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Antoniuk Dmytro

Candidate of Pedagogical Sciences, Associate Professor
Associate Professor of the Department of Software Engineering
Zhytomyr Polytechnic State University, Zhytomyr, Ukraine
dmitry_antonyuk@yahoo.com
<http://orcid.org/0000-0001-7496-3553>

Vakaliuk Tetiana

Doctor of Pedagogical Sciences, Professor
Professor of the Department of Software Engineering
Zhytomyr Polytechnic State University, Zhytomyr, Ukraine
tetianavakaliuk@gmail.com
<http://orcid.org/0000-0001-6825-4697>

**OVERVIEW AND CLASSIFICATION OF DIGITAL EDUCATIONAL RESOURCES FOR
ECONOMIC AND MANAGERIAL EDUCATION OF MASTER DEGREE STUDENTS
MAJORING IN INFORMATION TECHNOLOGIES**

Abstract. A wide range of forms and content of digital educational resources already exists and new forms appear regularly. Formal and informal organizations and societies work on the classification of resources. Countries and international organizations are establishing initiatives to support the development, sharing, and use of digital educational resources. Some of these resources are open, while others are accessible only to certain communities or geographic areas. This work intends to study the digital educational resources that enhance the development of managerial and economic knowledge and skills in the curriculum of masters majoring in IT. Methods of research applied: analysis, systematization, generalization, and classification were used to describe the proposed digital educational resources and their classification. The work provided the overview and classification of the digital educational resources for economic and managerial education of IT masters. The main varieties of the proposed digital resources are considered. Examples of the use of such digital educational resources in global institutions of higher education are given. The prospects for the future research require the analysis of the effective implementation of the latest solutions in the area of generative machine learning models. These technologies are reaching the levels of development when they become useful in the technologically-aided work of humans in routine as well as in creative jobs. Time is needed to see the first results of the usage of generative models in educational activities, as the parts of digital educational resources and their role in the digital transformation of educational institutions.

Key words: digital educational resources, economic and managerial education, masters majoring in IT, classification.

Introduction. A wide range of forms and content of digital educational resources exists now, and new forms appear regularly. Formal and informal organizations and societies work on the classification of resources. The Learning Technology Standards Committee (LTSC) of the Institute of Electrical and Electronics Engineers (IEEE) is one of the biggest communities working on the classification of learning technologies and resources. "The IEEE Learning Technology Standards Committee (LTSC) is chartered by the IEEE Computer Society Standards Activity Board to develop internationally accredited technical standards, recommended practices, and guides for learning technology" [16].

Countries and international organizations are establishing initiatives to support the development, sharing, and use of digital educational resources. Some of these resources are open, while others are accessible only to certain communities or geographic areas.

The Netherlands has established a consortium called SURF for the creation and sharing of digital educational resources, established by educational and scientific institutions of different levels [4]. The organization unites more than 100 members, such as research universities, universities of applied science, senior secondary vocational education institutions, university medical centers, research institutions, libraries, archives, etc. SURF stimulates and supports the creation of digital education technologies and helps the member optimize the cost of creation, implementation, and support of the resources and services.

Finland is worth separate attention. Neither being the biggest country nor having the biggest educational

budget, Finland is known as the country initiating, sponsoring, mentoring, and implementing a diverse set of innovations in educational technologies. Having a dedicated organization validates the methodical and educational value of the innovations. The site of the organization states: "Education Alliance Finland provides a product evaluation & certification service based on the global quality standard for learning solutions" [3]. The certification is valued by the educational institutions, so is usually requested by the company, creating digital educational resources [10]. All this contributes to the creation and use of a diverse catalog of digital educational resources, as well as research on the effectiveness and efficiency of education technologies.

Many scientists deal with the issue of using various digital resources in management and economic education. However, it is worth highlighting those who have made a significant contribution. Various possibilities of using digital resources in the educational process are considered V.Paepcke-Hjeltness [9], F.Sciarrone, C.Limongelli, O.Santos and M.Temperini [11], A.Shipepe and A.Peters [12].

J.Taylor [14] has analyzed various aspects of the application of artificial intelligence in the process of training MOOCs were d. Using cutting-edge artificial intelligence approaches, the published articles address some of the outstanding questions around evaluation in science courses, human-simulated answers, and drop-out prediction. A.Shipepe and A.Peters described designing an interactive career guidance learning system using gamification [12].

The **aim** of the article is to study the digital

educational resources that enhance the development of managerial and economic knowledge and skills in IT masters. In this work, such **methods** as analysis, systematization, generalization, and classification were used to describe the proposed digital educational resources and their classification. In particular, analysis and generalization were used to describe the possibilities of using digital educational resources. Systematization and classification were used for structuring by species.

