UDC 004.4+378

Dmytro S. Antoniuk
PhD in Pedagogics, Associate Professor, Associate Professor of the Department of Software Engineering, Zhytomyr Polytechnic State University, Zhytomyr, Ukraine
ORCID ID 0000-0001-7496-3553
dmitry_antonyuk@yahoo.com

Oleg M. Spirin
Doctor of Pedagogical Sciences, Professor, Vice-Rector for Research and Digitalization, State Higher Educational Institution "University of Educational Management", Kyiv, Ukraine
Chief Scientific Officer of the Department of Open Educational and Scientific Information Systems, Institute for Digitalisation of Education of the National Academy of Educational Sciences of Ukraine, Kyiv, Ukraine
ORCID ID 0000-0002-9594-6602
oleg.spirin@gmail.com

Tetiana A. Vakaliuk
Doctor of Pedagogical Sciences, Professor, Professor of the Department of Software Engineering Zhytomyr Polytechnic State University, Zhytomyr, Ukraine
Leading Researcher of the Department of Network Technology and Databases of the Department of Open Educational and Scientific Information Systems, Institute for Digitalisation of Education of the National Academy of Educational Sciences of Ukraine, Kyiv, Ukraine
ORCID ID 0000-0001-6825-4697
tetianavakaliuk@gmail.com

USING DIGITAL BUSINESS SIMULATORS IN ECONOMIC AND MANAGERIAL DEVELOPMENT OF MASTER'S IN INFORMATION TECHNOLOGIES

Abstract. The article substantiates the use of digital business simulators as the type of digital educational resources for decision-making knowledge, skills, and attitudinal and behavioral readiness development in economic and managerial training for a Master's in Information Technologies. The use of digital business simulations as the tool for immersive practices implementation in the educational process provides the possibility to conduct imitated experiences to serve an educational and research-related purpose. Contract Design and Principal-Agent dilemma simulation usage allows the modeling of situations realistically imitating reality and helps to form a basic attitude and understanding of contractual design and information asymmetry concepts in the economy and managerial science. The concepts are crucial for future professionals working in IT, interacting in teams, and developing in people- and task-management areas. The use of multi-user simulated environments for educational interaction of the groups of students provides a close to a realistic experience of acting in life- and work-specific situations. These experiences serve to ignite interest, improve motivation to learn, and establish the ground for a further deeper discussion on the topics and formation of the attitudinal and behavioral components of the economic and managerial competence as part of the soft skills of the Master's in IT students. The educational activity described and analyzed in the article proved to be useful for both educational and research-related purposes. The mistake, made by the organizer of the activity provided additional learning possibilities for the group and valuable input for the research. The students showed involvement, dedication, and active participation in the active learning imitated experience. The group showed learning progress toward conventional optimality in the simulated concepts. Used digital education resources provided acceptable ease of use and satisfying functionality of the analysis tools. The behavioral specifics, based on the gender differences were unpredicted, but valuable results of the educational experience. Further efforts will be put to the improvement of the technical integration of such simulators into the digital educational environment of higher education institutions and the development of methodological support for the use of such simulators in the educational process.

Keywords: digital educational resources; business simulation; situational modeling; information technologies.

1. INTRODUCTION

The problem statement. The latest development in information technology and pedagogical science enables and forces usage of the digital educational resources in the educational process of a variety of institutions. Scientists develop the resources and appropriate methodic and teachers-practitioners are implementing such resources in the educational process and provide feedback for improvement and further development. Business simulations are one of the types of digital educational resources.

Using business simulation for educational and research purposes has been in practice for centuries. This practice was theoretically developed and institutionalized as the educational method within the latest half of the century. The method of simulated experiences could be implemented within a traditional classroom setup or with the help of digital educational resources. The COVID-19 pandemic and the war in Ukraine further proved the need for immersive socializing educational activities for all levels of education. The educational gap, created by the COVID-19 pandemic and the war in Ukraine requires introducing of highly-effective educational methods and technologies. At the same time, they have to win the students' attention from other attractors and distractors. The need for the efficiency of the approaches is dictated by the limitations of time and funds in Ukraine, as well as in other countries. Simulation technologies have the potential to become part of the solution to the challenge. In addition to serving educational needs, they enable research efforts and allow for a combination of these two activities. This format of business simulation usage introduces active learning and socializing to the classrooms and provides researchers with environments for educational, applied, and theoretical experimentation.

Analysis of recent studies and publications. The researchers and education practitioners advocated classroom experiments to augment traditional forms of education [1]. Lin T.C. shows the advantage of in-class gameplay for learning outcomes and attendance of the students. The experiment on the causes and forms of bounded rationality in individual choice Anna Rita Bennato and others describe in their work [2]. Multiple offline games were developed to be conducted as a classroom experiment with an educational purpose. Bei Hong describes how to introduce active learning to the Global Supply Management Class by playing appropriate scenarios in card-based simulation prepared in advance [3]. The concept of heterogeneous firms in international trade was implemented in the classroom simulation by Nathaniel P S. Cook and Angie Pantuosco at the Department of Economics, Furman University, Greenville, SC, USA [4]. Classroom experiments using simulations in the paper-based setup or with the use of digital tools were successfully conducted in the schools also. Oleksii Ignatenko conducts this kind of educational experiment with Ukrainian school students. Guessing games experiments in school education and their analysis are part of his work, described in the series of articles [5, 6].

The development of computer-based simulations made it easier to conduct time-constrained and, at the same time, mass-scale experimental educational activities. Business simulations are a class of digital education resources created and used to teach game theory, decision-making, and economic, financial, social, and behavioral concepts. At the same time, it allows further study and research of such effects in different occupations, geographies, or setups. It helps fine-tune findings and advance the knowledge and tools available to improve policy design and delivery, decision-making, and incentive schemas' construction.

Different schools in a wide range of theoretical and practical domains use business simulators in education and supplemental research activities. Applied research on the use of business simulations in education and research has gotten significant attention in the previous decades and is growing in scale nowadays. The artificially created game “The Red/Blue Simulation” was created to teach the problem of collective actions [7]. The game was implemented by the “Economic Games” and “Simulation lab” simulation platforms [8; 9].

The organizational and technical challenge of implementing digital educational resources in the form of computer-based business simulations into the educational process arises from the not-yet institutionalized approach of integration with already-used IT systems. The problem of integrating business simulation software into the learning environment of educational institutions was studied by the authors earlier. The integration approaches were described in the article on the topic [10].

