INNOVATIVE EDUCATIONAL SCENARIOS IN GAME BASED TEACHING AND LEARNING

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Abstract
The didactical game can be considered part of an educational scenario in teaching and learning. This article aims to show how fundamental concepts from the economic-mathematical modeling area can be visualized, how to organize knowledge in coherent scenarios, presented in an educational game manner, to gain the attention and influence students' spirit of competition.
At the same time, benefitting from the 3D visualizations, the graphical interfaces for navigating in multidimensional spaces or projections are defined and thus imagination used for mental models construction is stimulated and human intuition is capitalized in the process of knowledge discovery, assisted by computer with analytic algorithms type. Exploration becomes a game feature and can be pursued both numerically and visually. 3D environments give realism to visualizations that are found in games, facilitating real-imaginary relationship throughout the game and enhancing learning motivation.
The innovative character of teaching is given by the method in which the teacher creates his own educational scenario by considering specific learning objectives, age particularities of students, time and space-related resources, the technical requirements of the game and the evaluation method. The paper makes several references to such projects, developed by the authors and implemented in working with students. Game based on demonstration (using simulation, modelling or visualization) coordinates users to obtain relevant information; the multiple representations of knowledge are so used and compared through a multitude of examples.

Keywords: educational game; teaching innovative; business game; 3D visualization; computer assisted.

JEL Classification: A2, A1.

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Introduction

Motto:

"The child laughs: *My wisdom and my love is play!*
The young man sings: *My play and my wisdom is love!*
The old man is silent: *My love and my play is wisdom!"*

Three faces - Lucian Blaga

Looking at the surrounding world we can notice that the play is the main form of learning at young ages. The child acquires knowledge and experience through play and this is reflected on his mental, intellectual and emotional development.

The game has a particular importance in the human evolution, becomes a means of knowledge that stimulates thinking and creativity by identifying solutions to a problem, what allows the development of critical thinking and emitting value judgments.

The high level of interactivity, the native tendency of individuals to be higher up into a hierarchy, make the game to be the most attractive opportunity and at the same time, the most effective learning form. From this point of view, the game is included among teaching methods that promote active learning.

According to Delors (2000) "education's pillars in the XXI century are: learning to know, learning to do, learning to be, learning to cohabit". The teacher creates training situations and sets appropriate strategies for teaching- learning to facilitate effective learning. The choice of methods used in teaching-learning is closely related to objectives and expected results. A reference of this is the "learning pyramid" (figure no. 1) that displays the extent to which new information is retained by students depending on the educational method used.

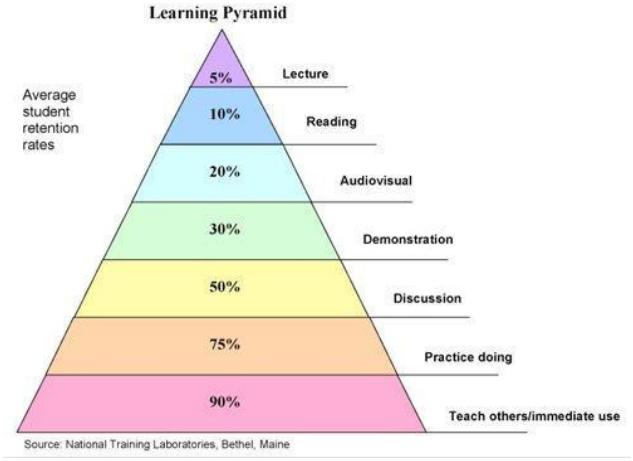

Figure no. 1: Learning Pyramid
Source: Soni, 2015

Despite the controversies related to the subjectivity of the proposed percentages (correctness), we note that the first three methods at the bottom of pyramid have registered

the best values. These are the participatory methods and in order to reach the innovative learning type, the requirement of contemporary society, it is necessary for the teacher to identify the best methods and teaching aids.

Thus, the case study, problem solving approach, didactic game and exercise stimulate thinking and creativity and enable the operationalization of knowledge, which explains the increased interest in learning. Also, we need to consider the computer assisted learning as one of the important directions of teaching and learning strategies modernization. According to the "pyramid of learning" the best method to design learning materials and deliver content through online courses is "learning by doing", although it isn't most effective (only 75% compared to 90%). All these led us to the idea of studying the relationship between computer games and computer assisted learning using 3D environments.

1. Games and computer assisted learning

Any virtual game, by simulated didactic action, has as a result the acquiring of new knowledge and practicing of some skills and abilities (Barjis et al., 2012). On the other hand, the students' interaction with a simulated environment leads to a higher level of their involvement in the learning process... The problem can be reverse drafted: to what extent can we invent games to facilitate the understanding and the assimilation of new concepts on a logical basis given an amount of knowledge that we are required to acquire?

