Efficient Integration of ICT Tools in Learning

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Abstract

Slideware is becoming the major learning tool in many universities. It has been adopted in teaching classes and in stand-alone study. Our paper aims to examine the efficiency of this tool in learning by relying on both analytical and empirical models. Our major observation is that slideware should be used carefully in the learning process. This is necessary to avoid the risks of transforming the class to lethargic and non-interactive environment as well as the risks of achieving surface learning in the student's stand-alone study. Thus, ICT tools should be integrated in learning in a more efficient way than using slides that just summarize the content presented in the book. The usage of ICT tools is important for improving the learning process when used for example to show dynamic model or explore the virtual reality. This could be done by relying on multimedia, computer animation, computer graphics, and computer simulation.

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) well organized to achieve efficient learning. In this research, we are going to investigate the learning system to identify the critical practices for improving its success by emphasizing on the efficient usage of the technical tools.

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 for not presenting just a textual presentation of the materials but for 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.

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 an explanation time of around 20mns. Then, we recommend the usage of interactive whiteboard as an assistant ICT tool in class helping educators to apply more efficiently the underlined best teaching practices. Moreover, to achieve successful learning system, other modern technical tools should be also practiced 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 presented in the slides and textbooks.

On the other hand, the paper emphasizes on the role of teachers as a critical component 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 use appropriately the interactive whiteboard to apply the best teaching practices. Therefore, 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 classroom 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 simulation tools in strengthening learning. Finally, the conclusion is presented in Section 5.

2. Inefficient learning practices

We have conducted a survey regarding the efficiency of the slideware usage in class teaching and standalone study as presented respectively in the following two subsections. 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).

2.1. Class Teaching

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 session 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.

Thus, the solution to present more comprehensive lecture 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. We believe that slideware and any other potential ICT tool (e.g., Smartboard) should be used carefully in class for not presenting just a textual presentation of the materials but for 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.

2.2. Stand-alone study

In our survey, 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 asking many coordinators from different university majors, they have all agreed that in the various courses that they coordinate textbook-based study helps the students to better understand the course materials in their stand-alone study. The structure of the materials can be better memorized as well as deeper understanding of content can be gathered when the study is based on the textbook. They have also agreed that more time and mind effort are required for slides-based study to acquire the same or lower level of understanding that could be attained in textbook-based study. Therefore, slides should not be considered as the main study materials replacing the textbook but only as review or summary materials.

3. Best learning practices

In this part, we are discussing how to use efficiently the technical tools for achieving the best learning practices. Nowadays, most of class lectures rely on the oral presentation of the slides to present information to passive listening students. 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.
- *Multimedia display:* tables, figures, diagrams, animations, video tracks are examples of ways that are able to bring into the classroom direct description of the concepts being discussed.
- *Simulation scenarios:* 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.

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. Moreover, 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, we recommend the usage of interactive whiteboard as an assistant ICT tool in class for improving the learning since it helps educators to apply more efficiently the underlined best teaching practices. Relying on the slides or interactive whiteboard as innovative technologies 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 simulation tools in improving students' learning.

4. Using simulation tools for strengthening learning

4.1. Introduction to Simulation

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 will 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.

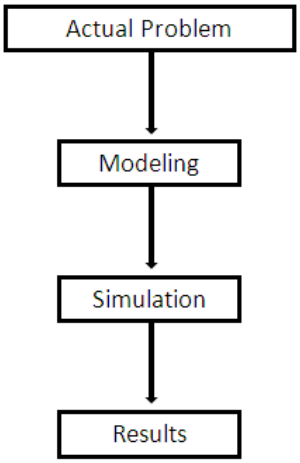

Figure 1. Simulation as research tool

4.2. 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 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.

4.3. Case study: using 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 expensive and sometimes 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 more 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.

Therefore, we emphasize on OPNET in this paper since we believe that it is an easier tool for learning than NS-2 although both tools are very interesting for research and development. OPNET can be flexibly used by students to study communication networks, devices, protocols, and applications due to its friendly high level user interface, which is constructed from open source code blocks with a huge library of specific functions. Such platform has a hierarchical structure which is composed to three main domains:

- Network domain: Network model specifies the network topology that presents the nodes as well as their physical locations (i.e., geographical coordinate), interconnections, configurations, and mobility. Figure 2 presents a snapshot taken from OPNET network simulator where a worldwide distributed backbone network is deployed using fiber optic technologies.

