

# E-Learning Methodology Development using Modeling

Sarma Cakula, Maija Sedleniece

**Abstract**—Simulation and modeling computer programs are concerned with construction of models for analyzing different perspectives and possibilities in changing conditions environment. The paper presents theoretical justification and evaluation of qualitative e-learning development model in perspective of advancing modern technologies. There have been analyzed principles of qualitative e-learning in higher education, productivity of studying process using modern technologies, different kind of methods and future perspectives of e-learning in formal education. Theoretically grounded and practically tested model of developing e-learning methods using different technologies for different type of classroom, which can be used in professor's decision making process to choose the most effective e-learning methods has been worked out.

**Keywords**—E-learning, modeling, E-learning methods development, personal knowledge management

## I. INTRODUCTION

ONE of most important things in long term developing of each country is effective educational system. In period of several last decades of previous century till now there can be observed a historic change from the industry age to the information age. If industry age was more related with the creation and utilization of material goods, and aligning with set information procedures, then information age is more tied with the creation and consumption of information and usage of non-standardized approaches for better decision making. The creation and development of the Internet has accelerated the transition to the information age. With the help of the Internet and the Web a more intensive creation, sharing and use of information has been available. That has dramatically shifted the way people perceive information. The importance and value of obtaining the right information in the right time has considerably risen. The new ways of acquiring information provides new options of doing business in many fields starting from car manufacturing, financial and security areas till education and health care areas. Along with the development of the Web also the information amounts people have to handle have increased dramatically. This has become to be known as the "information overload". Similarly workspace equipment and systems are becoming more sophisticated. That calls for extra skills and ways to handle the new work environment and the vast amounts of data that has to be dealt

with. This leads to acknowledgment that knowledge has become the most important asset for organizations and for individuals as well. With more high intensity this has been viewed as an active area of research [1]. The increased value and usage of knowledge in everyday life and in business develops a necessity for well educated individuals. One part of knowledge students can get in full time studies, what can make base of professional career but another part is study possibilities using modern technology and lifelong learning. That in turn demands for appropriately well developed education system, which points also to the lifelong learning strategy. The Commission of the European Community has been actively advocating for this since the end of last century. Commission's of the European Community [2]. initiative resulted in the Memorandum of Lifelong Learning to prepare the way for objectives to achieve in coming years. There should be found new ideas and ways how to give another momentum to lifelong learning. The bloom of different new technologies including highly popular mobile technologies might promise to provide some clues from the technological perspective. Most of the students after graduating from secondary school are forced to look for a job; therefore it is very important to provide them qualitative e-learning possibilities using the available technological solutions. Enhanced ways of teaching and learning such as e-learning and m-learning probably could cover the gap in education accessibility. E-learning as a study form can make study process more effective for this part of students who have professional experience already. One of the e-learning definitions is the delivery of a learning, training or education program by electronic means. E-learning involves the use of a computer or electronic device (e.g. a mobile phone) in some way to provide training, educational or learning material [3]. Author defines e-learning as using internet to get learning materials, to interact with the content, tutor and students for getting knowledge and support in the time of learning and making his own outlook based on this new knowledge. Technologies are obviously a major component in today's educational practice. There is no doubt that digital or e-learning, or e-enabled learning has made a difference to our lives, and that is largely based on digital information and communication technologies. ICT will go through cycles of development, hype, overshoot, disillusionment, shake out, and consolidated growth. We are probably currently at the disillusionment and shake out point and will start to see more tentative, consolidated growth from now on [4]. Most popular and accessible technological solution for e-learning is based on web technologies and using computer. The tendency to use mobile phone, different types of mobile devices, virtual and

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augment technologies in education also is growing but there are only few products and technologies in the world for study aims. Unfortunately there are not information systems what could organize all these technologies in unique system for learning aims. The same time e-course developers have not information about using different technologies, various techniques and methods of possible use and effectiveness of the training process in e-learning. More popular is using the same methods and materials for full and part time students, also for creating e-learning course content. It does not take into account the e-learning key feature, which focuses on students' acquisition of an independent material. The goal of the research is to work out, give theoretical justification and evaluate a qualitative e-learning development model in perspective of advancing modern technologies

