Implementation of ERP Simulation Games in Economic Education: Ukrainian Dimension

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Abstract

The effectiveness of the introduction of interactive teaching methods, such as simulation games in ERP-systems, in the educational process appeared to be promising both in traditional and online learning, thus, the global expertise in this sphere should be learned and shared in order to increase the competitiveness of Ukrainian education. The aim of this article is to develop models for applying simulation games in ERP-systems in order to exploit multidisciplinary educational opportunities in economic educational programs and to enable students of Ukrainian HEIs to master professional competencies both in face-to face and online learning. This study is focused on showing the models for applying the approach in the framework of the courses related to quantitative methods of decision-making support. The implementation of the proposed idea is presented in terms of Economic Cybernetics educational program. Two models of ERPsim implementation in the educational process are suggested, the advantages of each model are analyzed. Examples of the use of data from ERP systems for introducing the quantitative methods of decision-making support in such courses as Operations Research in Economics and Methods of Decision Justification in Economics under Information Uncertainty are given.

Keywords

ERP systems, simulation game, interdisciplinary teaching, competencies, Economic Cybernetics, ERPsim

1. Introduction

Competitiveness of graduates is one of the most important indicators of quality assurance in HEIs (higher education institutions). Therefore, implementation of the latest techniques, methods, tools, technologies, forms and systems into teaching and learning process currently has become quite a crucial issue. Moreover, recent digital transformation (digitalization) of business and rapid development of technologies have triggered reconsideration of the conventional approaches to educational process, namely, a shift from traditional face-to-face or online lectures to more interactive methods of teaching and learning.

One of such interactive teaching methods in economic education is so-called "a business simulation" or "a business game", which simulates a real market, where virtual companies can operate using a commercial version of such software as Enterprise Resource Planning Systems (ERP) that creates economic environment, where students are expected to make strategic decisions, for example, as real managers do.

Simulation games help students better understand how economic system works, allows them to try their hand in forecasting, gives them an opportunity to apply theoretical models to solving complex practical situations in the controlled low risk environment.

Safe environment allows students, on the one hand, to experiment with taking tactical and strategic decisions that will not lead to real consequences, possibly negative, while, on the other hand, learners can

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see, how their recommendations may impact company's performance, as well as they can understand the interconnection of all factors. Thus, games-simulations give an opportunity to students to benefit from low risk 'learning through doing'.

In general, ERP offers a holistic view of the economic system because it reduces information redundancy, offers information in real time, helps with process standardization, and improves information flow and communication among employees. Furthermore, due to the world globalization trend, many enterprises go global. These facts explain why ERP still remains the largest category of software costs for businesses. According to study [1], in 2019, sales of ERP software increased in total by 8.8%, and its global market value reached 38.8 billion US dollars. By the end of 2022 this indicator is expected to have grown by approximately 7% per year and the forecasted market value will have reached 44 billion US dollars. During our forecast period the ERP applications market is expected to have reached $97.1 billion by 2024, compared to $94 billion in 2019 at a compound annual growth rate of 0.7%. The situation in Ukraine is quite similar: according to experts, today near 10% of Ukrainian companies, most of which are big, are introducing contemporary ERP and CRM software.

Therefore, every year the need for practical skills in ERP, namely, in applying the acquired knowledge in real situations, is increasing dramatically. Computer business simulation is a tool for developing such necessary professional skills as: teamwork, conflict resolution and problem solving, competent decision-making, understanding of business processes and strategic thinking, interpersonal communication. Moreover, students get comprehensive understanding of the company's activities, that allows future managers to take more effective and rational decisions.

Implementation of such interactive teaching methods as ERP simulations appeared to be efficient even under COVID-19 pandemic, which caused significant changes in education. However, in Ukraine this approach has not been widely used yet, though its effectiveness has been proven as for traditional teaching and learning, as for online one. Thus, introducing this idea in Ukrainian education will increase the competitiveness of Ukrainian HEI's graduates enormously.

The aim of this article is to develop models for applying simulation games in ERP-systems in order to exploit multidisciplinary educational opportunities in economic educational programs and to enable students of Ukrainian HEIs to master professional competencies both in face-to-face and online learning.

The paper is organized in the following way: the next section reviews the related literature in terms of world's experience in this approach implementation. The third section covers interrelation between the key ERP competencies and program competencies of major '051 Economics'. The fourth section presents ERPsim games review. In the fifth section, models for implementing the approach in the framework of educational professional program Economic Cybernetics are shown. Finally, conclusions are drawn and discussed in the last section.

2. Related Works

A review of research-related scientific publications over the past 10 years demonstrates ever increasing interest to applying game approaches in teaching students majoring in economic studies.

Based on the survey conducted among the students from around the world, Levant et al. in [2] show the direct impact of business games not only on respondents' successful mastering of professional competencies, but also on the development of their soft skills. The researchers in [3] emphasize that in the context of globalized education, presentation of best practices (through publication of relevant studies) is essential for effective dissemination of the approach.

The effectiveness of the simulation approach in business education is proved by studies [4-7]. According to Nightingale [8], the use of simulation games in HEIs allows students not only to master decision-making competencies, but also to develop their problem-solving skills.

Alcivar and Abad in [9] demonstrate that gaming systems for ERP, compared to non-game learning tools, proved to ensure better effectiveness in reaching learning outcomes by the students and, moreover, to lead to higher user satisfaction during the process of learning.