- Node domain: Node model specifies the network nodes (routers, workstations, mobile devices, etc) through the internal structure of a network node. Figure 3 presents an example of a node model taken from OPNET presenting the different protocols of the layering model running at the prescribed workstation.

- Process domain: Process domain specifies the modules and source code inside network nodes (e.g., data traffic source model) which describes the behavior of processes and queue modules which are often modeled using the finite state machine (FSM) and implemented in object oriented programming language. The example presented in Figures 4 and 5 (taken from OPNET) show respectively the process of the transport layer protocol TCP running at the workstation along with the C++ source code of one of its states.

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.

5. Conclusion

One may conclude from the survey that we have conducted on more than 200 students 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 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. Besides, technology is an important component in the learning system as assistant tools and not as a replacement for the tutor and textbook. Tutors should not rely completely on these tools and neglect their role. To this end, best teaching practices for tutors have been emphasized and recommended to be integrated in the slides.

Successful learning could be achieved by using efficiently the ICT tools by tutors and students. To this end, we emphasize in this paper on the importance of interactive whiteboard as an assistant ICT tool in class for improving the learning since it helps educators to apply more efficiently the underlined best teaching practices. This is necessary for enhancing the student retention and improving his/her understanding. In the last part of the paper, we explore the importance of the simulation tools in stimulating student understanding and improving the learning system.

