

## Computer Simulation as an Innovative Didactic Method

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### Abstract

The teaching process in the 21st century is subject to constant transformations, as new teaching tools and methods appear. Computer simulations are gaining more and more supporters among teachers and lecturers. The first part of the article has an overview character. Its aim is to present computer managerial simulations, with particular emphasis on Marketplace simulation. The second part of the article is of empirical nature. It includes the analysis of the impact of computer simulation on the effectiveness of the training process while also comparing the results of this analysis with the efficiency of the training process in the traditional form.

*Keywords: Computer simulation, marketplace, innovation, teaching, efficiency*

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### 1. Introduction

Societies undertake educational activities in order to introduce next generations into current adult life. Decisions about the shape and form of these activities can be made on the basis of the image of an adult, functioning in an optimum way under the present and future conditions. There are ongoing discussions about the shape of the future education system and improvements in the implementation of the teaching process itself. Especially now, along with technological development, there emerge new tools and instruments designed to optimize the didactic process, especially in higher education. Innovative didactic methods aimed at enhancing the effects of the teaching process are increasingly often sought after, as it is their alumni who will be faced with real socioeconomic environment in a not too distant, several-year time perspective. It seems, therefore, that certain technological innovations must not be missing from universities of the 21st century. In the era of digitization and inundation with multimedia, traditional didactic methods are becoming archaic and also unreliable. Hence schools are increasingly willing to introduce educational ICT technologies, but they also reach for innovative solutions to make changes in the teaching methodology. Building intellectual capital takes place in the course of education at various stages of education, using various forms of teaching, including e-learning methods and computer simulations (Adamowicz, Pyra, 2018). Bearing those in mind, the main objective of the article has been set to be the determination of the effectiveness of the Marketplace computer simulation as an innovative didactic method, as well as characterization of the essence and a review of computer managerial simulations. In order to

achieve this, it is necessary to theoretically present computer managerial simulations, with particular emphasis on Marketplace simulations.

In order to compare the effectiveness of teaching with the use of computer simulation to teaching in the form of traditional workshops, the research was conducted on two groups of students. The first one consisted of 39 students of the Department of Economics and Management of the Pope John Paul II State School Of Higher Education in Biała Podlaska, with the use of statistical analysis of competence tests, which students were subjected to at the entry stage (before training with the use of computer simulations) and upon exit (after training with the use of computer simulations). The second group consisted of 20 students of the Department of Economics and Management of Pope John Paul II State School of Higher Education in Biała Podlaska, with the use of statistical analysis of competence tests, which students were subjected to at the entry stage (before traditional training) and upon exit (after traditional training).

### 2. The Conceptual Scope of Computer Simulation

The literature on the subject offers various approaches to the definition of simulation. This is commonly understood as the imitation of something else (Barton, 1974). Another feature is highlighted in the case of simulation as the reproduction of the essence of a system or its operation without using it (Meier et al., 1969). However, it is not the reproduction itself that matters but the opportunity to perform analyses and observations.

Scientists have begun to use simulation in the 1940s. Initially, they were used to solve mathematical models, because digital machines were not known yet, therefore they were very simplistic.

Along with the dynamic development of ICT technologies, the popularity of simulation tests with the use of IT equipment, especially a computer, increased. In this way, a new type of simulation was created - computer simulation. It is a kind of software running on one or more computers which makes it possible to imitate the behaviour of the abstract model of the analysed system (Kawa et al., 2016). Computer simulation is a particularly useful method when systems with a high degree of complexity are tested. It belongs to a group of numerical methods which are used to perform experiments on certain types of mathematical models, and then to describe the behaviour of a complex system over a long period with the use of a digital machine (Naylor, 1975).

The ability to try out new ideas and strategies before they are implemented in the real world in a relatively quick and financially safe manner is the main advantage of simulation. Due to the fact that results of simulation can be generally obtained quickly, it constitutes an extremely useful tool in the implementation of the didactic process at universities.