In 2006 Boyle and Strong introduced the list of the key skills that HEIs and business schools should consider when teaching ERP-related courses [10]. These skills are classified as ERP Technical Knowledge, Technology Management Knowledge, Business Functional Knowledge, Interpersonal Skills,

and Team Knowledge and Skills. This classification still remains up-to-date. Authors [11] show that using an ERP simulation game allows to achieve better results in obtaining all the competencies mentioned before. Baumeister et al. in [12] prove that ERP simulation games foster the development of students' methodological and social management competences and positively impact obtaining skills of taking decisions under time constraints. The idea of decision-making quality improvement due to application of this approach to learning is shared by the authors [13].

One of the first attempt of such approach implementation was simulation game ERPsim, an innovative training environment and approach developed at HEC Montréal to address the challenges in learning to use and understand ERP systems using SAP ERP [14, 15]. In [15] Léger et al. have presented a detailed description of Manufacturing Simulation Game, which is one of the most widespread ERP games in the world. In recent years the ERPsim game developed by the faculty at HEC Montréal has become widely used in more than 200 universities worldwide [16]. Most researches on ERP gaming are based on the using of this game. Thus, in [12] the key features of ERPsim are presented and their usefulness in teaching management in HEIs is analyzed. Nowadays, other games are being actively developed for SAP ERP, taking into account current situation with digitalization [17]. Alternative approaches to such games implementation are described in [18, 19]. Nisula and Pekkola have developed ERP-based simulation as a learning environment for SMEs [18]. They presented a learning environment that merges ERP systems, business simulation games and practice enterprise models so that they complement each other, allowing the learning of the SMEs daily management. Schwade and Schubert in [19] offered an innovative teaching concept called "The ERP Challenge", which consists of a business simulation game based on Microsoft Dynamics NAV and an e-learning platform.

Local experience of this approach implementation is given in [20, 21]. Thus, in [20] best practices of four Melbourne-based universities are presented. Dick and Syzmanski demonstrate the introduction of ERPsim into an IS class for business students [21].

About 10 years have passed since the first attempts of ERPsim implementation in the educational process were made. Since then, the researchers have widely studied the results of positive impact of ERP simulation games on the acquisition of different types of skills. Seethamraju in 2011 published one of the first studies, where the author revealed the significant impact these games had on students' abilities and pointed out the challenges of the process and teaching [22]. The efficiency of this tool is proved by Cronan et al. [23]. Chen et al. in [24] outlined the antecedent effects of enjoyment and cognitive appraisal (two important IS constructs) on learning behavior and learning outcomes during students' involvement with ERPsim. Darban et al. examined team collaboration effectiveness at the team level and participant effort at the individual level as predictors of perceived ERP knowledge update, which then influences intention to learn about ERP systems [25]. Results showed that effective team collaboration positively influences individual effort and perceived knowledge update. In one of the recent studies (2019) Beranič and Heričko [26] demonstrated that use of the simulation game for introducing the ERP concepts resulted in anticipated knowledge and skills and in increasing the students' intention for future engagement.

A number of studies demonstrate that simulated ERP games are widely used in the framework of various courses: Theory of AHP [27], which can be used in learning process for Decision Making Support, and Operations Research in Economics in terms of dynamic programming use for identifying optimal ERP game modelling technique [28].

Recent years have shown ever increasing interest in conducting such games in distance learning. Thus, Kreie et al. demonstrate approaches to implementation of ERPsim in online synchronous meetings [29]. Hwang and Cruthirds argue for a high level of learning efficiency through simulation games in asynchronous environment [30]. These studies show that students develop more positive attitude towards SAP and gain more knowledge about the use of ERP in online learning. The use of traditional face-to-face tools for students is expanded into the virtual classroom. The results of further research in this direction were summarized by Hwang in [31]. The findings demonstrated a significant improvement in post-game students' knowledge compared to pre-game, higher satisfaction with the experience and considering the game an effective learning tool.

A number of studies present proposals for the introduction of ERPsim in the curriculum. Léger et al. presented a trial version of the implementation of ERPsim in a typical ERP course curriculum using different simulation games during a 6-week period [32]. Kreie and Shannon illustrate how ERPsim can be used in multiple courses across various courses for an integrated learning experience that can be

beneficial for students [33]. The use of games was envisaged in such courses as Finance, Accounting, Marketing and Management.

Thus, there is a certain world practice regarding the implementation of the approach in educational process. However, the issues of implementation of this promising tool need further development not only for specialized ERP courses, or for courses related to business processes support (Finance, Accounting, etc.), but also for courses related to mathematical modelling in Economics, to the use of quantitative methods in Economics and control methods in Economic Cybernetics. This will allow not only to acquire and develop competencies related to company resource management, but also many other important competencies that are outlined in the educational programs for students majoring in economic studies.

The ERP system is real environment – an information model of an economic object, on the example of which students can apply certain knowledge acquired in different courses, check the effectiveness and rationale of the proposed solutions, and try applying certain tactics and strategies.

The specific feature of this study is the demonstration of models for implementing the approach in the courses related to quantitative methods of decision-making support, which are taught to the students majoring in economic studies. The ERP simulation games that are analyzed enable to broaden multidisciplinary teaching opportunities and to enhance the interdisciplinary teaching experience for students.