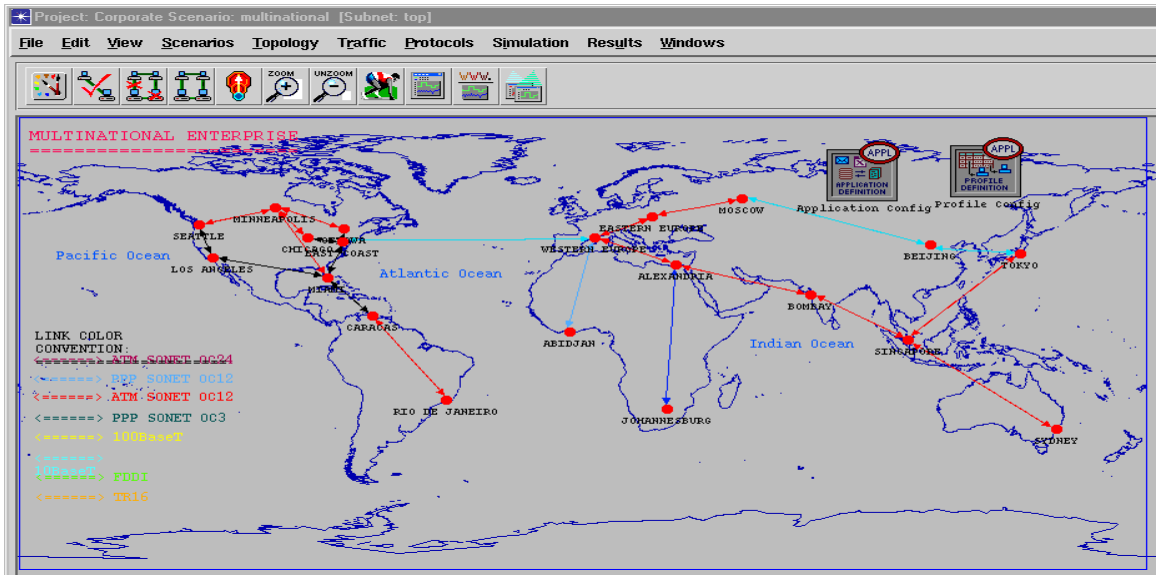

Figure 2. An example of Network domain in OPNET

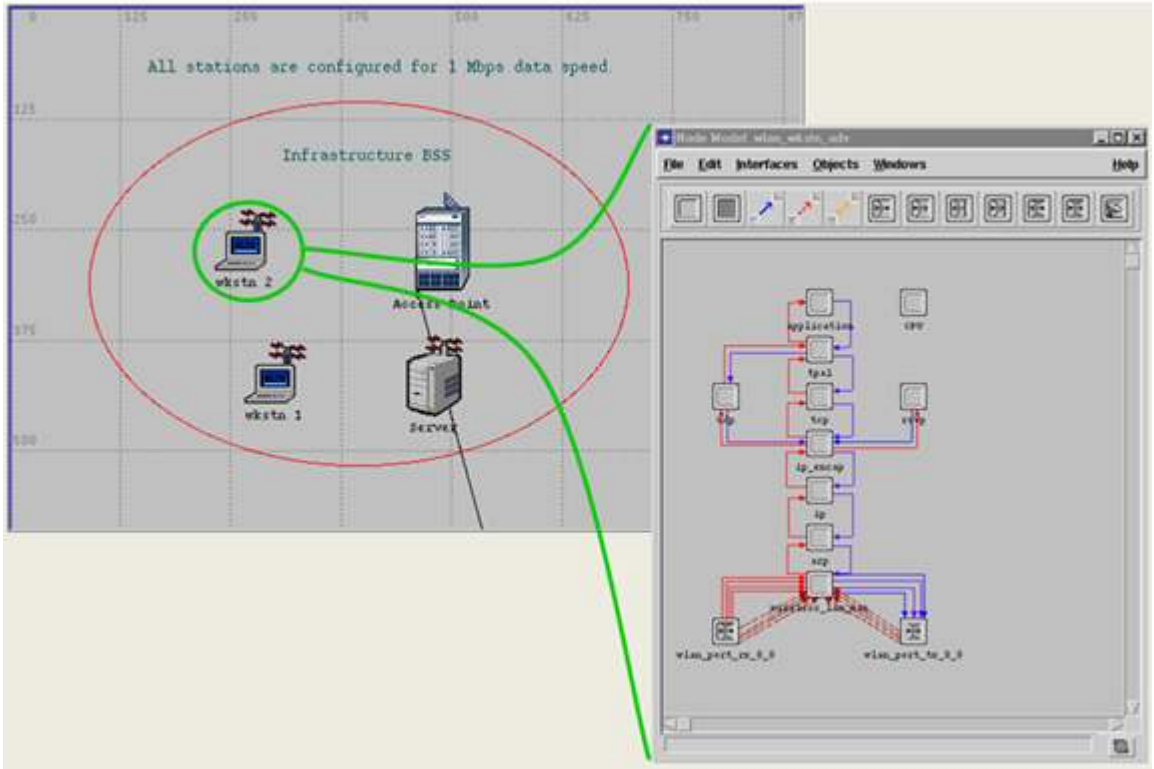

Figure 3. An example of Node domain in OPNET

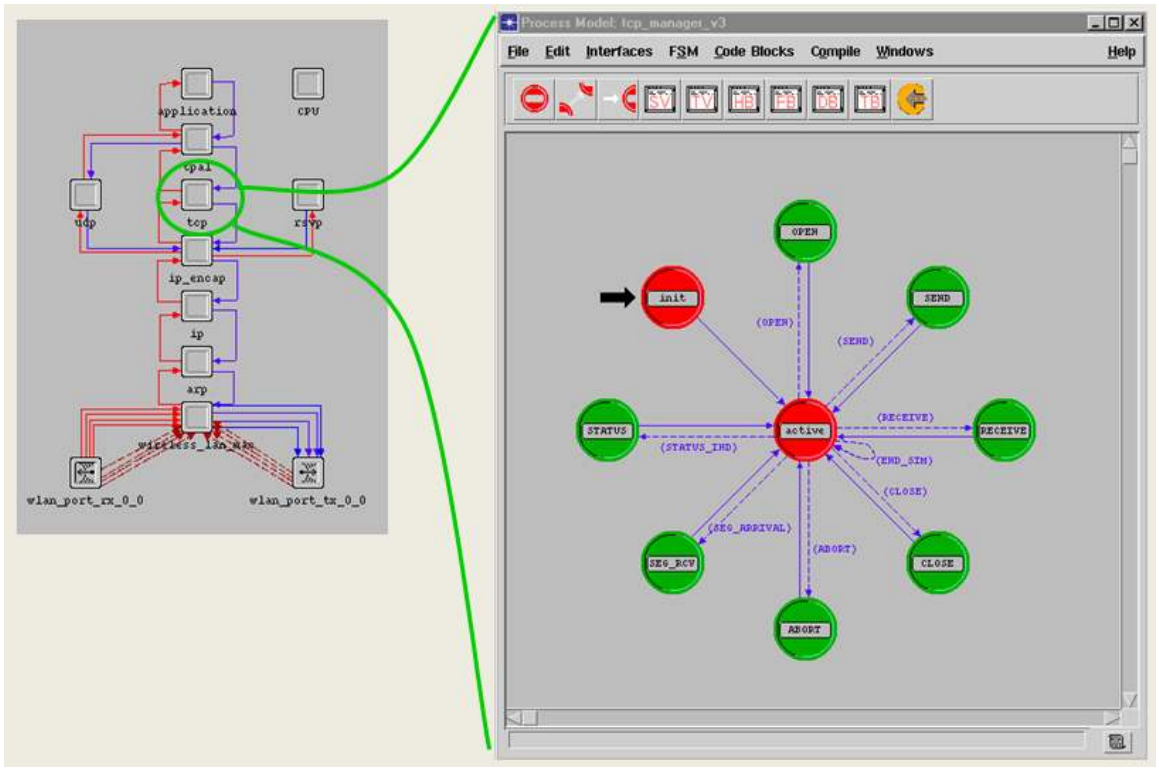