### **3. Characteristics of the Marketplace Computer Simulation**

Marketplace (<https://game.ilsworld.com>) is an example of a computer simulation, used for additional project classes for students of the Department of Economics and Management at Pope John Paul II State School of Higher Education in Białą Podlaska. It is a sophisticated type of software which imitates a competitive, continuously changing market. In contrast to traditional learning, based on theoretical textbooks, simulation exercises enable students or managers to learn and gain experience through making realistic business decisions. They deal with market analysis, strategy formulation and strategy management and can immediately observe the results of their activities. This approach allows them to memorize more information than through traditional methods of learning.

Web Marketplace is a modern simulator of entrepreneurship. It combines a powerful simulation model, which has been constantly improved over the last 12 years, with the latest web technology. It constitutes a virtual world in which students try to establish a company, and then take care of its successful development, competing for customers with the companies of their colleagues. Management takes place through decision-making cycles representing the company's quarterly operating periods. The number of simulations can vary from 6 to 12 depending on their level and complexity. In each cycle, the student is tasked with estimating the situation, and then planning the development strategy and putting it into action. Participating in the Web Marketplace game is a way to learn how a

company functions in a rapidly changing market, where the conditions are dictated by customers, and the competition is constantly trying to take your place.

In the virtual world of Marketplace, students get the first chance to test their knowledge in practice: they work in teams under real time pressure. All their decisions have realistic effects, taking into account the actions of all other participants in the simulation. At the same time, when analysing the activities of their enterprises, by adjusting the strategy and putting it into practice, students acquire the principles of business logic. Virtual environment stimulates the spirit of competition. Competition and emotions associated with it stimulate participants to learn, because economic knowledge is an essential element in mastering the simulation and achieving good results therein. They even teach to take failure according to the "learn from mistakes" principle, and the virtual advantage of the Marketplace is their virtual costs.

In Web Marketplace participants encounter the rules of business and the game of mutual relations between marketing, production, finance, accounting and team management. They discover the nature of realistic business decisions, including links between company departments, conflicts, dilemmas and potential outcomes. During the entire exercise, the students' understanding of the correlation between various areas of the company's operation increases in geometric progression.

### **4. Review of Other Computer Managerial Simulations**

The increased application of computerized managerial simulations is closely related to the change in the teaching paradigm in which the student takes an active part in the practice (Thatcher, 1990). Simulations not only create almost "real" experience, but also help to combine theory and practice. Modern computer managerial simulations are used to learn economic disciplines and management, such as strategic management, marketing, project management, economics and international business. In addition to the previously described Marketplace simulations, other pedagogical instruments in this area include Global Management Challenge (<https://gmcpoland.pl>), JA Titan (<http://titan2018.ja.org/home.php>), Sim Venture (<https://simventure.com>), Industry Masters (<https://www.industrymasters.com>).

Global Management Challenge is a computer simulation in the so-called general management field. Its goal is to provide the fullest possible depiction of the daily work of the senior management of a company, which produces largely indefinite industrial products, and conducts their sales on various markets. Participants, divided into teams, assume the role of the management board in a virtual company which they are to run for five consecutive

decision rounds. In their course, at a certain level of generality, they make decisions in the area of organization, finance, production, human resources, logistics, research and development as well as marketing and sales. The management must always keep in mind its main goal - to bring the managed enterprise to the best possible economic condition - which in this simulation is reflected in the price of the company's share stock.

JA Titan is a simulation of business activity, widely known around the world, which was prepared for high school students. On the basis of computer simulation of economic processes, classes are conducted during which pupils learn about the necessity of having theoretical knowledge, which is required to make correct economic decisions allowing the team to win in a simulated competition. The purpose of this program is to enable students to acquire knowledge and check the ability to use information in the field of microeconomics based on the rules of the production company, as well as the impact of economic phenomena on the effects of these enterprises. The program allows young participants of the simulation verify their current knowledge and skills in computer simulation exercises in a safe environment before they set up their own companies and compete with other companies on the real market.