3. ERP Simulation Games and Key Competencies for Economists

In today's world, business digitalization is an integral part of a growing company. High-quality ERP system allows you to automatize most business processes, combining them and ensuring data transfer between them. In recent years such companies as: SAP, Oracle, Microsoft, Infor, Epicor, Workday are the market leaders in ERP systems. The variety and complexity of their programs lead to the need for additional user training. Therefore, the need to master such systems is determined by the urgent needs of companies [9, 34]. Although there are many ERP systems, all of them are united by algorithms of interaction between their elements, which form a single controlled mechanism. Thus, having mastered the skills of dealing with at least one ERP system, you can easily adapt to using another one if necessary. For example, thanks to HEC Montreal, which developed ERPsim games based on SAP ERP, understanding and mastering of other more complicated systems became possible. SAP offers universal systems (SAP ERP, SAP S / 4 HANA) for any sphere, they are based on the best practice and experience of the companies from all over the world.

Davenport et al [35] identified five key competencies to make data-based decisions through using data from the enterprise system, namely: knowledge of the business, statistical and analytic skills, knowledge of data, technical skills, and communication/partnering skills.

Knowledge of the business provides a clear view of the fundamentals of contemporary companies functions, basic business processes for relevant data interpreting by the decision makers. Mathematical modeling and analytic skills include understanding of economic and mathematical methods and models for solving economic problems and provide the ability to take informed decisions using modern methodological tools. Awareness of data provides localization of the economic data for analysis, ensures awareness of what data are available and where they can be found. Technical skills include understanding of corporate and ERP software to extract and manipulate data. Finally, communication and partnering skills ensure coordination of employees while dealing with problems or making decisions.

In the previous section it was noted that positive impact of using simulation games for acquiring all the mentioned above competencies is proved by the results of practical application of this approach. We analyzed the main general and specific competencies required by the Standard of Higher Education for 051 Economics Major, Bachelor of Economics [36]. The results of the analysis show that 8 out of 13 general competencies are related to the mentioned key competencies, and only 3 out of 14 specific ones are not directly related to key ERP competencies. Table 1 outlines interrelation between competencies, required by the Standard of Higher Education and key competencies of ERP simulation games.

It goes without saying that these competencies require certain grounding in the different academic courses, such as: business, technological, statistical and mathematical ones.

Table 1

Key competencies for economists and their coverage in ERP simulation games

Key ERP Competencies	General (GC) and specific (professional) (SC) competencies in 051 Major, Bachelor of Economics	Coverage in ERP simulation games
Knowledge of the business	GC4. Ability to apply knowledge in practical situations. SC1. Ability to demonstrate knowledge and understanding of the problems of the subject area, the basics of the modern economy at the micro, meso, macro and international levels. SC4. Ability to explain economic and social processes and phenomena using theoretical models, ability to analyze and meaningfully interpret the results SC12. Ability to independently identify economic problems through analysis of specific situations, and to suggest solutions.	Awareness of general business needs at micro level addressed by the enterprise system. Study of specific characteristics of a business and its competitors. Application of acquired business knowledge in practical situations.
Statistical and analytic skills	GC11. Ability to make justified decisions. SC6. Ability to apply economic and mathematical methods and models to economic problem-solving SC8. Ability to analyze and solve problems in economic field and in industrial and social relations. SC9. Ability to predict socio-economic processes using standard theoretical and econometric models. SC11. Ability to justify economic decisions being aware of consistent patterns of economic systems and processes and through using up-to-date methodological tools. SC13. Ability to conduct economic analysis of economic entities functioning and development, to assess their competitiveness. SC14. Ability to conduct deep analysis of problems and phenomena in one or more professional areas, taking into account economic risks and possible socio-economic consequences.	Analyzing company resource data. Inventory control. Forecasting and planning (demand, supply, liquidity, etc.). Optimization of pricing, production and sales strategy.
Knowledge of data and technical skills	GC7. Skills in applying information and communication technologies GC8. Ability to search, process and analyze information from various sources. SC7. Ability to use computer technology and data processing software to solve economic problems,	Interpreting enterprise resource data. Data search. Data export. Understanding master data used in business processes.

	analyze information and prepare analytical reports. SC10. Ability to use modern sources of economic, social, managerial, accounting information for preparation of official documents and analytical reports.	Understanding transaction data generated in business processes. Gaining experience using SAP ERP.
Communication and partnering skills	GC9. Ability to adapt and act in a new situation. GC10. The ability to be critical and self-critical. GC12. Interpersonal skills. GC13. The ability to act socially responsibly and consciously	Simulation with management team coordinating responsibilities and actions. Adaptation to new business conditions. Awareness of the alternatives and making decisions.

For example, students of 051 Economics Major acquire knowledge of the business in such mandatory courses as: Economic Theory, Microeconomics, Business Economics, Accounting, Finance, Marketing and Management. Statistical and analytic skills are mastered in the following mandatory courses as: Statistics, Econometrics and in a number of elective courses, such as: Operations Research. Knowledge of data and technical skills, connected with mandatory course of Information Technology in Economics, and such other elective courses as: Decision Support Systems, Information Modelling of Economy etc. Communication and partnering are obtained in the framework of such mandatory courses as: Management, Information Technology and English for Specific Purposes. All the mentioned courses develop such competencies as: understanding of business, valid strategic and operational decision-making. Thus, introducing of ERP games will allow to improve these skills.

