

# Modeling Java Interactive E-Learning Virtual Environment

Majlinda Fetaji<sup>1</sup>, Bekim Fetaji<sup>2</sup>, Mirlinda Ebibi<sup>3</sup>

South East European University, Fax: 044 356 001  
{m.fetaji; b.fetaji; m.ebibi}@seeu.edu.mk }

**Abstract:** The goal of the research was to investigate what are the possibilities of improving and increasing quality of e-learning technology, accessibility to learning content, communication and learning by creating an interactive virtual learning environment tool for learning Java programming language. An analyses of virtual learning environments, e-learning systems and human-computer interfaces state of the art has been realized. Issues have been identified and proposed solutions and recommendations while reviewing the current situations in these fields. The research method was exploratory research to determine the best research design and then constructive research to build the software solution followed by empirical research to describe accurately the interaction between the learners and the system being observed. In order to assess and propose solutions to the identified issues an analyses of e-learning systems, systematic approach to learning processes, usability of the created virtual environment, human-computer interface analyses was reviewed. The outcomes of the research is a Java interactive virtual environment that provides a code editor with intelisense support, compiling options, option for running Java application or applet and capturing and validating the syntax errors from user side. Also it provides integrated help the learners need in order to learn Java language without exposing them to the need to leave the application framework and in this way promoting the Java learning environment as self sufficient to achieve its objective. This tool has been used in the course object oriented programming in java and the evaluation has been a very successful one reported in the outcomes section.

## 1 Introduction

The general process of learning nowadays is enhanced and supported through the use of information and communications technology (ICT) that's called e-learning. The usage of the ICT enhances flexibility and access to a greater amount of information, it is offering more effective way of teaching and learning to more students, the possibility for collaborating in the learning process, communicating and using different multimedia and web content, and different e-learning tools and eliminating the time and place dimensions as limitations for learning. These are the reasons we

see e-learning as a promising way for improving the quality and effectiveness of learning.

To have good and effective e-learning we have to focus on the pedagogical issues and background as well.

## **2 E-learning systems Literature review**

Many different definitions about e-learning exist, and still it is not clear what it exactly is defined and the question that is continuously raised is what is e-learning?

Researching the existing literature, will try roughly to extract the definition:

E-learning is learning that is enhanced and supported through the use of information and communication technology (email, discussion boards and video conferencing) and often include and mobile technologies and PDAs (Personal Digital Assistant). The technologies that may be used are: computers, communication technologies, internet and intranet, Web and mobile technologies, simulations and animations, multimedia and hypermedia, games; text, video, audio, and animation are used for presenting the learning content; and different software tools and virtual environments.

People learn through different learning methods: reading, listening, doing and visualization. Combining these methods using instructional design (to identify the training needs and to present the knowledge in a digital electronic format) and the learning content, e-learning can be used to replace the traditional face-to-face method of learning in classrooms.

An important concept of e-learning is reusability and the effectiveness of the learning objects. A learning object is a standalone electronic or digital chunk of the learning content that can be reused. It is also defined as “any entity, digital or non-digital which can be used, reused or referenced during technology supported learning” (IEEE, 2002). To be reusable it should be able to be reused in other learning objects or independently and accessible and deliverable using the communication technologies and interactive e-learning environments with no limitation of time, place and number of times accessed. To be effective it should be goal-supportive, to keep the user’s attention, flexible and have specific objectives.

Examples of Learning Objects include multimedia content, instructional content, learning objectives, instructional software and software tools, and persons, organizations, or events referenced during technology supported learning (LOM, 2000).

### **2.1 E-learning vs traditional classroom strategies**

As traditional learning can suffer because of the boring learning content or material, and the pure delivery way of the content also can e-learning.

E-learning as new approach of learning is learner-centered that means the learner himself conducts the process of learning and decides when and where and how the learning should happen meaning they can plan the learning for themselves. The learner doesn't depend on the other learners or the time lasting of the training or course. The learner can participate actively, communicate and collaborate with other learners or trainers, interact with the learning environment and content, test, and build his solutions, discover and repeat parts of the process that makes learning more confidential, accomplishing and motivating that implicates improving the efficiency of learning.

Instead of using learner professionals to transmit the knowledge to the learner's like in traditional learning strategies, in e-learning new technologies and new tools are offered to learners to self-pace the learning process and make their learning scenario [2].

Also, the traditional learning framework changes from a physical classroom to virtual online classroom or virtual e-learning environment, from a face-to-face conference to online video conferencing.

The way the content is delivered in traditional classroom learning is changed from verbal to non-verbal presentation using network technologies, internet and web technologies, multimedia video and audio presentation and hypermedia and text that can be easily revised.