First of all, we must study carefully what the *computer games* and *e-learning* have in common. Of course, both have a system of rules well established and known from the outset. The competitive spirit promoted specifically by games is also found in the learning process. The evaluation and awards system can be chosen so as to be the support of a real competition and a landmark for student placement into a hierarchy of values. The logical connections between the proposed concepts for learning, so needed for structured learning, have a correspondence on computer through navigation system and visual implementation of a possible path, both in games and e-learning.

Also, the graphical interfaces may contain clues for guiding and discovery in a world of concepts, keeping alive the explorer spirit of learner. Another common feature of the two domains is the presence of time factor, as rate of assimilation of knowledge or dynamics of the game. Further, we'll try to study the extent to which the game based learning helps stimulate creative imagination as a prerequisite for innovative teaching, in economic field.

2. Environments and tools for creating games

Educational games can be created both on the desktop and on mobile environments. Regardless of the type of created educational games or their delivery environment, teachers need adequate support, which on one hand facilitates the process of creating and secondly, contributes at increasing the motivation and the skills development of students, including game based items. This raises the need to maintain a balance between game-type elements that contribute to increased motivation and the pedagogical elements that facilitate learning. Accomplishing this entails that teachers, educational game creators, must have specific

tools available by which they can create these games. Among the environments and free tools enabling the creation of educational games the following are currently used:

- EUTOPIA- 3D online environment that enables the creation of virtual scenarios where students play a specific role and simulate a situation which supports collaborative learning;
- OGRE (Object-Oriented Graphics Rendering Engine)- centered on 3D environment enabling game development with an easy to use interface, made to minimize the effort required to interpret the 3D scene;
- 3D Game Studio- tool for any 3D game development;
- RPG Maker (Role-Playing Game Maker)- tool for creating the role-playing type didactical game;
- Microsoft XNA- tool that, using XNA platform, allows the development of computer games (single and multiplayer); the framework supports the creation of 2D and 3D games and integrates tools such as XACT (Cross-platform Audio Creation Tool) that helps to create content;
- ITyStudio- tool for creating 3D online games (30 days free trial) offers, in addition to included content library environments (over 40 environments available in 2D and 3D), the possibility of creating specific environments adapted to user needs and export of game on LMS platform (Learning Management Systems);
- e-Adventure - a tool for developing educational games 2D point-and-click type, environment for implementation of user-centered adaptable scenarios.

Some platforms are more visual and less technical, facilitating the games creation by the teacher himself. There are certain tools requiring programming knowledge, resources that are not possessed by all teachers and when creating complex game scenarios the involvement of experts is necessary. Another major inconvenience is that certain free available components of game are inappropriate or difficult to be reused.

3. Educational games in economics

3D virtual environments are built environments, based on graphics or 3D effects that offer a number of challenges both in achieving pedagogical design or content creation and in their implementation and use. This environment is interactive for users, like actions in a game, which allows them developing skills needed in a specific area (e.g., the ability to manage a company) and interacting with other users in online games from virtual environment, promoting a collaborative learning. According to Prensky (2001), a game can be considered important and thus be used in the educational process if it:

- has goals and targets;
- is based on a set of known rules;
- ensures interaction in competitive conditions;
- allows to periodically evaluating the results;
- provides a feedback;
- ensures obtaining a feedback, based on which the user can make hypotheses and take future decisions.

From the research concerning the interactive teaching methods that develop the students' creativity are noted:

- simulations;
- play- role scenarios;
- working groups in competition;
- case studies.

The computer simulations by their open, dynamic and interactive character, allow users to explore reality through a simulated version. The major advantage is the fact that the user is able to control his learning experience in the user virtual world where he acts. Thus, using and evaluating situations, the student acquires experience allowing him to share it with others, in a collaborative environment. In this way, the simulation games materialize the principles of effective learning through experiencing a simulated version of reality or practice.

The competitive games are very suitable to simulate the competition in the economy, to understand the idea of coalition and monopoly and their influence on price evolution in market economies. The simulations efficiency increases when it is based on a mathematical model, for instance at economic disciplines, because the effects of important parameters can be studied and thus the educational objective is reached through the understanding of economic process in a context of dynamic analysis. Especially helpful in understanding the concepts proves to be the study of derivatives, with direct applications in calculating the marginal values (differential) of some economic indicators such as costs, price or productivity. This understanding determines intuitive perception of the concepts of stationarity and co-integration as key elements in establishing causalities and decision making in the economy.