The advantages of introducing ERP-simulation games into educational process for training economists are as follows:

- integration of key concepts of a certain ERP-system into the cognitive area of students for better learning material memorizing;
- choice of different learning objectives: cognitive skills (knowledge acquisition and critical thinking), affective objectives (motivation, involvement), as well as social, emotional and collaborative skills;
- transition from theory to practice, which positively affects students' motivation.

These advantages are similar to the reasons for using cases, however, cases are 'static', but simulations are 'dynamic', when students can see the consequences of their decisions and deeds.

ERP-simulation games appear in different types, shapes and complexity. The duration of one game can range from one class to several weeks or even the whole semester. It can have linear structure, when problem situations appear one by one, however, it is also possible to link problem situations so that the consequences of decisions in one situation affect another one. Students go through several cycles of decision-making to understand how to manage the system by themselves, however, they can adjust their actions in line with the teacher's feedback. Real business situations as learning scenarios are very difficult to use in education due to certain factors that complicate the instant performance evaluation. Due to the fact that reality is usually quite complicated, students in a simulation game are offered a simplified model: an imitation of reality, which forms a starting point for them to master certain skills. Despite these simplifications, the main features of the real situation are preserved.

It should be mentioned that computer business simulation appeared to be more effective strategy than traditional methods of teaching and learning, as well as internships. The reason is in its ability to impact on the affective sphere, causing emotions such as pleasure, excitement, anger and joy. Traditional learning mainly affects the cognitive sphere of learning without proper attention to the emotional component [22].

All of the above allows us to emphasize the indisputable expediency and prospects of using this approach in the teaching and learning process for students majoring in 051 Economics. Moreover, it is necessary to seek for effective models of involving these games in the learning process, using interdisciplinary teaching opportunities.

4. ERPsim: Review of the Games and their Link to the Curriculum Courses for Economists

Let's consider some features of simulation games, which were piloted in the educational process of certain HEIs all around the world, on the example of a set of the HEC Montreal ERPsim games [37]. The simplest free Distribution game deals with the complete business cycle: planning, buying and selling. In particular, players run a wholesale distribution company that sells bottled water, competing with other wholesalers (other teams) to meet consumer demand and maximize profits. In order to form effective strategies students need to have in-depth knowledge of such courses as: Microeconomics, Marketing, Business Economics, Accounting, Management, Econometrics, Operations Research, Decision Support Systems and Methods.

In the Logistics Introduction game, the team will run a commercial dairy company. Processes of purchase, distribution (logistics) and sales (procurement, distribution and sales) of dairy products are considered. In the game Logistics Extended students need to perform 3 processes: planning and purchasing, regional product transfers and pricing. However, in the Logistics Platinum scenario, starting from the second round, students will need to perform the full planning / purchasing and sales / distribution business cycle. Practical application of knowledge acquired in such courses as: Microeconomics, Econometrics, Management, Marketing, Business Economics, Accounting, Operations Research, Decision Support Systems and Methods might enable players to win in the game.

In the game Manufacturing Introduction, the team is engaged in the production and sales of various types of muesli on the German market. At the beginning of the scenario, the team focuses only on sales and distribution. In the second round, production is taken under control. In the third round the raw materials needed for production should be planned and procured. During all rounds, the team will sell its products to a chain of grocery stores located in three regions of Germany.

In the Manufacturing Extended scenario, the team must run the full business cycle from the very beginning. During the game all teams will have increased production capacity, flexibility in changing product recipe, as well as high flexibility of financial investments. However, the Advanced Manufacturing Advanced scenario has an additional level of logistics, where students will be expected to transport products from the main warehouse to 3 regional warehouses in order to sell them. The deeper knowledge of Econometrics, Statistics, Management, Marketing, Business Economics, Finance, Accounting, International Economics, Operations Research, Decision Support Systems and Methods the players have, the higher their results in the game will be.

The game Retail has certain specific features. According to the rules of this game the teams participate in the purchase and sales of various professional items for men and women on the German market. It is necessary to take into account the seasonality of the garment industry. The seasonality of the garment industry should be taken into account. However, in the extended Retail Extended scenario, forecasting should be done from the very beginning. For this game students will need some knowledge in Econometrics, Management, Business Economics, Accounting, Operations Research, Decision Support Systems and Methods.

Table 2 provides information on the conditions, main processes and the required parameters of different games.