Figure 4. An example of Process domain in OPNET

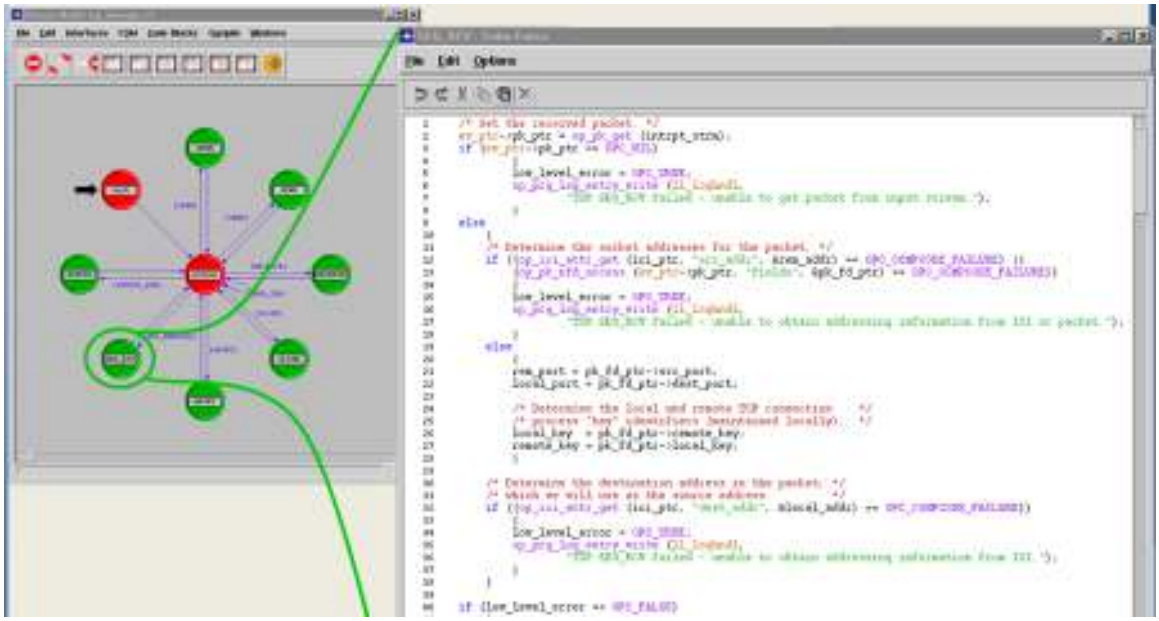

Figure 5. An example of Code level in OPNET

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