SimVenture is one of the most popular simulations on the English market, which aims to help young people develop business thinking and entrepreneurship, and thanks to their interest it is intended to make learning more enjoyable. It requires users, working individually or in teams, to make decisions and deal with their consequences in a way simple to understand. The simulation has many levels of difficulty which ensure that students face constant challenges at a level that matches their skills. Such depth of problem solving combined with the wealth of information contained in SimVenture means that on the one hand students must deal with a wide range of problems, but on the other hand, they can constantly monitor and evaluate their own progress.

Industry Masters simulation is an advanced tool used to train managers and students, imitating real business problems in a dynamic and interactive way. The simulation uses issues from many fields of economics, management and entrepreneurship in its construction. These are management strategies, Porter's 5 forces model, price mechanism, perfect market model, product life cycle, economics of scale, industry competition, concept of benchmarking. Simulation participants gain access to many financial reports and charts that show the results achieved as part of the activity conducted and indicate possible directions of action. The full profit and loss account, balance sheet and

statement of cash flows are published for each quarter, which enables detailed monitoring of financial results. The simulation may concern many markets (Poszewiecki et al., 2012).

### **5. Effectiveness of Teaching Based on Marketplace Business Computer Simulation**

Research on the effectiveness of knowledge transfer and skills is usually associated with an attempt to assess to what extent a given form of education is more effective in achieving the intended goals than other methods. More and more often in the didactic activity at the academic level different ways of working are finding broad application; from the traditional lecture, through exercises and laboratories, case studies and computer simulations and decision games, especially in the business profile.

Regardless of the methods used by teachers, their aim should be to achieve didactic objectives, and thus to achieve a certain level of effectiveness in the field of knowledge transfer, skills and competence education. The method of its measurement is a problematic issue. Most frequently, there are two forms, i.e. surveying students with questionnaires about the usefulness and quality of conducting classes, and analysis of results from knowledge and skills tests. The latter method is more objectivised, which is why the authors of the work decided on this form of measurement.

The effectiveness of teaching can be determined by the benefits gained in three areas: knowledge, skills and attitudes, and its measure is defined by the extent of achieving assumed learning objectives (Liu et al., 2007). Thus, the research process focuses mainly on the analysis of the final results of knowledge or skills tests and the measurement of participants' satisfaction. Conducting research on the effectiveness of various forms of knowledge and skills transfer usually bases on determining the differences between the study group at the beginning (pre-tests) and after the end of the classes (post-tests) (Cook & Campbell, 1979). Changes in the participants' cognitive structure which are possible to explain are measured by knowledge and skills tests, thus the pre- and post-test scores are compared.

The aim of this part of the work is to evaluate the efficiency, using Marketplace computer simulation, 3rd year students of the Department of Economics and Management of Pope John Paul II State School of Higher Education in Białą Podlaska. Workshops with the use of Marketplace simulations lasted from October 2017 to January 2018. They covered a group of 39 people, of whom 46.15% were men, and 53.85% were women. The distribution of respondents according to the field of study is shown in Figure 1.

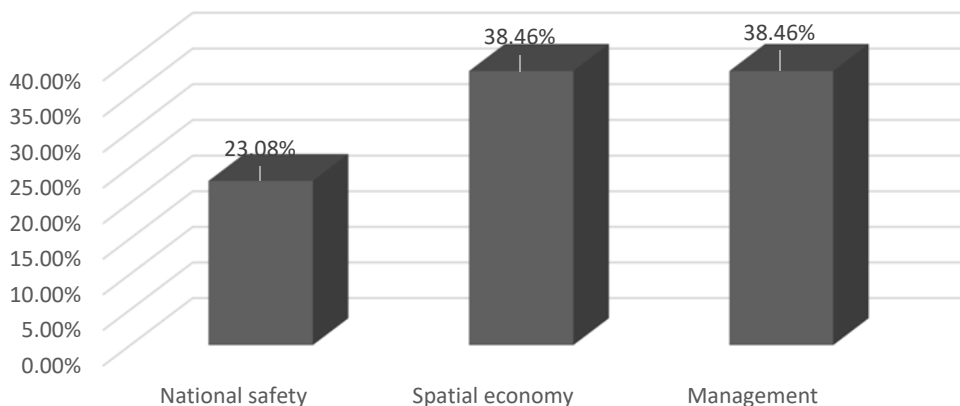


Figure 1: Structure of the Surveyed Students According to Their Field of Study

Source: Own elaboration on the basis of the analysis of competence tests among the students from the Department of Economics and Management at PSW in Białą Podlaska (n=39).