Table 2

Generalized information about ERPsim games and their basic processes

Game name	Initial data and limitations	Basic processes and decision-making
Distribution	6 types of water bottles, 1000 pieces of each type. Sales market - 3 regions of Germany,	*Sales process* (setting sales prices of finished products,

	demand for products in each region is known. There are no restrictions on the total number of available products. Approximate market size - € 6000 per company / day. For suppliers: Lead time (days): 1-3 Payment time (days): 10 For customers: Payment time (days): 10	determining the daily marketing costs on each type of product in each region). *Procurement process* (planning the number of purchased products, inventory control). *Planning process* (demand forecasting).
Logistics Introduction	6 dairy products. Every 5 days stocks are replenished by the same amount). The demand for products in 3 regions is different. Categories of expenses: 1) transport: 1000 euros - delivery from the supplier to the main warehouse; 100 euros - transfer from the main warehouse to the regional, regardless of the number of products; 2) Warehousing Costs: the maximum storage capacity is 4,000 units, the excess is charged 50 euros per day for every 1,000 units. Approximate Market Size € 12000 per team / day For suppliers: Payment time 5 days For customers: Payment time 4 days	*Sales process* (setting sales prices of finished products). *Logistics process* (choice of transfer strategy: 1) Planning Mode: Push or Pull 2). *Delivery Schedule*: frequency of transfers 3) number of transported goods).
Logistics Extended	Similar as for Introduction conditions. Logistics Introduction However, there is no initial inventory, the procurement process is not automated. Base Capacity (sum of all storage locations): 4,000 units Warehousing Costs: Extra daily fee for each additional 1000 boxes: € 300	In addition to Logistics Introduction: *Procurement process* (planning the number of purchased products). *Planning process* (demand forecasting).
Manufacturing Introduction, Extended, Advanced	6 different types of muesli (each type has two packaging options). Production restrictions: 1) Daily production: 16,000 units 2) Reset time of the production line (8 hours). There's only one production line - only one product can be produced at a time. When purchasing raw materials from the supplier, we have two types of costs: 1) Storage Cost for an excessive amount of finished products (maximum 250,000 units), otherwise the company will pay 500 euros per day for each additional 50,000 units. 2) Fixed Costs (Labor, Manufacturing Overhead, Depreciation-Equipment, Depreciation-	*Sales process* (setting sales prices of finished products, determining the daily marketing costs on each type of product in each region). *Procurement process* (planning the number of purchased products, inventory control). *Planning process* (demand forecasting, planning the number of manufactured products, Liquidity Planning). *Production process* (forecasting and planning of production costs, planning of raw material stocks for

	Building, Sales, General & Administrative, Loan Interest) every 5 days. Approximate Market Size: € 220,000 per team per week Grocery stores: 1) Payment delay of 10 to 20 days 2) Orders 4 products at a time	finished products manufacturing, planning of production schedule)
Retail Introduction	18 different professional attires for men and women in a German-based market. 4 weeks are allocated for delivery of the goods after the order, after this period if stocks are insufficient, the sale is either cancelled or the goods will be sold in part. 9 apparel retail stores in Germany. Each store will typically sell all products. Customers will buy any of the 3 styles, but there are preferences for some styles over the others. For suppliers: Payment time (weeks): 1, Lead time (weeks): 3, Transportation cost per order (€): 0. Fixed Overhead Costs: € 40 000 every 4 weeks. You also need to pay interest every 4 weeks on the balance owing on your line of credit. Inventory Holding Costs: € 1 000 Weekly fee for each 1 000 units (rounded up)	*Sales process* (setting sales prices of finished products). *Procurement process* (planning the number of purchased products, inventory control). *Planning process* (demand forecasting taking into account the seasonality of production).
Retail Extended	Two suppliers are available to provide all 18 products. Each supplier has its own payment time, lead time, prices, and transportation cost.	

It is important that students in teams can have different roles. This is provided by SAP ERP itself, and there are operations to which only one team member currently has access. Therefore, the coordinated work of the whole team is very important. For example, the Logistics Platinum game allows to have 5 players (planning manager, logistic manager, stock manager, pricing manager, sales vice-president) or 4 players (planning manager, logistic manager, pricing manager, reports manager). Decisions can be made collectively, but only one player can be appointed as the decision-maker.

Knowledge of mandatory courses studied by the economists and enumerated in this section is necessary for developing and implementation of the optimal strategy in ERP simulation games. It is important that winning in the game depends on different knowledge and skills acquired not only in business courses, but also in disciplines related to quantitative methods in Economics.

5. Applying Interdisciplinary Teaching Opportunities when Gaining a Degree in Economic Cybernetics

5.1. Models of ERP Simulation Games Implementation

Introducing of ERP simulation games to learning process for students majoring in economic studies has certain specific features for each educational program. Within major 051 Economics in Taras Shevchenko National University of Kyiv (TSNUK) there are a number of educational programs, including Economics and Economic Politics, Economic Cybernetics, Economic Analysis and Statistics, International Economics, Business Economics. Specificity of the educational program must be taken into account when teaching academic courses.

Let's consider the approaches to developing the models of ERP simulation games introduction into the teaching and learning process in the framework of the educational program Economic Cybernetics at TSNUK. Bearing in mind that Taras Shevchenko National University of Kyiv in 2009 joined the global initiative of SAP, namely, international program SAP University Alliances, and has been taking an active part in it so far, implementation of the ERPsim games that were designed specifically for SAP ERP seems to be quite relevant.

The Economic Cybernetics educational program is aimed at enabling students to build systemic worldview, to understand scientific approaches to economic problem-solving using mathematical models and up-to-date IT methods, as well as modern computer control methods and to take effective management decisions. This outlines the direct interconnection of the aims and objectives of the educational program and the aims and objectives of using ERP simulation games.

Elective disciplines of the Economic Cybernetics educational program are combined into two clusters: Economic-Mathematical Modelling (EMM) and Information Systems in Economics (ISE).