The traditional learning technologies are replaced with new learning technologies [2]:

1. Weblog (blog)- web-based publication consisting primarily of periodic articles
2. Moblog - Blend of words mobile and weblog (mobile weblog)-Content posted to Internet from mobile or portable devices, instant access to real time information
3. Wiki-Web application that allows users to add content (as on an internet forum) and edit content
4. VLog-Weblog that uses video as primary presentation format distributing video content, audiovisual communication via internet
5. Pod Cast-Technologies that enable automatic distributing of audio and video programs over the internet;
6. RSS-Real Simple Syndication is a way to track blogs

Aiming e-learning to be a way of effective learning and support learning, it has to be combined with different learning technologies and grounded on learning theory approach and pedagogical background.

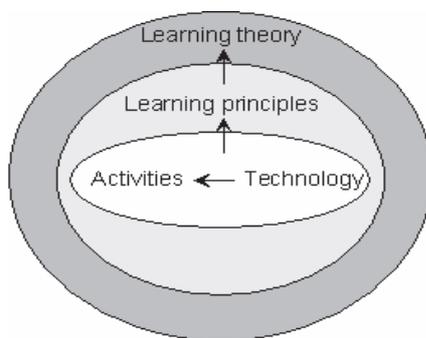
## **2.2 Pedagogy of e-learning and learning theories**

Over the last years, the education and learning and teaching have been influenced by the rapid technology development. That is the learning process has been changed towards more interactive learning activities and authentic experiences [3]. A tentative and research is made on how to design a quality e-learning.

According to Hannafin et al. (1997; 1999), to design our e-learning solution we have followed the approach that design and use of e-learning must be grounded in a learning theory approach. "In order to develop the use of e-learning from a pedagogical point of view, it is therefore not enough to study the existing practice.

Instead, it is necessary to have an understanding of theoretical principles of the learning process and of the ideal learning environment [6]". The learning environment is important because it models the learning process of particular course in a technological medium, so we have to ideally model the learning process. That is the interface that the learners interact with and the learning activities are taking place to achieve the learning goals.

This means that the design of e-learning can not be based only in the existing practice, it is necessary to understand the relation between theory and practice to ensure that the design of practice is founded on the learning theory. This concept is shown in the following figure [6]:



**Figure 1.** Theoretically grounded evaluation of technology

We have followed this concept as a pedagogical background of our e-learning solution. It describes that the different learning activities that are driven in the learning environment are supported by the e-learning technologies stated above. The learning principles are formed by the learning activities to be done to produce the learning outcome that are crucial to define the features and abilities the learning environment has to support. And according to the concept of grounded design in Hannafin et al. (1997) that is "defined as the systematic implementation of processes and procedures that are rooted in established theory and research in human learning" (p. 102), the implementation of the learning activities are rooted in the learning theory and human learning theory.

### 2.2.1 Learning theories

We briefly analyzed the learning theories to have a clear view which learning theory would support our e-learning solution in a pedagogical aspect.

#### a) *Cognitivism*

"Cognitive theorists view learning as involving the acquisition or reorganization of the cognitive structures through which humans process and store information." (Good and Brophy, 1990, pp. 187).

As Karl Kapp says the learner is a complex system that processes information, first one must understand how processing of information occurs within the human brain.

He says, the idea is that learning is more than the result of externally observed behaviors...much more occurs than simply observable behavior.

In the cognitivist's view learning occurs internally and through the social interactions with others. It is the social interactions that really trigger and assist the learning process as the learner makes internal connections between and among what has been observed and his or her experiences.

Cognition includes processes of conception, perception, recognition and reasoning and depends on the learners abilities.

#### *b)Constructivism*

The learners construct their own knowledge instead of having someone construct it for them. This belief is explained by the Constructivist Learning Theory. This theory states that learning is an active process of creating meaning from different experiences. In other words, students will learn best by trying to make sense of something on their own with the teacher as a guide to help them along the way [7].

Constructivism has been building its central promise of the "learner-centered" approach to education (Jonassen, D. H., 1999, Dick, W., Carey, L. and Carey, J., O., 2001, Jonassen, D. H., Peck, K., L. and Wilson, B., G., 1999).[3]

#### *c)Behaviorism*

Behaviorism concerns itself solely with measurable and observable data and excludes explicit ideas, emotions, and the consideration of inner mental experiences and activities and is not interested in conscious (cognitive) control processes. The brain is understood as a "black box" which gets certain input ("stimuli") and reacts in a deterministic way. In behaviorist thinking, the focal point of learning is in shaping the responses of the learner. The theoretical and didactical problem is to research the appropriate stimuli and to enforce the correct behavior with adequate feedback.