Principal-Agent dilemma describes the conflict of interests in the relations where one person or entity (“the principal”) delegates taking actions on his/her behalf to the other person or entity (“the agent”) [11, 12]. The metaphor of "Contract" describes the relationships between the principal and the agent. The principal-Agent dilemma manifests itself in employment contracting, energy consumption in landlord-tenant relations, personnel management, elected and appointed officials' behavior, trust relations, and other situations.

In their classroom experiment, Simon Gächter and Manfred Königstein studied Contract Design and Principal-Agent dilemma [13]. This article is dedicated to the imitated experience conducted using the Contract Design and Principal-Agent dilemma simulation described above and implemented by the “Economic Games” platform [8].

The concept of "business simulators" and the possibilities of their use in the educational process was considered by the authors in previous works [10].

The research goal. Given this, the purpose of the article is to highlight the experience of using digital business simulation to conduct educational activities in the process of economic and management education of the Master of IT and to analyze the results of the interaction in the imitated environment.

2. RESEARCH METHODS

The authors designed the educational activity and conducted it with the master’s in information technology project management students as the part of “Business in IT” course. 38 participants were involved in 3 rounds of simulated experience of the Contract Design and Principal-Agent dilemma. The simulation was intended to:

- introduce classroom environment and simulation technologies to the students of IT specialty for the future usage of these educational methods, forms, and technologies in the educational process;
- deepen the knowledge of the concepts in management, economy, and game theory such as principal-agent dilemma, decision-making, contractual relations, people motivation, and information asymmetry;
- introduce to and develop the “attitudinal and behavioral” component of the economic and managerial competence of IT specialties students;
- introduce students to the concepts of justice and reciprocity in personal and professional relations and their influence on the decision-making and contractual conditions development.

The group of students is homogenous in terms of the specialty chosen. Master in Information Technology Project Management is the program of study. At the same time, the grout was heterogeneous enough. The group of students had the following characteristics:

- had a wide variety of previous Bachelor majors – IT, philology, economics, management, engineering;
- had different previous occupations – IT, education, banking, engineering;
- the age was from 21 to 46 years old.
- The duration of post-graduation work experience ranges from:
- from “zero” for the students who started their master’s degree just after Bachelor program graduation;

– to twenty-five years of post-graduate work experience.

The gender structure of the group is in Fig.1.

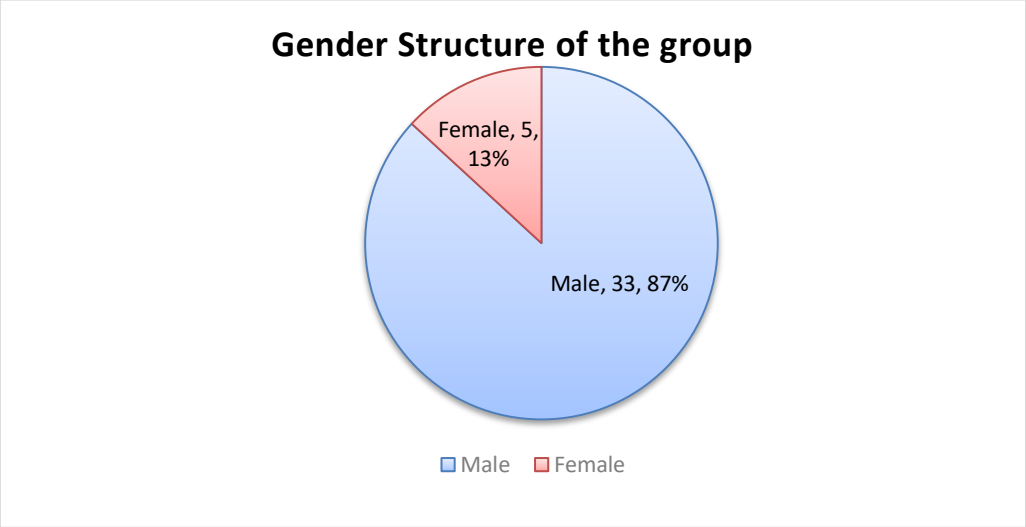

Figure 1. Gender structure of the group

DOU.UA reports the following Gender structure is representative of the Ukrainian IT market in Fig.2 [14].

Figure 2. The gender structure of Ukrainian IT Market specialists

We may see that the group of students has 13% of female participants in comparison with 23% of the female representative of the Ukrainian IT market on average in Ukraine. The hypothesis is that the difference might be attributed to the tendency of females to switch to IT occupations after graduating from other non-IT specialties at the universities.

Each round consisted of two parts. In the first part, participants acted as the principal, offering contractual conditions. In the second part, participants acted as the agent, deciding to reject or accept the offer and choosing the level of effort to be put in.

The simulation was conducted without preliminary detailed analysis of the economic concepts and mathematical methods of optimization of the outcomes of the actions. All the students in the group had the necessary general knowledge to understand the simulated situation and make simple economic and mathematical judgments and calculations. The time provided to make decisions in the rounds was not sufficient to conduct precise mathematical calculations of the simulated situation for the majority of the students. It was additionally proved by the observed behavior of the students during the simulation.

3. THE RESULTS AND DISCUSSION

Contract Design and Principal-Agent dilemma simulation implemented by the "Economic Games" platform were used as the digital educational resources to conduct this research, in the “Business in IT” class for master’s students of IT Project Management specialty.

The authors for the following reasons use the Economic Games:

- It is easy to organize, conduct and analyze the results of the simulation for the groups of students of moderate size. Bigger groups might be better served by the simulation collections integrated into a learning management or other system to manage access to the simulation and analytics.
- An open collection can be used freely for educational, entertainment, or research purposes.
- The collection proposes simple simulations with reasonable quality and stability of use in moderate groups of students.
- Academically affiliated authors with knowledge of academic and research-related needs and requirements created the collection.

The Economic Games site [8] contains options for single and multiplayer games. Single-player games highlight such concepts as price discrimination, competition, monopoly, horizontal differentiation, pricing, and contracting theory. These games are suitable for concept demonstration by the teacher or facilitator or for self-study by the students. The bigger part of the library is represented by multiplayer games, dedicated to the following categories: industrial organization, IO market games, externalities, and public goods, game theory, Information asymmetry, finance, and macro. Some simulations care about the influence of the particular environment or the situation, while others are mathematical and behavioral games, that provides a more pure, problem-agnostic experience and learning experience. Multiplayer simulations might be used for group simulated experience with the facilitator, teacher, or teaching assistant, organizing, conducting, and debriefing the results of the educational activity.