## II. THEORETICAL BACKGROUND

Quality assurance is one of the Bologna action lines. Quality means freedom of deficiencies – freedom from errors that require rework, customer dissatisfaction, customer claims and etc. [5, 6]. Qualitative education contains learner responsibility, educator responsibility and administrative responsibility. Quality assurance undoubtedly has a specific purpose for evaluation, and students themselves want to get good education as well [7]. The inclusion of online learning technologies into the higher education curriculum is frequently associated with the design and development of new models of learning. It is essential in modern study process to observe the principles of constructivity, interactivity, externalization and instrumentation according to Brunner's theory [8] and theory of activity [9]. The perspectives of education is hardly imaginable within borders of a single organization or an individual country, and determines necessity for a wider and wider exchange of information. This can be technically provided by IT, provided it serves the needs of the society. It is important in the study process to develop basic academic skills, highly organized thinking and problem solving skills. Theory of construction determines learning to be an active process in which a student constructs new ideas and conclusions based on previously acquired or actual knowledge. It means that future education should prepare student for three main tasks:

- to solve different type of problems
- to find information quickly
- to structure knowledge

An individual can be trained as a highly skilled specialist if teaching and training process that increases the potential skill and know how level, also fosters intellectual development broadening cognitive horizon and guiding student towards the lifelong learning approach. This process is connected to objective contradictions:

- between disposition towards independency in the selection of knowledge from one side and the existing forms and methods of professional training from the other,
- between the large amount of information and superficial knowledge from one hand and the quality of practical skills in a definite profession from the other [10].

From an individual's perspective knowledge is as ones memories and skills, and its physical location is mainly in the brain [11]. Knowledge is rather intangible and that it can not be fully realizable in common with all our human being. Thus a considerable role is performed by person's characteristics such as psychological traits, motivation, volition and his or her intelligence. KM (knowledge management) represents a mix of different areas, practices, tools, and strategies combined under one umbrella. Some of these are rather new. Others are already well known and used by people centuries ago. Learning by doing and master and apprentice mentoring relationship are examples of widely used forms of interaction and knowledge transfer. If to focus on an individual's knowledge then the term personal knowledge management (PKM) comes up. PKM encompasses processes that an individual needs to carry out in order to gather, classify, store, search and retrieve knowledge in one's daily activities. A more specific definition is given by a well known author in KM area Thomas Davenport, where knowledge is a fluid mix of framed experience, values, contextual information, and expert insight that provides a framework for evaluating and incorporating new experiences and information. It originates and is applied in the minds of knowers. In organizations, it often becomes embedded not only in documents or repositories but also in organizational routines, processes, practices, and norms [12]. KM is usually viewed in a business context in organization. Thus KM is a business activity with two main aspects:

- treating the knowledge component of business activities as an explicit concern of business reflected in strategy, policy, and practice at all levels of the organization; and,
- making a direct connection between an organization's intellectual assets – both explicit (recorded) and tacit (personal know-how) – and positive business results [13].

One of the main goals of KM, as pointed out by Tiwana [14], is to facilitate opportunistic application of fragmented knowledge through integration. It means that creative experience have been took place in this context. Creative experience of studies is the knowledge, skills and attitudes gained and assessed by a student in the process of theoretical and practical cognition, which have become a personally important and can be applied in various life situations [15]. Development of creative experience in study process is one of the main goals of nowadays education.

There are some web-based e-learning course models scientifically worked out by different scientists. One of the most popular and effective model of web-based e-learning course is developed by Kaschek [16, 17]. He develops the framework for the design of e-learning system. This framework is based on an Abstract Layer Model. Model is worked out like a cycle what goes through several pyramid layer [18]. The model developed by authors performs course formation through a definition layer, a technological layer, a didactic layer, a tutorial layer, a presentation layer and implementation layer. Implementation layer is not viewed in detail and is left to the technical staff competence.