The study material consisted of balance sheets of competences in the form of tests to which students were submitted as part of the ex-ante evaluation (February 2017) and then as part of the ex-post evaluation (June 2018). The competence test consisted of two parts: self-assessment (8 areas) and substantive questions (8 questions). The thematic scope of the competence balance corresponded to the thematic scope which was implemented as part of the Marketplace computer simulation at the Venture Strategy difficulty level, covering gameplay in the dimension of 6 decision periods: 1st quarter - welcome to the Marketplace; 2nd quarter - entering the test market; 3rd quarter - results of the test market; 4th quarter - investing in the future; 5th quarter - expanding business strategy; 6th quarter - improvement of business strategy. At the end, final results are presented. After completing the entire didactic process, the participants were supposed to acquire the following knowledge and skills: practical skills in strategic management of the enterprise (general assessment); knowledge of organizing the company and starting operations, knowledge on market entry - management of sales offices, brand design, advertising, production prices, market research; ability to correct the strategy and develop the market - assessment of the financial result, necessary correction of financial and marketing tactics; ability to invest in the future of the company - assessment of the company's results on the market, investments in research and development, adjustment of production decisions, pro forma report; ability to develop a company's strategy - demand analysis, teamwork assessment, employee motivation, sales channels; ability to improve the company's operational strategy - assessment of financial

and market results, in terms of team work and competitiveness, necessary adjustment of activities, production schedule; practical reporting skills - profitability analysis, assessment of the financial result, deviations from the plan and their justification.

In the case of substantive questions included in the tests, the following issues were considered: market potential analysis, SWOT analysis, organizational phase, Quality Function Deployment quality planning method, research and development (R&D) works, marketing mix, financial strategies and production costs.

With regard to the self-assessment, the scale from 0 to 5 was used (5 means very high, 4 - high, 3 - average, 2 - low, 1 - very low, 0 - none). With regard to substantive questions, 1 point was assigned for each correct answer. The final indicator of the level of managerial competences was the total arithmetic average of the obtained score from self-assessment and substantive questions. For statistical analysis of input and output indicators, descriptive statistics tools were used in the form of central tendency measures, i.e. median, arithmetic average and dominant.

When analysing and evaluating the effectiveness of the Marketplace computer simulation, it is necessary to determine the increments of "benefits" obtained in given result areas as a result of teaching. The arithmetic average of points from the balance sheet of all students at the entry stage was 2.21, while at the exit stage it was 4.89. Similar increases can be seen in the values that occur most frequently in a given set (dominant), as well as in the middle values dividing the data set "in half" (median), as shown in Figure 2.