Contract Design and Principal-Agent dilemma simulation were chosen due to the existing need to introduce students to the concepts in their academic course. The choice of the vendor has been substantiated previously in this article and the choice of the simulation was dictated by the academic need within the course of study. The simulation is a multiplayer game and is one of the options to choose from in the "Information Asymmetry" part of the catalog. The setup of the simulation to start using it is simple. Figure 3 depicts the convenience and easiness of setting up the simulation for the group of students directly in the catalog.

The computer-based multiplayer simulators can be used to facilitate a wide range of methods of education. This work describes the educational imitated activity that uses an active learning method to study the concepts, work with the parameters of the environment of the concept, develops a basic level of personal attitude, and puts the ground for the future use of the other forms in studying the proposed concept. The simulated experience with the use of the digital educational resource was used in this case to initiate a productive lecture on the topic of the principal-agent dilemma, which is one of the cornerstones of the managerial and economic development of individuals. The active learning experience showed practical controversy and

the complex nature of its potential solutions to the students. This ignited my interest and involvement in the next lectures and practical discussions on the topic. The "markets with asymmetric information" was another concept that was introduced during the simulated experience. This concept attracted the attention of the students and paved the way for the successful usage of problem-based learning, involving discussion, group analysis of the situations, and synthesis of the hypothesis for the improvement of the efficiency of the markets.

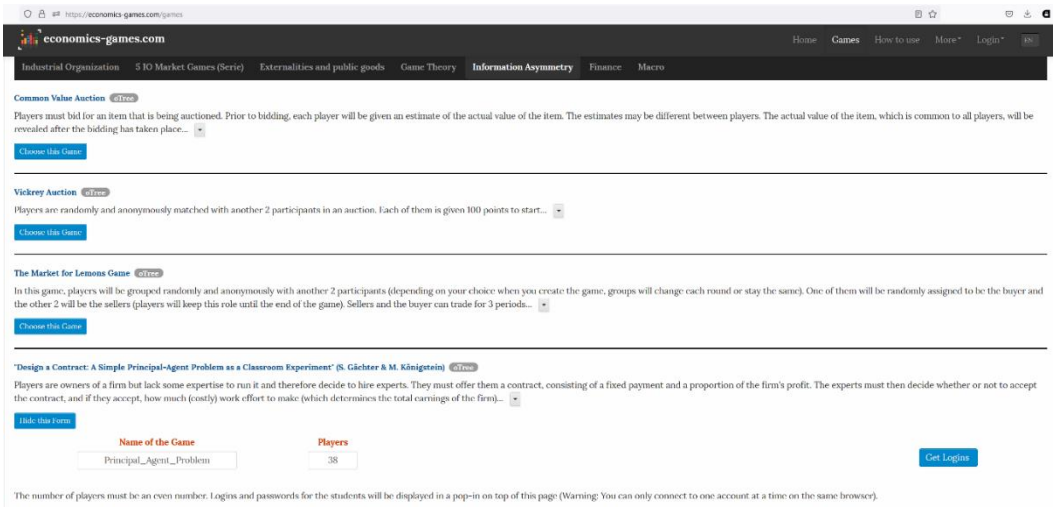

Figure 3. Contract Design and Principal-Agent dilemma simulation setup

Educational scientists and practitioners are developing methods and assessing the efficiency and effectiveness of using simulated environments in different forms of educational interventions. The studies cover a wide range of research from the approaches of introducing simulated experience into educational activities to assessing the effectiveness of such interventions. “Simulation-based education involving online and on-campus models in different European universities" by the authors from Spanish and Dutch universities examines the use of simulation-enabled educational models in the universities in online and on-campus setups [15]. The research of Garry Falloon from Macquarie University proves the transferability of simulations - enabled knowledge and skills transferability to real-world tasks for younger students [16]. The lectures become more immersive and persuasive when simulated environments are used for the visualization of demonstration of the theoretical concepts and problems with practical problems presented. Contractual relations and the markets with information asymmetry are the key concepts to attract the attention of the students to using Contract Design and Principal-Agent dilemma simulation. Injections of the simulated experience to the lectures help attract the attention of the students and stimulate further interest in the topic discussed in the class.

Practical labs help to develop behavioral and attitudinal components of the appropriate competencies. ICT allows teachers to organize educational environments and processes to combine predictability and repeatability of the environment with the always-new particular experience and findings for the students and the scientific research of the teacher, if in the same field with the simulations or the processes. Multi-user simulations allow to involvement whole group of students in practical experience that will incorporate some traits of particular individuals into the content of the problem-based education happening in the lab. Students can feel the reality of the problem and what is more important – the reality of the actions, executed by their particular peers and not by abstract actors in case of studying the experience of others. Personal involvement in the simulated environments and educational experience with the other close peers causes deeper interest in the topic and more extensive future reflections. Both,

formal retrospectives in the classroom and informal discussions with the other participating peers. Experiences from the practical labs create motivating grounds for future lectures, in-class discussions, and self-studies.

Self-study with the usage of the simulators is being organized in form of reflection essays, extensive practicing, inter-student interactive exercises, or other appropriate and productive formats, depending on the domain of study, particular class, and type of program. A reflection essay is one of the valuable forms of self-study, formative, or summative assessment. Extensive practicing can be organized for one student in single-player simulations or the form of simulated multi-player experiences. This form of practicing allows the creation of an immersive and usually unique educational environment for each student in the group. Inter-student interactive exercises might be in form of regular or competition-like simulated experiences. It enables group-based motivational factors and at the same time competition-based factors of personal motivations. Due to the unique configurations and in-progress development of the simulated environments, this type of self-study might require additional efforts if assessment or grading is expected. At the same time this type of experience, if properly organized, conducted, and used afterward, is the source for the scientific research quantitative data and qualitative input.

Let us consider in detail the process of preparation, implementation, and analysis of the results of using this simulator in the university's educational process.

Some players need to be defined in the simulation setup phase, and logins and passwords need to be created by the facilitator in batches and distributed among the participants.