On the other hand, the simulations built around activities on roles (without determined actions) seek for a different approach to educational games, with major impact in economic disciplines learning, such as management. An innovative tool, well-known as "business game", is based on Kolb's theory of experiential learning (Kolb, 1984). This game includes four different stages of learning from experience (figure no. 2).

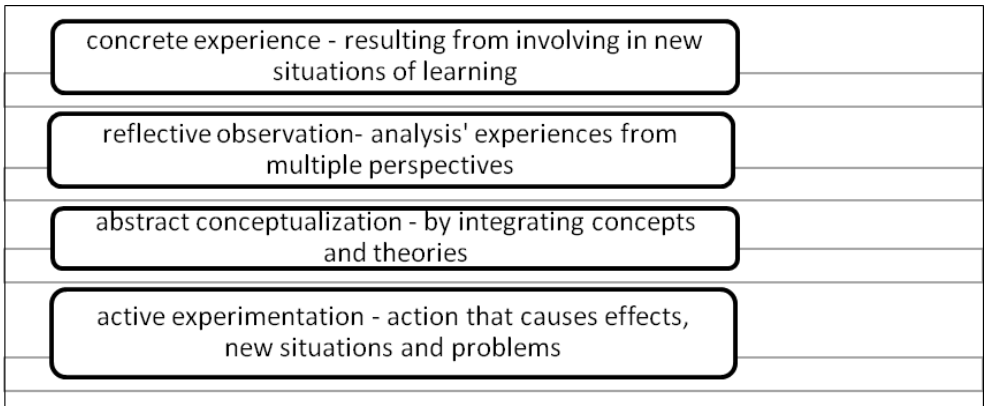

Figure no. 2: The Kolb Learning Cycle
Source: Kolb, 1984

By simulation, the business game becomes an exercise in which the user takes the risk of leading a company, regardless of the circumstances in which it is. Thus, the user through his actions, will implement the knowledge acquired, will test hypotheses, taking sequentially a series of decisions and will see the results of his actions. At the same time the user will understand the real-world processes and develop specific skills that can be directly transferred into practice.

The benefits of using educational games in the economic field could be synthesized as:

- acquiring knowledge necessary to economic field by solving the required tasks within the game, knowledge obtained through investigation and problem solving with varying degrees of complexity;
- obtaining relational skills acquired in meaningful learning contexts which encourage collaborative processes;
- the acquisition of skills by using knowledge acquired in various situations and linking knowledge from different disciplines economy;
- improving decision making skills as a result of experience gained through simulation, when choose alternative ways for acting in different contexts; thus, there is the possibility of resuming an action and choosing different ways to see how it changes the final result, when there aren't unique answers or definite winners;
- training the skills to recognizing multimodal characteristics of the game, through discovery, practice and interaction;
- enhancing the learning through acquisition of skills for the interpretation of images, sounds and actions of the game and perceive the relationships between sets of knowledge;
- increasing motivation of learning by collaborative action, in developing strategies and solutions required to interact with the learning environment of the game.

The innovative character can only be achieved through repetitive trials and following the feedback of each stage and at the end of a round; each time trying new decisional variants to isolate and deduct effects of a decision. It is transposed by the existence of a distinct phase of performance measurement and evaluation, for comparing between players and also between teams. The spirit of observation, intuition, sharing ideas between team members can contribute substantially to the correct interpretation of results, the discovery of new decisional reactions or new models for reasoning. The competitive spirit of the game stimulates creativity, keeps up the interest in the exploration and discovery of knowledge. Designing an efficiently game is a major challenge, given that the teacher creates the game from learned outcomes and learning must be done in an effective way, in order to capture the interest of students.

4. Visual support for creating educational scenarios

Multidimensionality is one of the key attributes of the video support in games (Kim and Lee, 2012); it corresponds to multiple perspectives on the approach of a real economic phenomenon. At the same time, the common human perception limits the mental projection to three-dimensional space of the everyday life interactions; thus, one has to face the problem of dimensionality reduction. A starting point in this process can be the variability in the data; this is always associated with the amount of information and therefore the directions where data scattering is large, will be preserved by the projection on a subspace with fewer dimensions. To identify the informational contribution brought by

each dimension (Shashi et al., 2002) in explaining variance of the data, the eigenvalues of matrix observations is calculated; this is suggested by a simple mathematical model for covariance maximizing, solved using Lagrange multipliers (figure no. 3).