As it was already mentioned, the specific feature of this research is a study of interdisciplinary teaching opportunities, however, not in the framework of business courses, which is fully described, for example, in [33], but in terms of the courses to mathematical modelling in Economics, Quantitative Methods. in Economics in order to test the given approach for decision-making support in real practical situations.

For developing the models of ERPsim games implementation, we propose first of all to analyze the matrix of compliance of program competencies with the components of the educational program. We take into account only those components that are taught not earlier than during the 5th semester, in order to actualize as much knowledge, already gained by the students, as possible.

Among the mandatory non-business disciplines, the study of which allows the students to acquire statistical and analytical skills the following courses are outlined: Econometrics (5th semester General Competency (GC)11, Specific Competency (SC) 6, SC9), Operations Research in Economics (5th semester, GC11, SC6), Economic Cybernetics (6th semester, SC11). These disciplines are taught during the 5th and 6th semesters. Among the elective courses, the above conditions are met by the following disciplines of the EMM cluster: Theory of Economic Risk (5th semester, GC11, SC6), Game Theory in Economics (6th semester, GC11, SC11), Financial Mathematics (6th semester, SC6), Modelling of Economics (6th semester, SC6), Modelling of Decision-Making Processes (7th semester, SC11, SC11), Methodology of Economic and Mathematical Modelling (7th semester, SC6), Forecasting of Socio-Economic Processes (7th semester, SC6, SC9). Among the elective courses of the ISE cluster, the following disciplines meet the specified conditions as: Information Technologies of Economic Modelling (6th semester, SC6) Methods of Decision Justification in Economics under Information Uncertainty (6th semester, GC11), Decision Support Systems (7th semester, SC11, SC11), Data Mining (7th semester, SC13).

Based on the deep analysis of relevant competencies, tasks to be solved by the students in games, and the involvement of students from both clusters, the following models of ERPsim implementation can be proposed.

Figure 1 presents a set of curriculum courses, where different simulation games are used during 5th, 6th, and 7th semesters. During the study of Operations Research in Economics after considering topics related to Inventory Control and Transport Logistics in a class students are introduced to the ERP system by playing the Distribution game. Between the rounds and during the final debriefing students discuss embedded models for Inventory Control and Transport Logistics, also they discuss possible alternatives for the relevant decisions justification. Moreover, they define the main properties and benefits the ERP system.

Distribution game allows students to practice certain methodological approaches and gain first experience in game. A more difficult business environment, such as Logistics, students should be offered in the course of Economic Cybernetics when considering the practical aspects of the optimal control systems synthesis. At the same time, they can use the knowledge gained in the courses of Operations

Research and Econometrics. During the first class students analyze logistics and sales processes, implement simulation of these processes (Logistics Introduction), determine the direct links and feedback in the system and make suggestions for decision-making optimization. During the next two classes they also analyze planning and procurement processes, implement simulation of these processes (Logistics Extended), offer methods to support procurement planning, and do demand forecasting. After discussing the results and suggestions, the game Logistics Platinum can be introduced. Its results will allow to draw a conclusion about the level of students' acquisition of the skills in optimization of the logistics processes management. In the same course, it is advisable to introduce the Retail game. It differs from Distribution and Logistics and allows students to consider other approaches to business process management that are specific for retail sphere. Four classes can be allocated for this game, three of which – for the implementation of Retail Introduction and its results discussion, and the rest – for implementation of Retail Extended, then students can summarize the results of both games and discuss strategies for the synthesis of optimal control systems.

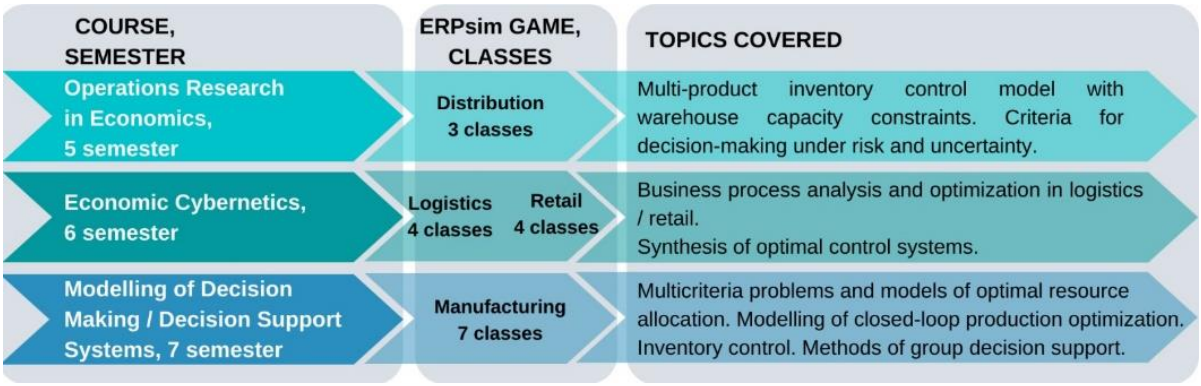

Figure 1: Curriculum using multiple ERPsim games: Model 1

The most difficult version of the game Manufacturing can be involved in practical classes in the framework of such cluster courses as: Modelling of Decision-Making Processes and Decision Support Systems. During the first two classes students, first of all, master the processes of selling and producing a new product, learn to perform the planning process and, finally, the processes of procurement and distribution (Manufacturing Introduction). During lessons 3 to 5 students are expected to take into account new financial and operational constraints, while the complexity of modelling increases (Manufacturing Extended). They should also use reporting and analytical tools to improve their decision-making skills. During classes 6-7 students are expected to demonstrate their achievements in the final simulation game – Manufacturing Advanced. After the game, the feedback is gathered from students on the simulation results, on the reasoning for the way of using the ERP system for optimization of the company's management.