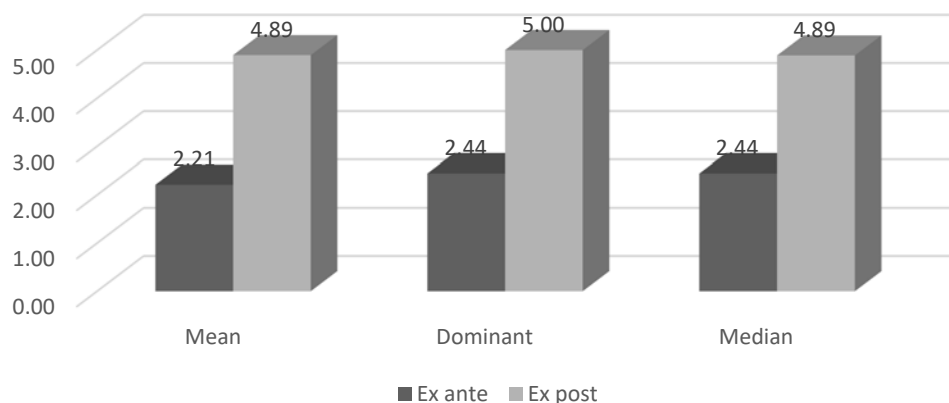


Figure 2: Measurements of Central Tendency (ex-ante and ex-post) for the Indicator of Competence Level  
 Source: Own elaboration on the basis of the analysis of competence tests among the students of the Department of Economics and Management at PSW in Białą Podlaska (n=39).

Such correlation of the basic indicators of the level of competences in input and output results stems from the innovative form of the workshops conducted through the application of computer simulation. The surveyed students presented their opinion at the end of the simulation whereby the intuitive interface, online access 24 hours a day, 7 days a week, content presented in the form of

transparent graphics, animations, exercises in the form of microsimulation or the possibility of using modern methods of communication with other team members and an instructor (chat, e-mail), was decisive for their greater involvement in the decision-making process. Detailed scores on the balance sheet for all 39 surveyed students are shown in Figure 3.

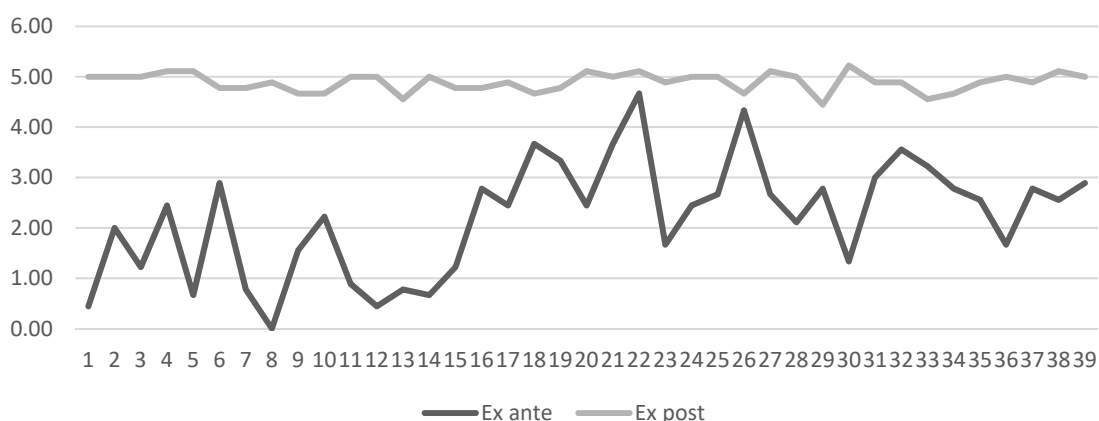


Figure 3: Competence Level Indicator (ex-ante and ex-post)  
 Source: Own elaboration on the basis of the analysis of competence tests among the students of the Department of Economics and Management at PSW in Białą Podlaska (n=39).

In Figure 3, it can be seen that in the case of 14 students who achieved the lowest entry rate (indicator <2.0), the impact of the Marketplace computer simulation on the level of managerial competences was very significant. It consisted in the growth of this level by several hundred percent, and in some cases, there occurred an increase of 1025%. In the case of students who achieved a high entry indicator (indicator > 3.0), the increase in this

level was also visible, as it was in the range of 40% - 45%. Summing up, it should be noted that these changes were incremental, and the impact of Marketplace business simulation on increasing the level of managerial competences of individual participants is significant. Detailed, percentage point changes of the competence level indicator are presented in Figure 4.