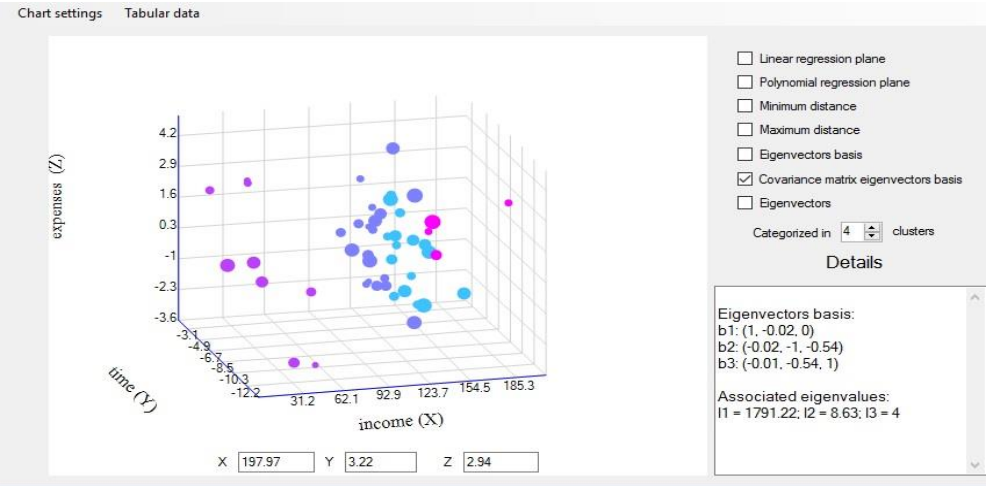

Figure no. 3: Using eigenvectors for data variance analysis
Source: own software

On the other hand, the repetitive character of the same data appearance is an important element in the discovery of patterns, contributing to the simplification of the understanding and to knowledge discovery. As observed in figure no. 4, there are two different learning planes:

- practical one, based on available data and benefiting from technological support for their modeling and determining the optimal dimensionality for the analysis;
- another abstract plane, based on thinking, reasoning and abstractisation; it uses, but also enriches the existing knowledge base at a time.

Interactive visualizations mediate the connection between the two planes, being based on real data, but at the same time providing support for an intuitive and imaginative human exploration. 3D visualizations, by stimulating the human capacity to imagine the multidimensionality of phenomena, creates prerequisites to become aware of the things yet unnoticed, to discover new patterns in data, leading to the formulation of new questions and working hypotheses (Oblinger, 2004).

When the first adjusting loop, based on data, is exhausted and can not bring any extra knowledge, a second adjusting mechanism is triggered, by changing the economic model of thinking. Involving the human factor, the use of interactive visualizations has a subjective character, depending on the capacity of each individual to explore and summarize iterative information to integrate them into a coherent mental model. Information tehnology support comes not only with the graphical representation but also with multidimensional data analysis algorithms, guiding the user exploration toward directions where informational variance is high. Not incidentally, the development of interactive visualizations is linked to analytics, ie the development of a detailed analysis of the data, which is closely connected to business intelligence.

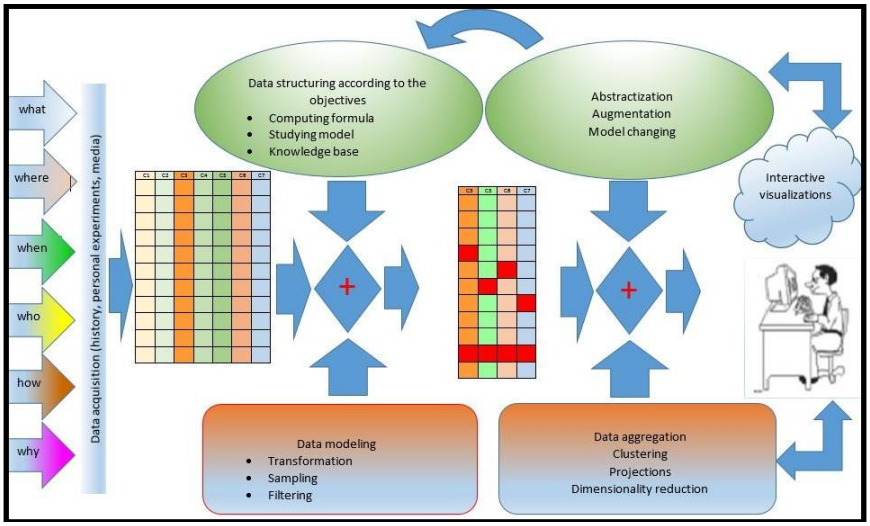

Figure no. 4: Integrating interactive visualizations into learning cycle
Source: Own projection