The teacher or facilitator gets access to the administrator’s page where the flow of the simulation and preliminary results are being monitored.

38 participants participated in the simulated experience of the Contract Design and Principal-Agent dilemma for 3 rounds. Each round consisted of decision-making on behalf of "the Owner of the business" (Principal) and "the Expert" (Agent). The expert had full information to make a rationally optimal decision and the owner had to guess the reaction of the expert to the proposed contract conditions.

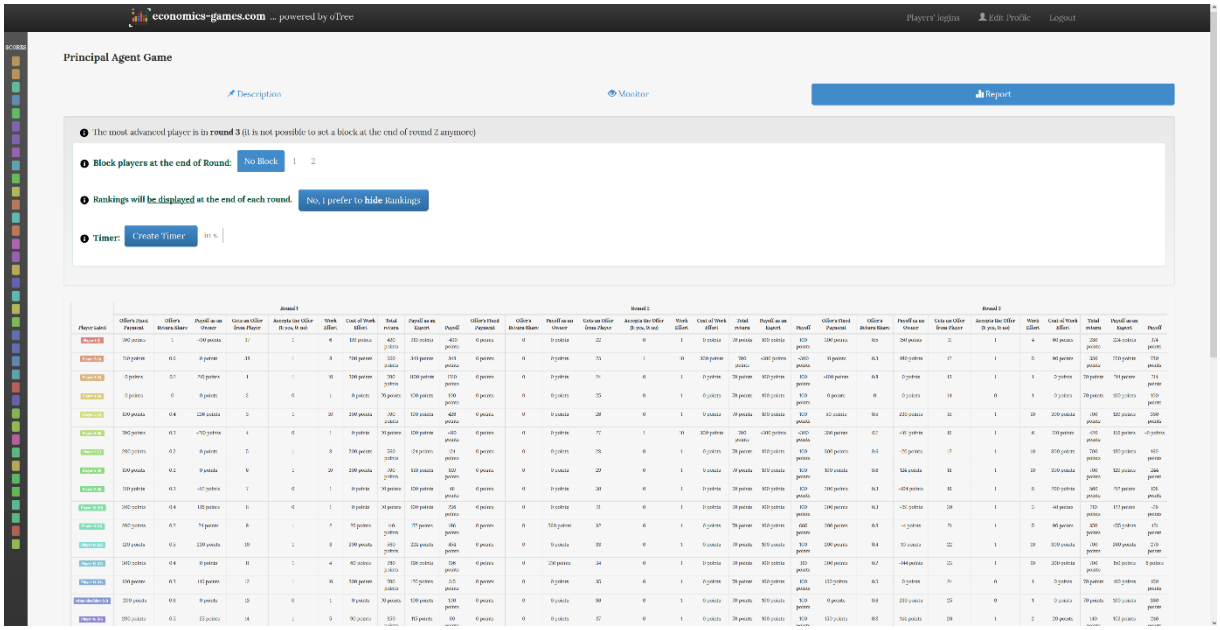

Figure 4. Final aggregated results of the simulation

It needs to be disclosed that the Round 2 of the simulated experience was influenced by the mistake in the actions of the administrator. Fig. 4 shows evidence of the influence of such a mistake on the results of Round 2. It led to the fact that the fixed part and return share was set

to "0" for all the participants. Despite the inability to use the data from Round 2 for general and trend analysis of the game, this specific set of input data highlighted particular factors of decision-making. Despite the inability gets any gain, 4 participants out of 38 have accepted their offers. 3 out of 4 experts, who accepted the offers chose to put in a high level of effort (8 to 10). The 4-the participant who accepted the offer chose to put the level of effort, equal to "3". In all these cases total value created was higher than the sum of the "Cost of work effort of the expert" and "Alternative cost" for the expert. This generosity or the belief in the need to generate bigger total value for the society resulted in the creating value (Total return, in terms of the simulation) and a positive payoff for the owner. In a real-life situation, this behavior of the expert could result either just in a higher value created for society or even in the possibility to claim a share of the income, received by the owner. The mistake made by the administrator in the process of the simulation led to:

- additional unexpected findings about the factors in decision-making in the contracting and Principal-Agent dilemma related situations;
- highlighting the specific traits of people in the group of students;
- learning outcomes for the participants of the simulation.

The situation, caused by the mistake in active learning, supported by the simulation as the digital education resource, proved to be generating new knowledge and develop competency, as the result, being valuable for educational and scientific purposes. The format and the environment of conducting the simulated educational experience are depicted in fig.5. Google Meet platform and multi-tab browser setup were used.

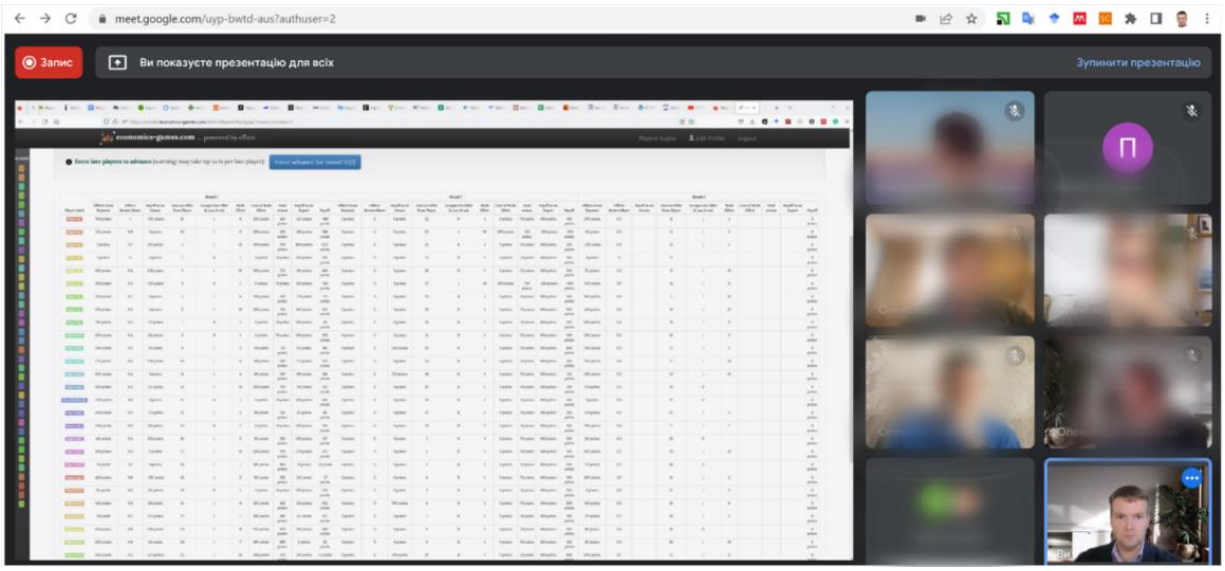

Figure 5. Simulation experience guided by videoconference and preliminary results