In all games, students are expected to use the reporting available in the ERP system, and the results of other analytical tools to improve their decision making capability.

Figure 2 shows an alternative implementation of the approach through cluster courses.

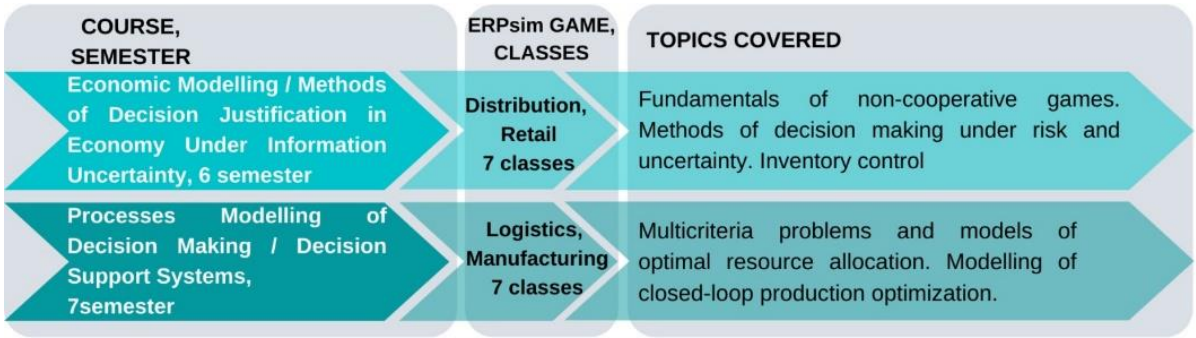

Figure 2: Curriculum using multiple ERPsim games: Model 2

The advantages of Model 1 are as follows: consistent immersion of students in business process modelling (during 3 semesters), mastering of the necessary skills in the framework of mandatory courses that gives equal opportunities for students of both clusters, more variants of team building, availability of bigger amount games. Also, the introduction of simulation games will allow to expand the list of competencies covered in the next edition of the educational program (now it is about achieving GC11, SC6, SC11).

Model 2 covers all competencies in the EMM cluster, but in the ISE cluster it deals only with GC11, SC11. It is designed for implementation during the 6th and 7th semesters. A certain advantage of such an organization of the learning process is that, by this time, students will have already learned such courses as Operations Research and Econometrics. One more advantage of Model 2 is the opportunity for students to master more skills than the cluster is aimed at. Thus, for students of the EMM cluster it is possible to focus more on mathematical support of decision-making processes, and for students of the ISE cluster - on information modelling in Economics. You can organize games between students of two clusters. However, in Model 2, the simulations are used in fewer courses, so students will have less time to practically apply the approach.

Both models can be introduced as in traditional and as in distance learning. The choice between them, in our opinion, depends on two main factors. The first factor is the interest of teachers in implementing the approach, because introduction of innovations usually requires certain enthusiasm from the teachers. In addition, from a formal point of view, the implementation of this approach will cause syllabus changes introduction. The second factor is the cost, because only the Distribution game is free. Model 2 can lead to higher expenses, because it involves pay-to-play games in a bigger number of courses. The negative impact of the second factor can be decreased through applying for help to SAP partner companies or employers.

5.2. Examples of Using Data from ERP Systems to Implement Quantitative Methods for Decision-Making Support

Some steps have already been taken to launch the widespread introduction of simulation games into the educational process at the Economic Cybernetics department of TSNUK.

While studying the course Information Systems and Technologies in Economics (7th semester, ISE cluster), students participated in the game Distribution, after which they discussed various opportunities for decision-making support that would provide the best strategies in the game. They determined which methods could be applied to the data extracted from the enterprise system, and carried out their practical implementation. The feedback of the students on implementation of simulation games was absolutely positive. It is worth mentioning that among them there were students, who already have experience in working for the companies that use SAP ERP and SAP S/4 HANA.

Here there are examples of application of knowledge and skills acquired in the framework of such courses as: Operations Research in Economics and Methods of Decision-Making Justification under Information Uncertainty while using the data presented in the game Distribution.

Let two distribution companies compete, each of which must determine the optimal volume of water supply in six types of bottles in the given region. For justification of effective managerial decisions, the following solutions are proposed:

1. Problems of planning the supply of bottles to each region in a competitive environment. Baseline data - a forecast of sales of different types of bottles made by each of the companies. The main result is profit of companies that depends on the optimal supply strategies for each type of bottles. Decision support method - zero-sum antagonistic game models or bimatrix game model.
2. Problems of planning the supply of water bottles depending on the unique preferences and demand for this type of bottle in a given region of Germany. Baseline data are alternatives of product demand and supply, profit from sales or losses of the distribution company, depending on the interrelation between supply and demand. The main result is the company's profit depending on the

optimal supplies. Decision support method – use of different decision-making criteria under conditions of risk and uncertainty.