We can conclude and as it is argued that different learning theory approaches support differently the e-learning technology. The design of the learning activities is dependent on the learning theory and human learning principles, particularly the learning content and its organization in learning objects. The modeling of the learning environment is founded on the learning activities that depend on the cognitive, and intellectual abilities of learners and their educational and social background.

We have used the constructivism learning theory because it is problem-solving oriented, flexible in a context of time and place, consists of independent learning activities that are problematic for students and they have to solve, learning objects that represent a problematic situation like a given problem that is not finished.

### **3 Human Computer interaction –user interface design**

A research in the field of human computer interaction is made on how to design an effective, user friendly and ease-to-use graphical user interfaces where the goal is to improve the interaction between computer and user according to user needs. Shneiderman [12] says: "*Researchers have shown that redesign of the human-*

*computer interface can make a substantial difference in learning time, performance speed, error rates and user satisfaction”.*

In order to be HCI properly designed, there are requirements to considerate [13]:

- information presentation to be tailored to the end-user's need to be able to browse, select and update rather than approach applications with prior knowledge
- support for actions that correspond to human reasoning about the application
- representation of the user’s conceptual objects as interface objects
- continuous visual feedback in response to user actions
- prevention of invalid options being used
- context sensitive help, input error checking, error recovery and input default substitution,
- provision of short-cuts for the experienced user
- prevention of the need for excessive pre-knowledge of the underlying system

Human issues are important to be followed when designing a human computer interface. For example, previous computer experience and design expectations - not all the users have the same level of education to use computer and technology, some may have used Windows-like interface, and some may have used command-line based interface or other platforms interface; cultural issues – users may have different cultural background so the designer has to considerate in the aspect of using graphics that in different culture and religion have different meaning, even some happy and fun graphics in one culture with Christian religion may offend the Muslims, or for example the cow’s image is forbidden in Buddhist religion; differently abled users – the designer has to considerate the disabled users with color blindness for example, that are not able to differentiate the basic colors, or who are not able to hear well; learning time – the interface design should be benefiting in shortening the time to complete a task using the familiar interface components for completing the learning activities, menus and selection objects – should be ease accessible, menu objects should be grouped by common functionality characteristics, icon tips – should explain shortly and clearly the icon’s function; also short concise messages should be provided and placed in an appropriate place [14]; the number of colors not to be over passed as the interface would have heavy look and feel whereof it would be unattractive, use the multimedia content but do not overthrow the interface because it would get the opposite effect; the interface should contain a way out of the situation they are, and always “undo” to be as opportunity [15].

Individual cognitive, perceptive and intellectual ability, the previous skills and educational and cultural background, are very important and must be considerate during the design.

To have a usable graphical user interface we have to provide a good interface design, and Shiderman [12] has proposed the “eight golden rules of interface design”:

- 1 Attempt for consistency.
- 2 Enable frequent users to use shortcuts.
- 3 Offer informative feedback.
- 4 Design dialog to yield closure.
- 5 Offer simple error handling.
- 6 Permit easy reversal of actions.
- 7 Support internal locus of control.
- 8 Reduce short-term memory load.

## 4 Modeling Java Interactive E-Learning Virtual Environment

Over the last recent years, the interface of the e-learning environment has become a critical component in aspect of accepting or dropping-down an e-learning course. The HCI principles and design interface principles are crucial to design a usable interface of the learning environment.

Over several years of our experience working in a classroom with students in subjects covering learning programming languages, we came to conclusion that this course is more effective if the learning environment is electronic and has an effective graphical user interface in order to enhance the efficiency of learning and keep students attention, and make the system ease to use and more attractive to students especially to novices.

To achieve a greater efficiency in learning to program particularly in Java programming language, in a perspective of a good learning system our project is a simple e-learning environment, with an effective graphical based interface that is aimed to provide the computer science students -beginners with some of the basic elements and aspects of the procedure of programming.

In order to design an effective e-learning solution we have observed three factors:

- Learners- Their needs, motives for learning, prior experience of learning, social and interpersonal skills, preferred learning styles and expectations of the course and of the practitioner
- Learning environment (e-learning environment) as an interface between the learners and the learning resources, tools, facilities and the learning objects and
- the learning outcomes – the goals and learner needs that need to be accomplished

To support the novice programmers, our project provides a set of specially designed tools. It includes an editor for editing programs and file manipulation, visual tools for compiling and executing the program and help content that are all presented within a single user-interface framework. This allows students to move from one activity to another with a minimized effort. All this provides a maximum support to the novice programmers since program construction can be conducted entirely through menu interaction.

The project is designed bearing in mind to reinforce students and others who want to learn, to use just coding to create Java applications and applets, and usually for the novices it will be a good introduction to the structural programming principles, and create the habit of proper coding styles [16].