The analysis of the fixed part of the payment to the expert has been visualized in Fig. 6. Participants tended to decrease the fixed part of the payment to the expert. Maximum and minimum amounts of the fixed payments went down in Round 3 in comparison to Round 1. The Mean of the fixed part of the payment is lower in Round 3 compared to Round 1 (129 in comparison to 180). The median of the fixed part of the payment at the same time is higher in Round 3 compared to Round 1 (135 in comparison to 120). It proves the trend to offer lower fixed parts. A small number of rounds (learning iterations) did not give the possibility for participants to substantially learn to rationally maximize the profit, offering motivating contract conditions to the expert. At the same time, the students already acknowledged anecdotal evidence of the lower influence of the fixed part of the payment on the motivation of the Agent.

Detailed analysis of the atomic simulation round and personal results of the students are shown in Fig.7.

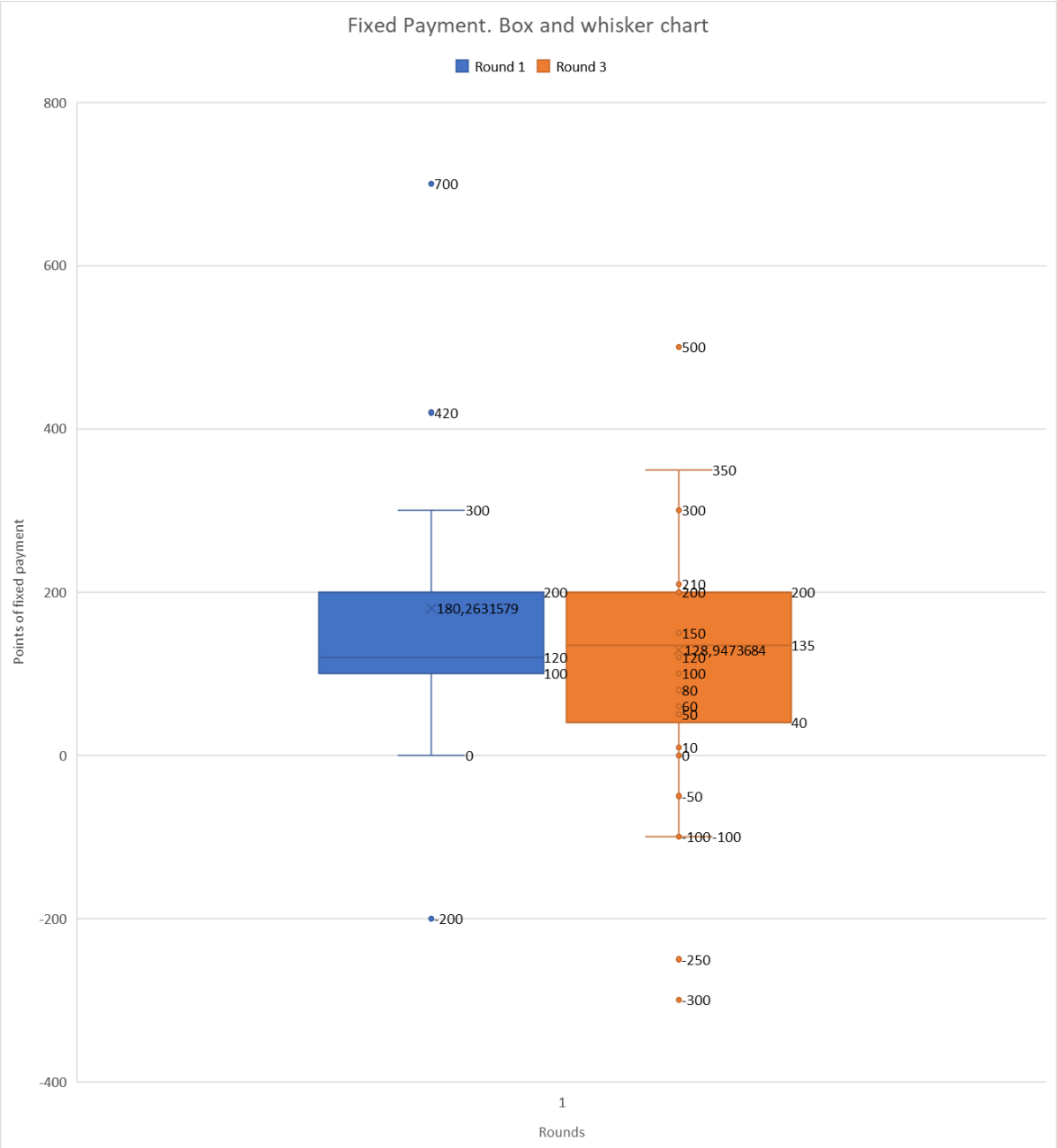

Figure 6. Fixed Payment. Box and whisker chart

The analysis of the fixed part of the return share with the expert has been visualized in Fig. 8 Median is the same for both rounds and is equal to 0,5. It shows that the majority of the participants' group keeps a strong preference to offer a share proportion close to 50/50. This preference would be changing in case of multi-round iterations of the simulation and getting deeper into mathematical optimization of the implemented rules of economic relations. The Mean of the return share grows from 0,44 (44%) to 0,47 (47%). Two median quartiles of the values are in the range of 0,3 to 0,6. This range might be also explained by the tendency of the participants' group to gravitate to the average (50/50) share proportion. Participants tended to increase return share to the expert. It is in line with the scientific results of the analysis of these

types of relations between the owners of the business and the hired managers (experts). The Clustered column chart, presented in Fig. 9 shows the experimentation attempts of the group. 32 out of 38 participants have changed their proposal for the return share from Round 1 to Round 3.