Results and Discussion. The resources under consideration in this work must satisfy one of the following criteria: to have complex technical implementation process, e.g. interactive, problem-solving, or data/process/phenomena visualizing software; set of educational materials and the principle of its organization to extensively cover at least one economic or managerial concept.

Digital learning resources where generative machine learning models are the main part of the resource being outside the scope of this work due to the beginning phase of such implementation and the limited time of their availability. There was not enough time and information to observe the possibilities, limitations, and approaches to using these types of digital educational resources in the educational process. What is already evident, is the possibility and the need to implement generative machine learning models as components of the digital educational resources.

Commercial digital learning resource aggregators are worth mentioning. Being powerful players in the educational market, they play a significant role in the development, marketing, and implementation of digital educational resources. These market players might be classified as follows: Long-existing educational publishing-houses; Emerging startups, scale-ups, and established players in Educational Technology Market (EdTech); Niche solutions for particular knowledge domains or providing particular technology (virtual chemistry laboratories, metaverses, math tasks resolvers and processing engines, stock exchange trading simulations), etc.

Acknowledging the role of the commercial digital learning resources aggregators, we consider them as either the resources to provide a set of digital education resources or as the developers of one of the types of resources, discussed within the scope of this work.

Massive Open Online Courses (MOOCs) took their name in 2008, given by Dave Cormier from the University of Prince Edward Island in Canada. The real market entry of MOOCs happened in 2012 when Sebastian Thrun and Peter Norvig from Stanford University publicly introduced their "Artificial Intelligence" course. More than 160,000 people around the world enrolled in the course. A lot of MOOC platforms and aggregators have emerged since then, like EdX, Coursera, Udacity, etc. The platforms offer courses to be used by individuals as well as higher education institutions, incorporating MOOCs into their offerings as separate courses or parts of the existing courses.

Two massive open online courses were used in the educational practice of the authors for the economic and managerial education of IT master degree students:

– Leading people and teams Specialization from Coursera and Michigan Online [2]. Leading People and Teams Specialization was successfully used to introduce a significant number of already seasoned IT team leads to the formal concepts and modern knowledge in the field of team and people management. The educational intervention was supervised by mentors with extensive teaching and practical experience at IT companies. The educational experience was enriched

by guided discussions and peer-reviewed assignments. The specialization was chosen as a successful example of the up-to-date approach to content selection on the topics of people management and leadership, education experience design, and forms of educational intervention. The experience was productive and helped to attract the attention of the technical specialists, who manage people in their day-to-day jobs and are exposed to the proven challenges and best practices in the field.

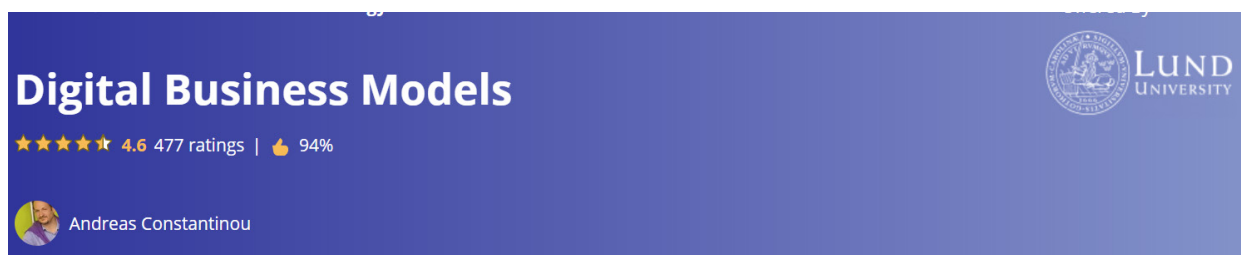
– Principles of Economics from EdX Stanford Online [14]. Principles of Economics was chosen as the course to build an initial understanding of economics, its rules, and its mechanisms. The course was used to enrich the wider course for IT masters. A reputable institution, an experienced author, and an appropriate level of complexity for beginners in the field were the main factors in choosing this MOOC for the purpose. The course combined appropriate coverage of the introductory topics in economics with an easy and attractive teaching style. The self-paced format of the course provided the possibility to use the course materials and assignments in synchronization with the main course schedule.

The use of courses already prepared and validated by reputable educational institutions not only allows for an enrichment of the scope but also improves the quality and attractiveness of education in offline institutions. The use of popular MOOCs helps to widen the worldview of students by exposing them to knowledge and practice domains outside their major specialization.