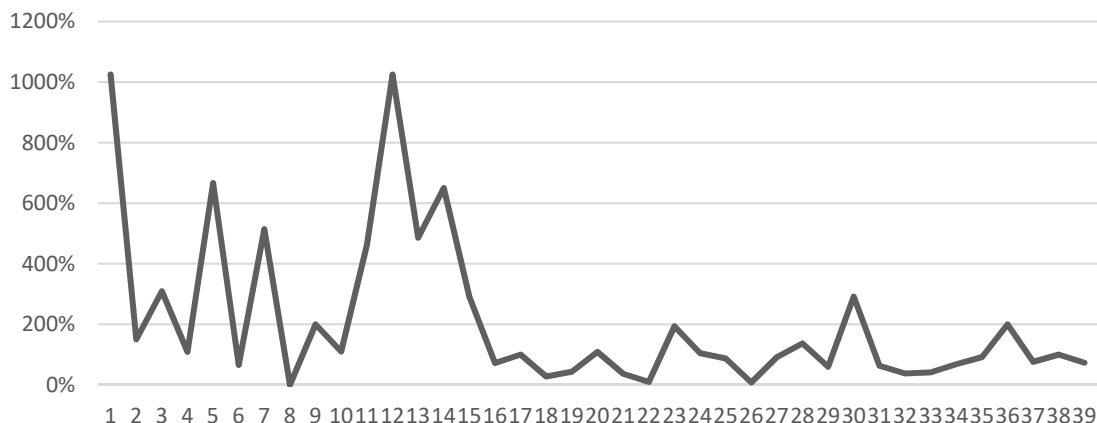


Figure 4: Percentage Change of the Level of the Level of Competences

Source: Own elaboration on the basis of the analysis of competence tests among the students of the Department of Economics and Management at PSW in Biała Podlaska (n=39).

The conducted research and analyses demonstrated high usefulness and effectiveness of such tools as computer managerial simulations, in particular Marketplace, which constitutes a good case study. It is worth mentioning here that the didactic workshops with the use of the Marketplace business simulation were one of seven measures which were implemented as part of the didactic project "Między szkołą wyższą a etatem (between university and a full-time job)", co-financed by the European Union under the European Social Fund. Other project activities, being an attractive training offer for students, are workshops on time management, change management, communication, on-line training in logistics, study visits or open lectures with business practitioners. In order to emphasize the high didactic effectiveness of computer business simulation, a similar analysis of the level of competence indicator will be presented below, but this time for traditional training, without the use of modern ICT tools. However, the problem consists in the fact that the evaluations of traditionally conducted workshops which are given after their completion by students participating in them, do not always refer to the assessment of long-term learning objectives. It is also difficult to ignore other aspects which determine the assessment of their usefulness, such as the ease of obtaining confirmation for a given subject measured by the outlay of one's own work, the personality of the teacher, and even the time of day in which the classes took place. Thus, this component of assessing the effectiveness of education is still largely controversial, but in the opinion of the authors of the work it seems reasonable to present due to the use of a uniform tool in both types of training, i.e. a balance of competence.

Training in business management, responsible for the growth of the same components among students, as in the case of Marketplace simulations (managerial competences), took place in March 2017, in the form of traditional workshops. It included a group of 20 people, in which the number

of men and women was equal (10 people each). Most of them were students of the third year of Management (65%), the others were students of the third year of National Security (35%) of the Department of Economics and Management of Pope John Paul II State School of Higher Education in Biała Podlaska

The study material was composed of balances of competence in the form of tests to which students were submitted to as part of the ex-ante evaluation (February 2017) and then as part of the ex-post evaluation (June 2017). The competence test, the thematic scope of the competence balance, and the scoring system were the same as in the case of Marketplace computer market simulation. A brief summary of the most important analytical values for comparative purposes is presented in the text below.

The arithmetic average of points from the balance of competence of all students at the entry stage was 2.65, while at the exit stage it was 3.28. Similar increases can be noticed in the values which are the most common in a given set (dominant - 2.40 ex-ante and 3.00 ex-post), as well as in the middle values dividing the data set "in half" (median - 2.70 ex-ante and 3.33 ex-post).