Our e-learning solution is grounded on the constructivist learning theory where the learning environment should consist of situations which provide problems, in the sense that they are problematic **for the students**. In the learning environment the students should work with problematic situations. The independent student work supports the individual and subjective construction of knowledge. The students should work individually, but they might also help each other in groups. So their work is based on their independent exploration, and they construct their work. The role of the teacher is to guide and help the students in this process [6]. Because of the individual work of the student they learn with no limitation of time and place dimensions. The learning content embedded as a help component is easy-to-find, useful and well organized in useful learning objects that are flexible, goal-centered and have specific

learning objectives. The learning objects are units of lectures, examples, and uncompleted solutions of problems.

The environment has a simple user interface and provides a framework to offer just the essential functions needed to write Java code providing an editing environment, command to compile it using the Sun Javac compiler, and to run the java code, and getting back the compiling errors if any exist or getting the result of the program execution without leaving the system's framework, it will allow the users to concentrate on the language structure and the principles of coding. The environment provides application usage help with introduction help, application help, and Multimedia help which covers the usage of the application, Java learning content and all the documentation embedded in the application. Then the links to Java online tutorials, that will cover the Java language in general, and finally the online support which offers the frequently asked questions, feedback form and email contacts for communication with the user and higher interactivity [16].

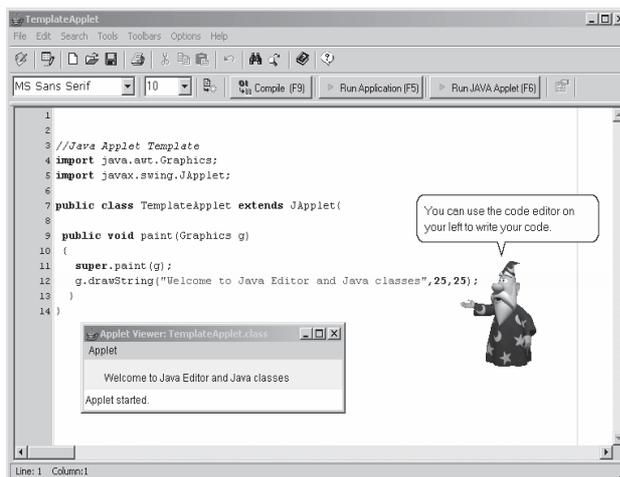


Figure2. GUI of the e-learning environment

Existing e-learning environments for learning Java programming language have very complicated user interface that may discourage users, make them fill afraid and need a considerable amount of time to learn to use the interface and lose concentration and interest in learning. Besides, they have technical requirements for installing into the computer where students accounts are usually restricted, and have to be paid. Instead, our e-learning environment is set to just starting an application whereas it is added to the Angel learning management system that our university is using and of course we distribute it for free- this e-learning solution is created for their needs.

The interface of the learning environment has a big impact to the efficiency and quality of learning.

To design a usable interface of our e-learning environment for learning object oriented programming in Java, we have founded the design on HCI principles and design principles for effective graphical interfaces stated above.

We have used the empirical method of gathering information and the empirical methods for evaluating the user interface that means we have tested the interface with real users that participated in the design. We have also used the Heuristic usability inspection method done by group of experts to find the usability problems that are overlooked by user testing.

We use these usability testing methods in each phase of interface development to gather information on the usability of the graphical interface, to detect and correct mistakes, to improve productivity and satisfaction of users and to evaluate the system before its implementation as advised and proposed by Dumas, J. S., & Redish J. C. (1999) [17].

We have used the approach of prototyping and evaluation during the development process of GUI design. The prototype is tested on users, and the results are used for enhancing of the design in the next stage of development.

A qualitative research on usability of the graphical user interface was conducted, and the results showed several benefits of the graphical user interface of the learning environment.

## 5 Conclusions

To develop an e-learning solution, we suggest to be grounded on a learning theory and to model the learning environment according to the learning activities that are based on that learning theory.

Designing a user interface, as we suggested above has many benefits. The benefits are:

- flexible, direct, ease-to-use and effective manipulation
- users can quickly determine how to do their work
- instant visual feedback
- the performed work is maximum with minimum information required from users (ex. they do not need to know how the process of building and executing a code is done, they just use the icons or menu commands for that)
- reduced number of errors made to perform a task
- reduced time to perform a task
- reduced time to learn

A quality e-learning environment with effective graphical user interfaces has the following advantages: learner flexibility, accessibility of information, possibility for collaborative learning and communication, grater interactivity of the learner and learning environment and innovative way of learning and teaching.

At the end we promote the Java learning environment as self sufficient to achieve its objective- learning Java programming language and enhancing and improving the process of learning .

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