Modern advanced technologies enable and support a processing of large amounts of information in reasonable time. Regular PCs (personal computer) are being used for regular office tasks, for studying process, for CRM (customer relation management) systems and for very many different other aims. Mobile technologies popularity is soaring in the World level be it business environment or a private sector. Many different mobile devices such as PDAs (personal digital assistant), regular mobile phones, camera phones, PMPs (personal media players), or gaming consoles are being widely used. All of them can process some type of data, media or information. Many individuals starting from children till grannies use mobile phones for staying in touch with their loved ones. Advanced technologies such communication enablers (chat rooms, electronic message boards, e-mail, voice and video communications, and the new phenomena - twitter), smart boards, different simulation technologies and so on have an influential role in education as well. Students can be supported by number of different technologies be it a regular PC based or using some kind of a mobile device. A training course quality can be enhanced by a support of technological solutions. PKM (personal knowledge management) practices go hand in hand with just mentioned advanced devices and technologies. An instructor deploying PKM approaches and using mobile device and/or PC based technologies can create an effective further follow-up system which would support trainees in their work duties after they have left the training department thus helping for just acquired new skills to mature in their heads.

### III. METHODOLOGY

Modeling as a method is widely used in different scientific fields and sectors. This method allows create a simplified representation of a system at some particular point in time or space intended to promote understanding of the real system and manipulate with a model in such a way that it operates on time or space to compress it, thus enabling one to perceive the interactions that would not otherwise be apparent because of their separation in time or space. Depending of system which will be created there are various modeling tools.

Pilot model of e-learning methods development which allows simulating the effectiveness and students' satisfaction of different learning methods was created using system dynamics modeling tool Stella 9.0.3. This tool was selected because it allows represent simulation model as close as possible to real life situation and also some other reasons: user friendly interface, opportunity to clearly define and import/export input and output data.

*Modeling in this environment is provided using four models' developing elements:*

- Stocks: The basic building block that is used to represent anything that accumulates (populations, biomass, nutrients, water). Usually these are tangible, countable, physical accumulations, but it is also possible use stocks to represent the degree of non-physical accumulations: in this specific case stored knowledge units and attraction of each learning method.

- Flows: Used to represent activities that lead to inputs and outputs to stocks. These activities will change the magnitude of stocks in the system.
- Connectors: Connectors transmit information to regulate flows. Connectors can connect into flows or converters but never into stocks. Only flows affect the magnitude of stocks. However, connectors can affect both input and output flows.
- Converters: Converters contain equations that generate an output value during each time interval of a simulation. Converters often take in information and transform it for use by another variable in the model. They are also handy for storing constant values. [19]

*Imitation modeling in STELLA environment is based on three main steps:*

1. step: Model construction. During this step, it is important to consider what the essential elements of the model are, and how they qualitatively influence one another.
2. step: Parameter assignment. During the second modeling step, the relationships among elements have been expressed numerically.
3. step: Model Dynamics research: The last step of the modeling process is to explore the model output. Output is generated in tabular and graphical form. It helps easier explore quantitative or quantitative outcomes.

As was previously noted the model developed by authors is based on Abstract Layer Model. In definition layer course has been identified and set course aim and objectives. In this layer also potential target audience has been defined. As most important characteristics for audience are used student perception type and its combinations. To get information about target audience students must take VARK test where as a result get perception type level in kinesthetic, audial, visual or reading/writing perception. Technological layer based on student's profile choose appropriate technical solutions. To get information for this layer student must fill form about available technologies and their wish to use them in learning process. In didactic layer according course aim and objectives learning methods effectiveness has been evaluated. In tutorial layer collective opinion about specific technology and method's use in the learning process has been established. Based on previously achieved evaluation of methods and technologies efficiency and students perception types stored knowledge units has been identified. And in presentation layer course developer based on models output information choose optimal learning methods which most effective helps achieve course aims and motivate students. This layer has been considered as model's output data layer.

*E-learning methods development model, realize simulation of several processes:*

- Simulation of available technologies-this part imitate the existence of each technology for each student, based on probabilities, which are subordinated to the model,

- Simulation of perceptions distribution-this part simulate existence of each student's perception and count the number of each type students in course,
- Simulation of learning methods technological practicability-this part of model determines is it possible to realize certain learning method using available technologies,
- Simulation of students stored knowledge units using each of learning methods-this sub-model established effectiveness for learning method, simulating stored knowledge units for one student and all group.
- Simulation of enjoyment using each learning method-this sub-model simulating "enjoyment" unit's accumulation rate in course using one or the other learning method.