3. Problems of water sales price optimization in competitive environment. Baseline data are – alternative sales prices of competitors. Main result – setting an equilibrium price for all participants in the game. Decision support method – use of different decision-making criteria under conditions of risk and uncertainty, methods of game theory.

For building optimal strategies in the game Logistics, you can rely on the results of solving the following problems of operations research:

1. A problem of managing stocks of finished products in the main warehouse of the company. Baseline data – fixed costs for delivery of a batch of products from the supplier to the main warehouse of the company and from the main warehouse to regional warehouses, the maximum capacity of warehouses, additional costs for storage of products. Main result – optimization of the volume of product delivery to the main and regional warehouses, the time of replenishment of stocks in the main warehouse and sending to regional warehouses. Decision support method – multi-product inventory control model with restrictions on warehouse capacity.
2. A problem of planning product transfers to regional warehouses. Baseline data – tariffs for delivery of products depending on the distance between the warehouse of a commercial company and regional warehouses, demand in the regions and supply offers. Main result – transfer cost optimization. Decision support method – model of a multiproduct transport problem.
3. A problem of maximizing the flow of products from the supplier to the regional warehouses, taking into account the limited storage capacity. Baseline data – maximum capacity of the main and regional warehouses, supplier's offer, demand in the regions. Main result – optimization of volumes of product delivery to the main and regional warehouses. Decision support method – Ford-Falkerson algorithm for the maximum flow problem.

To justify the optimal decisions in the game Manufacturing, you can rely on the results of solving the following problems of Operations Research and Decision-Making Theory:

1. A problem of optimal allocation of resources for production. Baseline data – types of products and packaging, standards of ingredients use for different types of muesli, production capacity. Main result – optimization of production of different types of muesli. Decision support method – multicriteria model of optimal resource allocation.
2. A problem of optimizing the production sequence with the least time for equipment readjustment. Baseline data – types of products or types of packaging, time for readjusting of production lines. Main result – optimization of production sequence. Decision support method – Little's algorithm for the problem of closed-loop production optimization.
3. A problem of managing stocks of raw materials in production. Baseline date – raw material storage costs, storage cost breakpoint, raw material price depending on suppliers, wholesale and retail raw material prices, price break points, raw material batch delivery costs. Main result – optimization of the volume of raw material supplies, frequency of replenishment of stocks, choice of raw materials suppliers. Decision support method – inventory control model with price break points.
4. A problem (model) of planning product transfers to regional warehouses. Baseline data – tariffs for delivery of products depending on the distance between the warehouse of a commercial company and regional warehouses, regional demand and supply. Main result – transfer cost optimization. Decision support method – model of a multiproduct transport problem.

6. Conclusion

The need to find new forms of teaching that would be effective in both online and offline learning and to contribute to developing of numerous general and specific program competencies of future economists, shows the prospects of implementation of ERP simulation games in teaching and learning process for students majoring in Economics. This approach is not new in European education, however, this practice of Western universities is still not widespread in Ukraine and this gap needs to be filled in.

Simulation games can be used not only in a course on ERP and related business courses, but also in courses that form statistical and analytical skills. One of the obstacles for their introducing in teaching

and learning process is the necessity to choose an effective model for their implementation. The results presented in this paper illustrate how ERP simulation games can be used in multiple courses on quantitative methods in Economics for integrated learning experience that students will benefit from.

Each specific educational program requires its own specific model of using the approach, thus, this paper gives the idea, how to do this. We propose to analyze the matrix of compliance of program competencies with the components of the educational program. This will allow to identify mandatory and elective courses that form statistical and analytical skills, find correlation between processes and tasks embedded in games and methodological decision-making support, identify relevant topics and conduct a series of classes, where students will be able to apply the acquired knowledge in real situations that require justified decisions. The results of the games should be monitored and analyzed in order to improve this approach application in the subsequent teaching of these courses. Feedback from students can be collected, where they can express the level of their satisfaction, point out weaknesses and outline prospects of this tool application. The experience of using games shows that at the end of the game debriefing is a necessary step to reflect on students' learning achievements during the experimental event, to examine the simulation game, to discuss the results, and to turn the experience into learning.

Unfortunately, most of simulation games are not free of charge that prevents them from wide introduction in learning process. In order to use the ERPsim family games, one should be a member of the international SAP University Alliances program. Membership in this international program is quite promising from all sides, thus, powerful HEIs of Ukraine should strive to join this program, however, it is acceptable to apply for financial help to partners and employers who are interested in improving the quality of education. By the way, prospects for expanding presence of Ukrainian HEIs in SAP University Alliances were discussed in [38].

In addition to acquiring the competencies mentioned in this paper, future economists expand their knowledge of terminology in English and in general they are more exposed to additional language practice. These processes are especially intensified during competitions between teams from universities around the world, such as the International ERPsim Competition. Before 2020 these competitions were annually conducted by ERPsim Lab HEC Montréal. Teams from around the world can demonstrate their ability to manage virtual company with the advanced ERPsim Manufactoring scenario using the SAP S/4 HANA. The use of Business Intelligence and Cloud Analytics is also an important part of such competitions. ERPsim Lab also develops simulations for Data Science. The implementation of such games in the educational process is also promising and our further research can be devoted to this issue.

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