In the case of the same training, but conducted in the traditional form, without the use of a computer business simulation, the progress of the value of the managerial competence level was less dynamical.

In Figure 5, it can be noticed that for the majority of students, the impact of traditional training on the level of managerial competences was insignificant compared to the training using computer simulations. Only for 3 students an increase of over 40% was recorded in the balance of competence, and for the vast majority it ranged from 15 to 36%. In the case of 3 students, the training practically did not bring any effects, because the recorded growth was at a level lower than 10%. Detailed,

percentage point changes in the competence level indicator are presented in Figure 5.

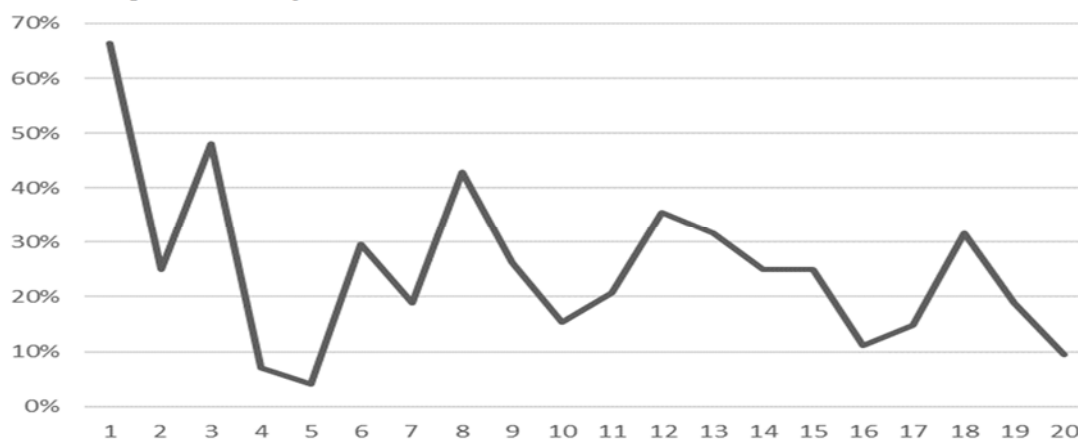


Figure 5: Percentage Change of the Indicator of the Level of Competence

Source: Own elaboration on the basis of the analysis of competence tests among the students of the Department of Economics and Management at PSW in Białą Podlaska (n=20).

The analyses presented, indicated that the training conducted with the use of computer simulations is characterized by higher efficiency than the training conducted in a traditional way. Thus, it is worth asking: Why are computer simulations so effective? As it turns out, the answer is quite simple and is determined by the following elements: a high level of realism; dynamic competition by making mutually-influencing decisions; a clear illustration of dependencies and emphasis on new ways of thinking; supporting discussion on the most important problems both in the team and between individuals; a direct reference to business allowing the use of specific skills in corporate practice; high quality and versatility of the tool allowing the inclusion of additional elements (chats, forums, group discussions), also less formal; user-focused orientation; adaptation to a specific target group; focus on results; ability to build relationships and support teamwork (Adl, 2010).

## 6. Conclusion

Teaching theorists acknowledge that the key to effective teaching is to involve the participants in the teaching process as much as possible. Their active participation together with innovative forms of message and communication between the users themselves as well as the teacher guarantees excellent results. As our own research shows, based on the balance of competences, the use of computer simulation in teaching results in increasing the level of managerial competences several times higher than in a similar training conducted in the form of a traditional training workshops. The case study presented in the article, i.e. Marketplace computer simulation, demonstrates that students put a lot of commitment into virtual competition, thanks to which they acquire appropriate knowledge and skills to make rational decisions that guarantee proper company management. The

computer managerial simulations allow teachers to support the learning process. Simultaneously, students have more control over the whole teaching process, and therefore greater motivation and responsibility. By participating in experimental science, students are able to understand the issues that were previously difficult and unattainable. Additional opinions collected from students during the interview summarizing the training confirm that computer simulations are an interesting addition to traditional lectures, exercises and laboratories.

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