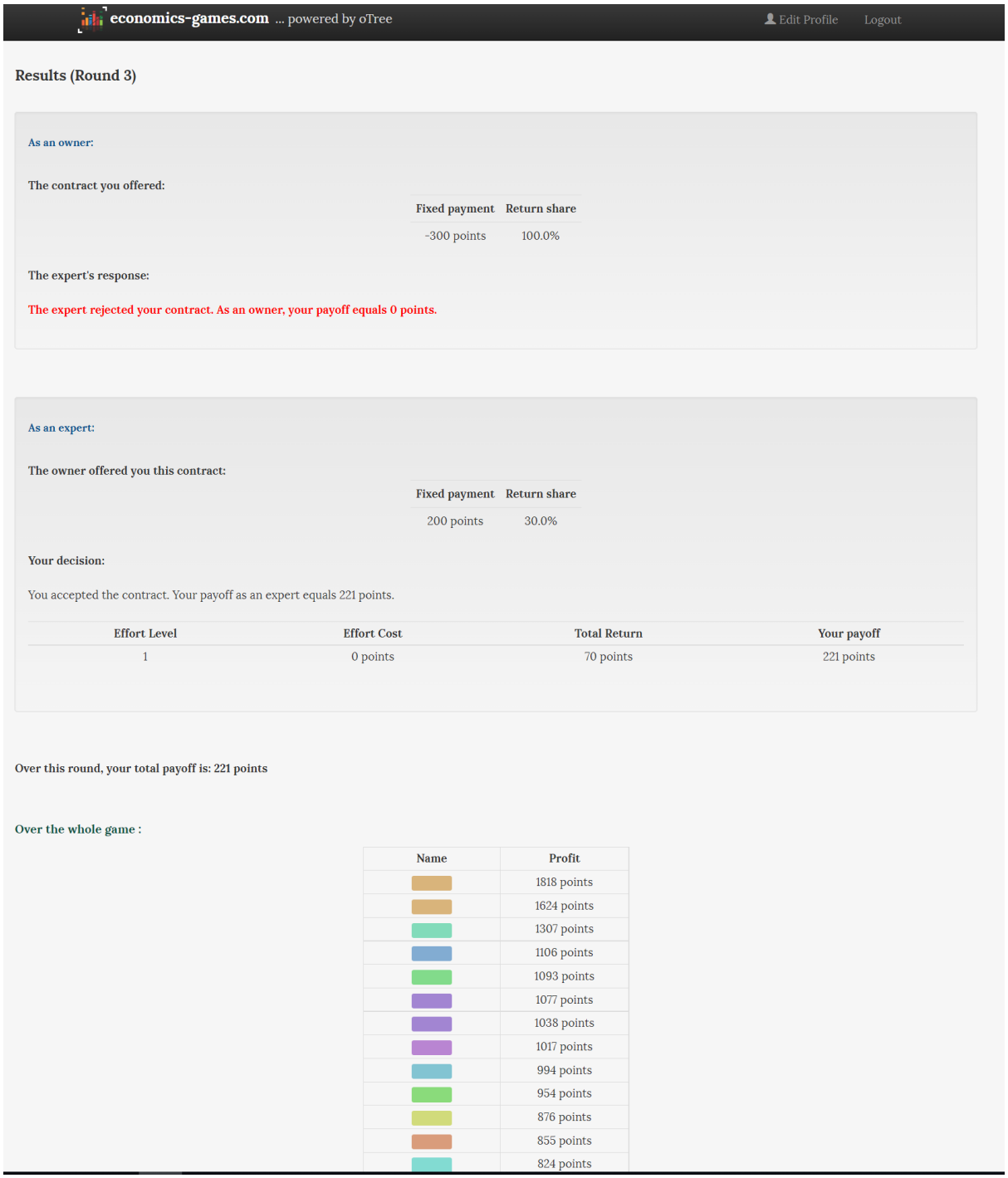

Figure 7. Personal detailed results for the round of simulated experience

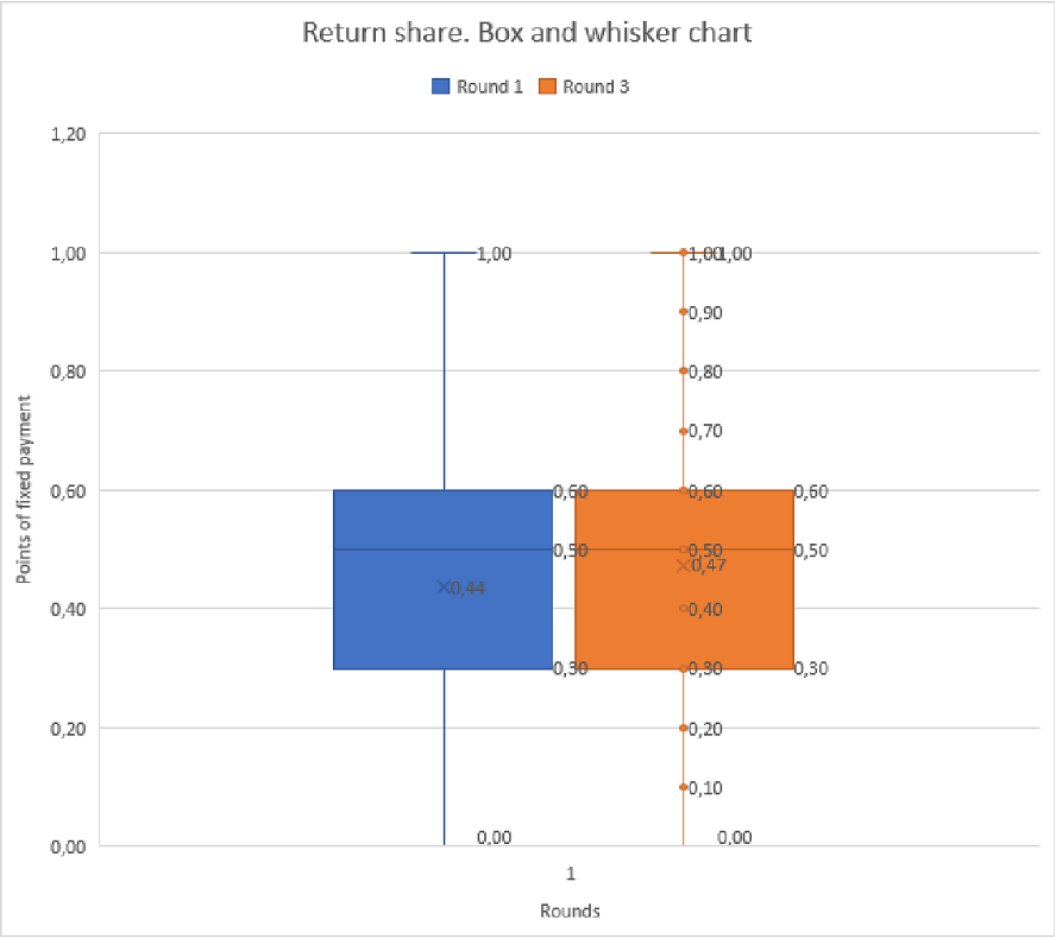

Figure 8. Return share. Box and whisker chart

The gender-related difference in the results of the simulation was of interest during the analysis. The data is provided in Table 1.