Small Private Online Courses (SPOC) became the evolution of MOOCs, aiming to use the advantages of scalable, repeatable digital educational resource offerings with high-quality support from professors and teaching assistants. The format leverages a limited scale to provide a better interactive experience for the cohort of students. It usually serves corporate learning and development (L&D) offerings and executive education (usually for money) courses. It might be an independent offering, part of the formal education experience, or a certification. Emeritus is one of the most well-known providers of SPOCs [8]. It established cooperation with a wide range of leading universities and became the centralized provider of executive education programs. Some universities offer programs in SPOC format independently. Harvard Kennedy School, for example, offers the Public Leadership Credentials certification program in this format [15]. Despite some expected democratization of education caused by the growing online offerings, institution name still plays a significant, if not crucial, role in the popularity of the MOOCs and SPOCs offered.

The division between MOOCs and SPOCs is fuzzy. It depends on the breadth of access to the course and also on the availability and intensity of the human-provided support during the educational experience with the course. Wider usage of AI technologies to provide human-like support to students is expected in the future [11].

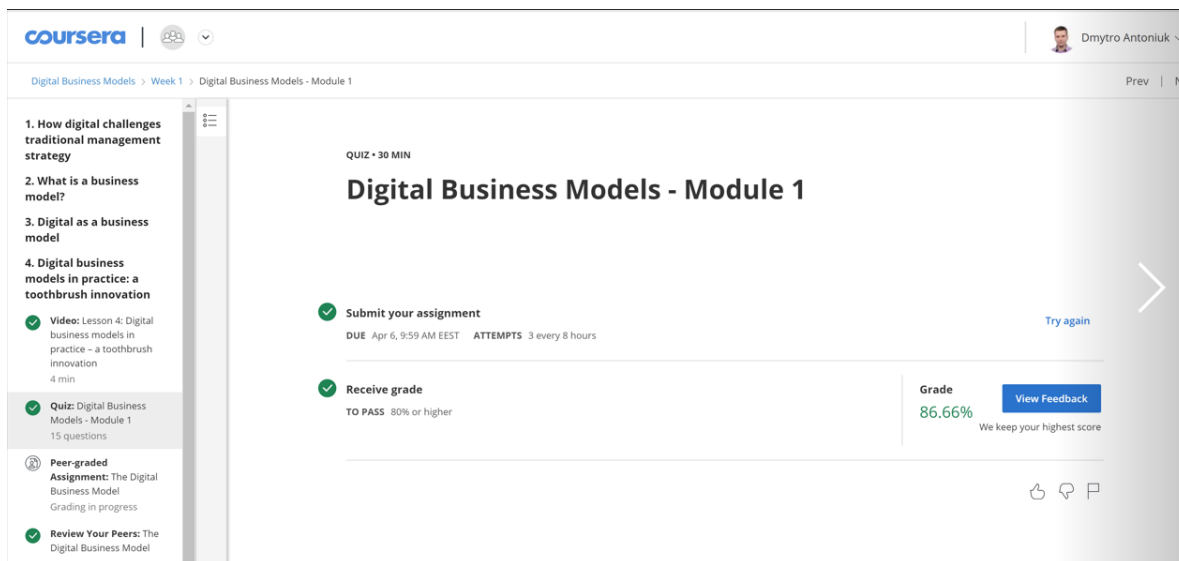
The authors have successfully used the "Digital Business Models" MOOC as part of the "Business in IT" course, taught for a Masters in IT Project Management at Zhytomyr Polytechnic State University in 2020 [1]. The course is developed by A.Constantinou from Lund University and delivered via Coursera. The headline of the course proposition is showed on the pic. 1. While the course is Massive Open Online by its nature, additional value was added by explicit discussions of the materials, results, and the ways to apply the knowledge to the particular environment and domain of the students. The group was not big enough to conduct quantitative research on the learning experiences and results.



Pic. 1. Digital Business Models course from Lund University on Coursera

Qualitative interviews with the students involved in this learning activity showed the value of embedding a concentrated MOOC in the specific domain of the course with a broader scope of topics and learning objectives.

Pic.2 presents the example of the results of the final assessment in the course. Feedback from the students was positive on the use of the relevant materials from the reputable educational institution.

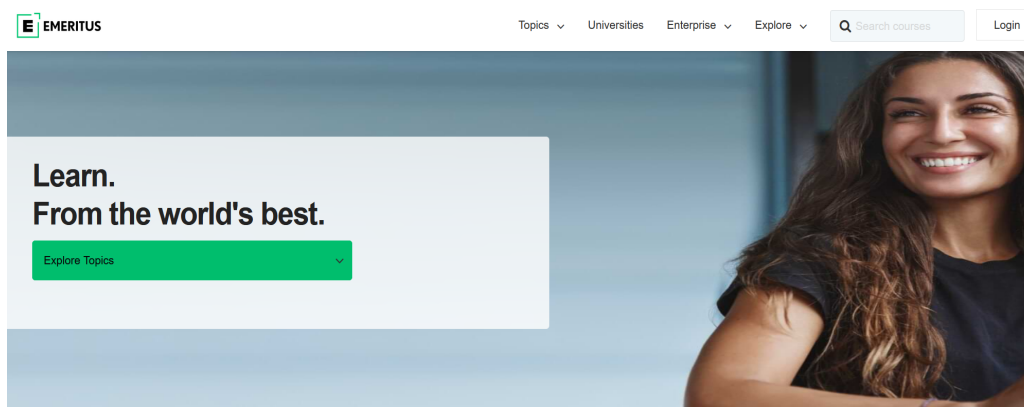


Pic.2. Simultaneous completion of the MOOC, provided in the SPOC format with facilitation

