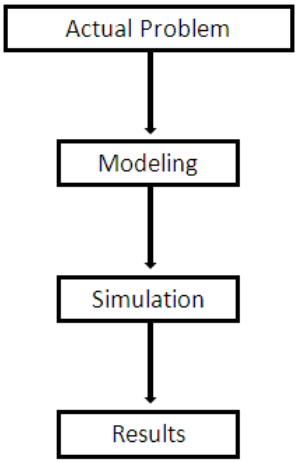

Figure 1. Experimenting through simulation

4.2.2. Importance of Simulation in learning

Network Simulator is a research software tool which when used in learning could help students to better understand the networking protocols and mechanisms. Particularly, students face great challenge to understand theory learned in class as for example in the domain of computer networking how devices are interconnected and communicate each other to transfer data in the network. In addition, networking students has to learn the different types of protocols and their roles in data communication in details.

Through hands-on simulation it will be possible to visualize their functions in the class room, lab, and at home. In other words, simulation provides the students dynamic behavior of the theory explored in the text materials that can help them to better understand the real system under study. This means that it is important that students make simulations to better understand the model of behavior of the system.

Aside the technical knowledge, the simulation-based learning environment helps students develop special skills such as decision making, problem solving, designing, troubleshooting, creative and critical thinking. Instructional simulations have the potential to engage students in "deep learning" that empowers understanding as opposed to "surface learning" that requires only memorization as stated by Blecha (2013).

Deep learning means that students learn scientific methods for modeling, experimenting, and testing the system although this is usually the work of research scientists and engineering technicians. This helps in stimulating the scientific thinking of the students. For example, simulation helps the student to understand the relationships among variables in a model or models since it allows students to change parameter values and see what

happens. In this way, students become experimented in optimizing the configuration of the system and settings the values of its parameters. Besides, simulations provide students deeper understanding of probability and sampling theory. This is achieved mainly through the manipulation and analysis of the generated curves or trace-files which are necessary for deriving analytical conclusions and predict outcomes from specific limited set of simulated scenarios.

Moreover, the work of simulation motivates and permits to conduct group discussions which are useful for students to make reflections, brainstorming, and to extend understanding. Group discussions try to find answers on questions about how they have simulated their problems and why they have obtained such results. In other terms, instructional simulations provides the students a great opportunity for active learning. For example, for running a simulation, students has to define a testing scenario, select the parameter values, extract relevant results, and formulate new scenarios that facilitate to derive more general conclusions. Then, students can extend the acquired knowledge from the achieved simulations to new problems and situations. For more details in this topic, Bransford et al. (in Bransford (2000)) develop general pedagogical prescriptions that work well with instructional simulations.

Shute (1989) and Katz (1993) find that there is some evidence that students who think in a scientific manner conduct more enhanced simulations than other students. Besides, Shute (1990) has made other interesting observation which is that the students practicing simulations in class are able to learn a set of concepts in less time than students in a traditional lecture-based class. Given these findings, the proverb of the Chinese philosopher Xunzi "Tell me and I forget; teach me and I may remember; involve me and I will learn" could be applied in our context by relying on instructional simulations as efficient tool for achieving successful learning and improving the critical thinking of the students. Therefore, intensive lesson preparation by instructor for integrating the simulations in the class teaching materials as well as active participation from students is required.

4.2.3. Network simulator

The infusion of computer-based learning into teaching and learning has altered considerably the instructional strategy in our educational institutions and changed the teaching and learning approach. The integration of computer-based instructional strategies is essential especially for students in the domain of technology. In this section, we emphasize on the usage of simulation tools in the domain of computer networks since this domain fits with our domain of expertise. Basically, practical methods are necessary for

learning more efficiently networking concepts (e.g., design, protocols, and configuration) but it is sometimes expensive and not feasible to apply it in the real network. As for example the case of conducting a test in a wide area network having access to a huge number of network nodes. With the new era of computer technology, computer simulation can be considered as the most practical assistant tool for achieving successfully the educational objectives.

Using software simulation tool (e.g., OPNET, NS-2) in learning, we can bring the real networking environment in to the class room, lab, or home to attain more deep learning. There are plenty of network simulation tools but these are among the most interesting and used ones. While NS-2 (and its new successor NS-3) is one of the most popular open source network simulators and it is widely used in research, OPNET is one of the most famous and popular commercial network simulators. The second become mature and has occupied a big place in market after being used for a long time in the industry. OPNET has a free academic version but it support limited range of protocols and software features.

However, it is easier for the students to use OPNET rather than NS-2 especially in the undergraduate levels due to its powerful graphical support which does not have similar in NS-2. Network topology can be constructed and its configuration from the application layer to the physical layer can be set through the graphical editor interface. Moreover, the mapping between the graphical interfaces and the source code of the system is also available for being easily accessed and edited.

Thus, such network simulator is very suitable for learning since it allows easily the student to visualize, edit, navigate, customize, and run through the supported various tools as Network model editor, Node model editor, Process model editor, Packet format editor, Source code editing environment, Simulation tool, and Animation viewer. Moreover, OPNET is able to provide the students the opportunity to select the metrics to measure to support them in curves at the end of the simulation instead of letting them struggle with analyzing trace files.

4.2.4. Evaluation

We have evaluated the advantages of using the simulation software by three two-person groups of students having different cumulative academic results; their GPA are respectively A, B, and C. To simplify the discussions, we denote by project A the one where its members having A grades, project B the one where its members having B grades, and project C the one where its members having C grades. The projects were part of their final year projects and they are related to the field of testing the performance of protocols, mechanisms, and architectures related to different computer communication technologies.

The evaluation was focusing on the following themes:

- Deep Learning of concepts presented in the communication courses.
- Learning new concepts.
- Acquiring new skills: modelling, designing, critical thinking, and troubleshooting.

Monitoring the student performance was along the whole academic year of 2012 2013 which is the period of their final year project. The observation made by the author as supervisor of these three groups can be categorized as the following:

- In the literature review phase of the projects, there was a clear difference between projects A, B, and C in understanding the state-of-the-art and identifying the project problem. As expected, project A was the best followed by project B and project C was the worst.
- In the design phase where the students have to determine the scenarios of simulation in a way that models adequately the problem of study, projects A and B have shown similar levels and project C has shown lower level.
- In the experimentation phase where the students have to simulate their testing scenarios, smooth motivation, enthusiasm, and performance was shown by the members of the three projects A, B, and C.
- In the analysis phase, projects A and B have shown similar levels and project C has shown lower level.
- In the reporting phase, project A was also the best followed by project B and project C was the worst.

To sum up, although it is expected that the performance of projects A, B, and C to be strongly correlated with the grades of the groups, we have found that it is not always the case in all the project development phases. Students have shown much less discrepancy in the experimentation phase which is based on hands-on simulation. This means that such tool stimulates also the students with lower academic scores to perform in a better way.

5. Conclusion

One may conclude from our survey study that slides are not efficient learning tool when used for textual presentation of course materials. ICT tools should be used carefully to improve the learning process by explaining and exploring the text. More specifically, it should be used when it is necessary to show mainly computer simulation, computer animation, or computer graphics. Otherwise, it will transform the class to lethargic and

non-interactive environment from one side and attain surface learning in the stand-alone study. To this end, best teaching practices for tutors have been emphasized and recommended to be integrated in the slides. Moreover, we validate the importance of the simulation tools in stimulating student understanding and improving the learning system. For this purpose, specific technical and pedagogical competencies need to be trained for effective usage of the different technical tools and for applying the relevant codes of practice in learning. Thus, successful learning system could be achieved by using efficiently the ICT tools by tutors and students.

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