Table 1.

Gender-related differences in the results

	Round 1			Round 3		
	Offer's Fixed Payment	Offer's Return Share	Work efforts	Offer's Fixed Payment	Offer's Return Share	Work efforts
Average (all)	180,26	0,44	6,08	128,95	0,47	5,29
Average (female)	148,00	0,34	5,80	58,00	0,36	6,80
Median (all)	120,00	0,50	6,00	135,00	0,50	5,00
Median (female)	70,00	0,40	7,00	120,00	0,20	8,00

The data shows the difference in the results of male and female participants of the group. The table contains “female” and “all” results, where differences are already seen well. It means that the difference between “female” and “male” will be even bigger, especially if normalized to the quantity of the representatives of each categories. “All” category provides us with the data about the general results and separation of the “female” category just give us possibility to shortly highlight unpredicted differences. The Average and the Median are significantly lower in Round 1 and Round 3 for female than for male participants. It means that female participants in the role of Principal are ready to share fewer rewards with the Agent.

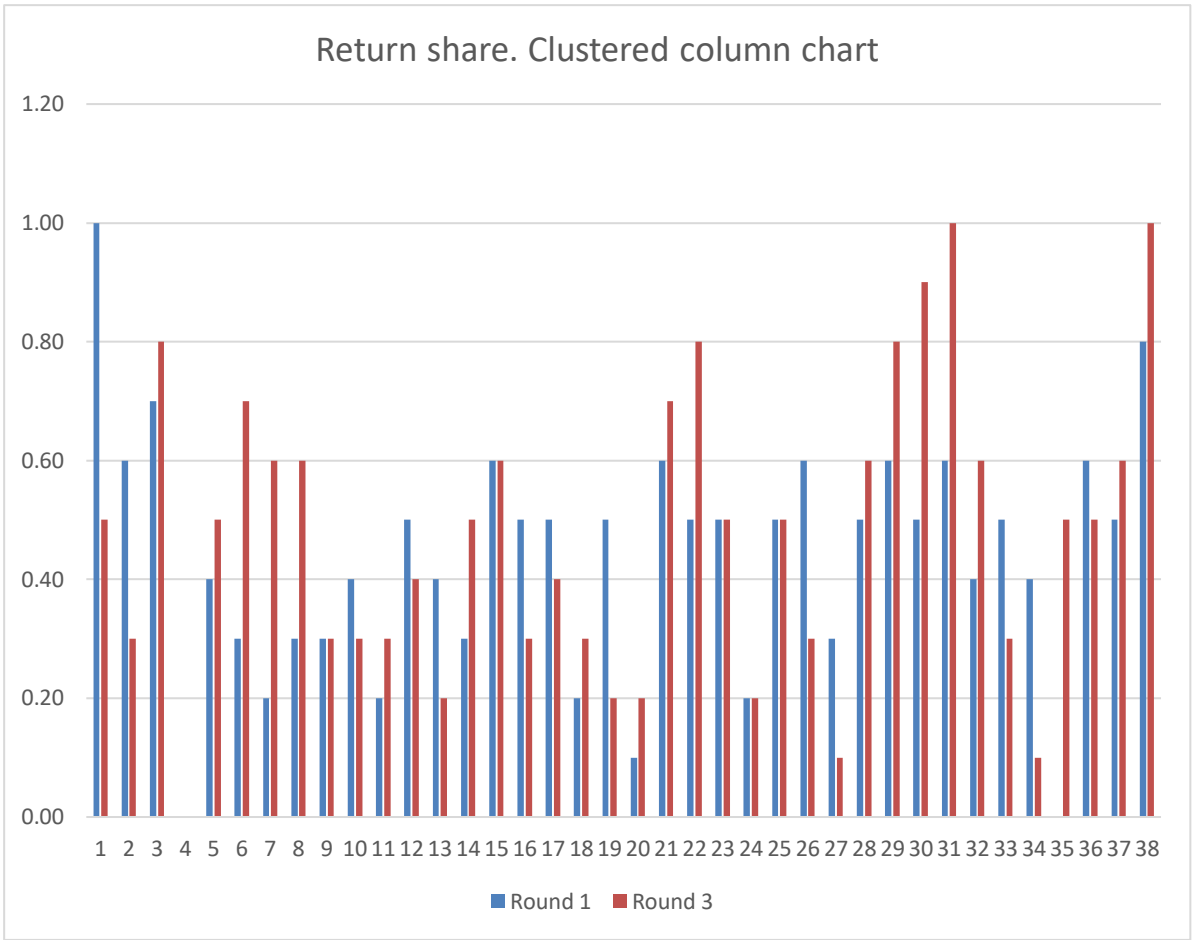

Figure 9. Return share. Clustered column chart

Data shows that 19 students raised their offer of return share, 13 students lowered their offer and 6 students – kept their offer of return share on the same level. Considering the small number of rounds, conducted in the simulation and the limited time, provided for mathematical calculations of the economic value, it is possible to conclude that the group of students tended to gravitate towards offering higher return share levels. It might be a sign of the semi-conscious implementation of experience-based knowledge and intuition on the material motivation factors for professionals, such as experts and managers.

"Work efforts" characterize the number of efforts the Agent puts to complete the work, considering the offer made by the Principal. The group overall showed declining average and median work efforts from Round 1 to Round 3. At the same time, female participants, having similar results as male participants in Round 1, significantly raised their average and median work efforts in Round 3. It gives the possibility to observe the difference in the behavior of male and female students in this simulated experience. Female students showed higher readiness to put effort to perform the duty despite diminishing financial results of such efforts. While male students were more rational in their decisions on the level of effort to put in.