The games must offer an exciting environment where students get involved intellectually and emotionally. In the game, the characters, action and the interaction must be relevant to the educational context of user and must not be frustrating. Educational scenarios focus on action in the sense of constant encouragement to do something, to act, to choose, to interact in the game. The whole idea of the game is to capture the interest of player, to urge him to action, to take the role of a character and identify with it, to perform a certain mission or reach some objectives and be rewarded for this (Mason and Renie, 2008). Games must start from a clear reality and have a strong internal consistency and logics. Therefore, for the sucess of the game it is necessary:

- graphical interface must be friendly and easy to use;
- structure and navigation must be very intuitive and clear: no hidden options or buttons, without overloading with accessories and other mechanisms;
- presenting the results must be made in a suggestive way, easy to interpret in order to support fast decision making, in future iterations.

Understanding the complex concepts requires decomposition on logical steps to ensure real assimilation of an idea, rather than memorizing a formula; for example, understanding the concept of elasticity may prove to be difficult. In economics, the elasticity is a measurement of relative variation of a variable in relation to the relative change in other variable. The best known example is the price elasticity of demand, which shows the percentage change in demand (q) at a 1% change in price (p):

$$e_{q/p} = \frac{d_q}{q} : \frac{d_p}{p} \quad (1)$$

where:

$e_{q/p}$- demand elasticity of price;
d_q/q – the percentage change in quantity demanded from an economic good;
d_p/p - the percentage change in price from an economic good.

The difficulty of understanding increases where the change is the result of several factors. For example, Cobb-Douglas production function (Fuleky, 2006) expresses the increasing production on account of capital and labor:

$$Y = a \times K^{\alpha} \times L^{\beta} \quad (2)$$

where:

Y- production;
a - coefficient of proportionality;
K - capital;
L - labor;
α, β - production elasticity according to capital and labor, respectively.

This increase can be decomposed according to each individual factor, labor (L) and capital (K) and their simultaneous interaction. On the basis of simple calculations, it can be seen that α is exactly the production elasticity in relation to K and β the production elasticity in relation to L. A logical learning scenario may have the following steps:

- absolute difference $d_q = q_1 - q_0$;
- relative variation d_q / q_0;
- elasticity for a function of one variable;
- elasticity for a function with multiple variables;
- differential of a function with several variables, for continuous and discrete cases;
- indifference curves visualization;
- decisions based on application of differential around the optimal points.

Depending on the level of knowledge, the scenario can support detailing, shortcuts or references to other concepts, already known. A 3D visualization of the production function in dynamics (from different perspectives), by simulating at different sets of appropriate values for the parameters α and β (like in example above, figure no. 5), would facilitate the understanding the concept of factors yield (Smeureanu and Isăilă, 2016).

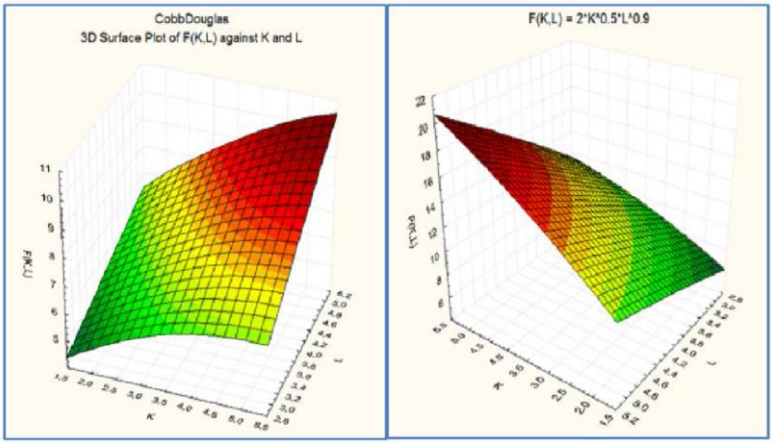

Figure no. 5: Point of view and perspective control for a Cobb-Douglas production function
Source: Run with Statistica software

Conclusions

Educational games have the potential to increase the motivation in learning and facilitate the development of abilities and high-level skills; this is a sufficient reason for considering the gaming as an important tool in teaching. On the other side we also note the existence of open source applications to create educational games in 2D or 3D environments.

All these are important elements which the teacher has to take into account to create the educational scenarios. Thus, teaching becomes innovative and learning specific objectives can be achieved. However, the widespread use of educational games is limited by domain-specific technological challenges, especially when the teacher's available resources are limited. On the other hand, the time needed to create the game and then tune it from running observations, becomes an impediment for spreading this type of training.

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