The most important part of this model is simulation of students' stored knowledge units. The other processes only supplied the necessary data, or improve it.[20]

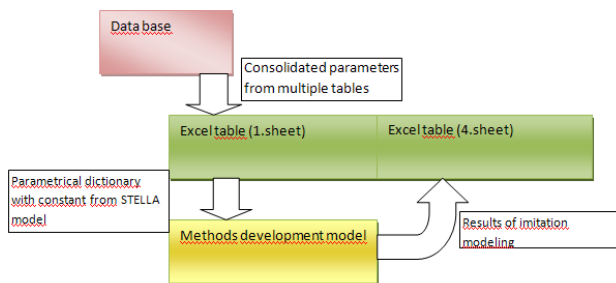


Fig. 1 Data import and export

Created model consist from more than 100 parameter and import data from table which get information from data base. In this data base information about learning courses and methods, skills, which must be developed by each methods and course, as well as individual influence of perception for methods usage has been stored. The way of data import and export is shown figure 1.

#### IV. RESULTS

For experimental modeling environment is chosen Vidzeme University of Applied Sciences Faculty of Engineering which realizes professional bachelor studies in Information Technologies using e-learning environment. After the graduation student gets Professional bachelor degree in Information technologies and programming engineering qualification.

There are 3 completely different courses- Programming, Professional communication and Business statistics, were tested using created imitation model.

At the course beginning students take VARK test where they as a result get perception type level in kinesthetic, audial, visual or reading/writing perception. Based on test results probability of each perception has been calculated. The probability of audial perception 61,4%, visual 48,2%, reading/writing 66,5% and kinesthetic 69,9%. From this aspect most important information for this group comes using hearing, reading/writing and tested in action. The next step was questionnaire about more enjoyable technologies and

methods what they want to use for learning and for technologies what they have. All of them have computer and mobile phone. Also they checked which methods they do not want to use. As the result of computer modeling for courses Programming and Professional communication there are accumulated knowledge units and methods attraction for students in the table I.

As shown in the table more effective methods for programming course are chats, the next are internet competitions, wiki and internet based home works. After that there are presentations using and virtual laboratory. Also for course Professional communication most effective methods are chat and wiki. Then come internet competitions and presentations.

TABLE I  
RESULT OF COMPUTER MODELLING FOR COURSES PROGRAMMING AND PROFESSIONAL COMMUNICATION

Methods	Accumulated units		Attraction of method
	Programming	Professional communication	
Chats	38148	31635	59
Computer games	20064	21150	53
Internet competitions	34686	27324	59
Internet tests	16422	12225	65
Reading	12480	10695	55
Mikro	9177	9780	19
mp3	7923	9360	44
PC based works	33750	17928	44
.ppt	26829	23772	55
Papers	14703	15750	26
sms tests	12183	8496	19
Tekstual home works	15717	13500	44
Vidconf	17577	17835	71
Video mat	20412	16605	61
Virt lab	25080	10575	68
wiki	34020	30132	59

Similar results were also for course Business statistics although there was a different target group. More effective methods for Business statistics course are computer games, the next are internet competitions, presentations and chats. After that there are wiki using and virtual laboratory.

#### Modeling results lead to conclusion:

- There are methods which are equally effective even for tematically different courses.
- Synchronous online methods like chat, computer games, internet competitions and wiki accumulated the biggest amount of knowledge units.
- If within one course two methods are with statistical equal efficiency then course developer needs to choose method which is more attractive for students and support more perception types and technologies.

Analyzing teacher experience for teaching business statistics for experimental group of student's computer games and internet competitions in practice increase understanding

comparatively complicated theory of statistics and use it in praxes. The model helps to find the most effective methods for individual group and course content.

#### V.DISCUSSION

The paper presents theoretical justification and evaluation of qualitative e-learning development model in perspective of advancing modern technologies. The main accent in this research was made to e-learning methods effectiveness and learning students with different perceptions but there some other aspects to be researched. In the future research in development of personalized e-learning system development will be continued. Future work will be related with development of personalized e-learning knowledge transfer model using effective methods of ontology.

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