Classroom experiments and simulated experiences, including those organized with the use of digital educational resources are significant and valuable parts of modern educational practice. These types of active learning interventions need to be theoretically and methodologically prepared, and organizationally and technically supported on the level to enable consistent and qualitative educational experiences for the students. Digital educational resources in the form of business simulations are usually not yet ready to provide a wireless experience to the teacher and the students. Designing and implementing a modern comfortable

user experience, including integration with the digitalized systems of educational institutions, training centers, and application sets widely used by regular persons is a challenge for product managers in academic and commercial institutions. At the same time, this niche might provide a possibility to the research and development centers of educational institutions and new successful commercially and socially oriented businesses in the EdTech domain. Collaboration between academia and business has the potential to become the crucial factor of success for both parties.

The influence of the gender structure of the group on the results of the simulation might be of interest and might become a question for future research.

4. CONCLUSIONS AND PROSPECTS FOR FURTHER RESEARCH

Using Contract Design and Principal-Agent dilemma simulation, implemented by the "Economic Games" platform, as the digital education resource was justified, described, and analyzed in this work. The use of the simulation showed its appropriateness and was informative in educational and scientific areas. It shows that an immersive educational experience can be organized within an acceptable amount of time and conducted by one person within the standard time of one class at the university. The technical implementation of the business simulation allowed the organization, to conduct and analyze the educational activity. The students' audience was involved and attentive. The process of the simulation forced students to actively participate in the class, analyzing real-world problems, studying concepts, developing personal attitudes, and forming future behavior in the domains of corporate governance, public policy, public administration, people management, behavior science, economy, and finance. Organizational failure in one of the stages of the educational activity enabled unexpected but useful additional learning of the aspects of reciprocity, fairness, and diligence.

The formation of the attitudinal domain-related profile of the group may be dedicated to the scientific outcomes of the experimental educational activity. The formation of the practical interest, inquiry, and the ground for the further research of the concepts, introduced within the experiential learning session provided the possibility to use the other educational methods in the consequent educational experience of the group.

Integration with the institution's learning management system and the possibility to add some characteristics of participants could further simplify and enrich the experience for teachers and students.

Further efforts will be put to the improvement of the technical integration of such simulators into the digital educational environment of higher education institutions and the development of methodological support for the use of such simulators in the educational process.

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Text of the article was accepted by Editorial Team 05.02.2023

ВИКОРИСТАННЯ ЦИФРОВИХ БІЗНЕС-СИМУЛЯТОРІВ У ЕКОНОМІКО-УПРАВЛІНСЬКІЙ ПІДГОТОВЦІ МАГІСТРІВ ІТ-СПЕЦІАЛЬНОСТЕЙ

Антонюк Дмитро Сергійович
кандидат педагогічних наук, доцент, доцент кафедри інженерії програмного забезпечення
Державний університет «Житомирська політехніка», м. Житомир, Україна
ORCID ID 0000-0001-7496-3553
dmitry_antonyuk@yahoo.com

Спірін Олег Михайлович
доктор педагогічних наук, професор, проректор з наукової роботи та цифровізації
ДЗВО "Університет менеджменту освіти", м. Київ, Україна;
головний науковий співробітник відділу відкритих освітньо-наукових інформаційних систем
Інститут цифровізації освіти НАПН України, м. Київ, Україна
ORCID ID 0000-0002-9594-6602
oleg.spirin@gmail.com

Вакалюк Тетяна Анатоліївна
доктор педагогічних наук, професор, професор кафедри інженерії програмного забезпечення
Державний університет «Житомирська політехніка», м. Житомир, Україна
провідний науковий співробітник сектору мережних технологій і баз даних
відділу відкритих освітньо-наукових інформаційних систем
Інститут цифровізації освіти НАПН України, м. Київ, Україна
ORCID ID 0000-0001-6825-4697
tetianavakaliuk@gmail.com

Анотація. Стаття обґрунтовує використання цифрових бізнес-симуляторів як різновиду цифрових освітніх ресурсів для розвитку знань, умінь, навичок, персонального ставлення, здатності приймати рішення в економіко-управлінській підготовці магістрів галузі інформаційних технологій. Використання цифрових бізнес-симуляторів в освітньому процесі надає можливість проводити експерименти для досягнення мети освітньої та науково-дослідної діяльності. Використання цифрового бізнес-симулятора "Дизайн контрактів та дилема Принципала і Агента" дає змогу змоделювати ситуації, наближені до реальності та сприяти формуванню базового персонального ставлення та розуміння теорії контрактових зобов'язань та дизайну ринків з асиметричною інформацією у сфері економічних та управлінських наук. Ці концепти є важливими для майбутніх спеціалістів у галузі інформаційних технологій, які будуть взаємодіяти в командах та розвиватись у сфері управління людьми та проєктами. Використання багатокористувацьких цифрових бізнес-симуляторів для освітньої взаємодії груп студентів надає наближений до реального досвід перебування в життєвих і робочих ситуаціях. Такий досвід сприяє підвищенню інтересу, покращенню мотивації до навчання, а також формує базу для поглиблених обговорень теми і формування поведінкових компонентів економічної і управлінської компетентностей магістрів галузі інформаційних технологій. Описана та проаналізована в роботі експериментальна навчальна активність показала користь як в освітній, так і в дослідницький сферах. Помилка, що була зроблена організатором імітаційного середовища, надала додаткові навчальні можливості групі студентів та цінні дані для наукового аналізу. Студенти продемонстрували залучення та активну участь в освітній імітаційній сесії. Використання пропонованого цифрового бізнес-симулятора продемонструвало простоту в застосуванні, а також достатній рівень функціональності засобів аналізу результатів симуляції. Виявлені особливості поведінки, залежні від статі учасників, були неочікуваними, але цінними результатами проведеного освітньо-наукового заходу. У подальшому передбачається вдосконалення підходів до технічної інтеграції в середовище ЗВО таких симуляторів, а також розробка методичного супроводу для використання таких бізнес-симуляторів в освітньому процесі.

Ключові слова: цифрові освітні ресурси; бізнес-симулятори; моделювання ситуацій; інформаційні технології.