The case also provides an example of using informal education materials and technologies in a formal education setup. The combination leverages higher motivation to complete the course from formal education with agility and easier accessible specialization from informal educational institutions.

The Emeritus platform is the exemplary aggregator of Small Private Online Courses. The platform aggregates

guided courses from the world's leading educational institutions. Those are usually courses provided by higher education institutions for Executive education applicants. Small cohorts are being formed and guided by the professors, instructors, teaching assistants, and technical staff of the universities and the Emeritus platform. The part of the list of the partner universities of Emeritus might be seen on the pic.3.



Partnerships with top universities to make world-class education globally accessible.



Pic.3. Emeritus platform and its partner universities.

Short educational courses. This category includes digitally organized and provided short courses, that may be used as parts of more integral courses in formal education. Such courses might be developed and provided by governmental or non-governmental organizations, commercial companies, or education providers.

Diia Education is an example of a government-provided set of digital educational resources in the form of short courses [17]. Diia education provides short, self-paced courses on the basics of the topics valuable for the life of regular people and also specialized categories of learners, such as school teachers or medical workers.

Another valuable example in this category of digital educational resources is the site with the materials from the "CS 007: Personal finance for engineers" course, provided by A.Nash at Stanford University [7]. The resource provides access to the course, developed by a seasoned investor in the IT sector. The materials are being used by the author for teaching the course at Stanford University and short on-demand courses and speeches. The material is also being openly provided for the mass audience. The author believes in and highlights the importance of personal finance management knowledge and skills for IT specialty students and specialists.

Short educational courses provide educators with the opportunity to include concentrated material on a specific topic in a formal university course. It allows for combining wider coverage of the formal course with the deepness and expertise of the material on the particular concept or topic.

Certification Preparation Programs. Certification programs are a type of informal education, aiming to provide knowledge and/or train skills in a specific domain or technology. Certifications might be established and provided both by governmental and non-governmental or commercial organizations. Governments may also delegate certification to non-governmental organizations or commercial enterprises.

The International Organization for Standardization (ISO) is one of the most well-known international certification bodies [5]. ISO standards are internationally recognized proof of quality in a wide range of areas and activities.

The Project Management Institute (PMI) is a relevant example of a non-governmental organization that established certification programs and actively promotes them. The certification is "the de facto standard" in the project management domain.

Commercial enterprises are also interested in establishing regionally or internationally recognized certification programs. The corporate-established certification programs help companies to ensure the quality of service provision by the certified specialists, connect and retain specialists and service companies to the brand and technologies of the certifier company, and create additional income streams. Some of the most known IT companies, providing certifications in technical and non-technical domains are Microsoft, Cisco, Adobe, Salesforce, etc.

Cisco Academy is a long-term example of a corporate university, successfully transformed into a source of information and high-quality digital education resources for a wide range of topics in networking technologies, networks, and IT security. The initiative is now broadening its exposure to a broader set of knowledge and skill areas in IT, such as software development.

Certification Exams. Certification exams are the final part of the journey to reach formal recognition of knowledge, skills, and abilities in a certain domain.

Being de-jure independent from formal education, this type of examination sometimes proved to be useful as an integral part of formal educational programs and courses.

Certification exams from technology and consulting vendors like Cisco, Microsoft, Adobe, and organizations like Project Management Institute (PMI), International Organization for Standardization (ISO), etc. provide widely recognized credentials for employers in the relevant areas of the IT sector. Certification exams are being developed by professional teams and serve both parties: for the vendors, it creates a closer connection to the professionals and for the customers, it serves as proof of professionalism. The second purpose is in a way similar to the role of the diploma of an educational institution, so the certification may become a part of the diploma as proof of a wider range of capabilities. Pic.4. presents the levels of mastery in the Microsoft certification proposition.

Certification exams might have a direct or indirect impact on the grade for the course in formal education. Integration of the certification exams to the courses of formal education serves to help to ensure an appropriate level of competence in a certain domain and also helps higher education institutions to be competitive and in demand for the more practically oriented applicants.

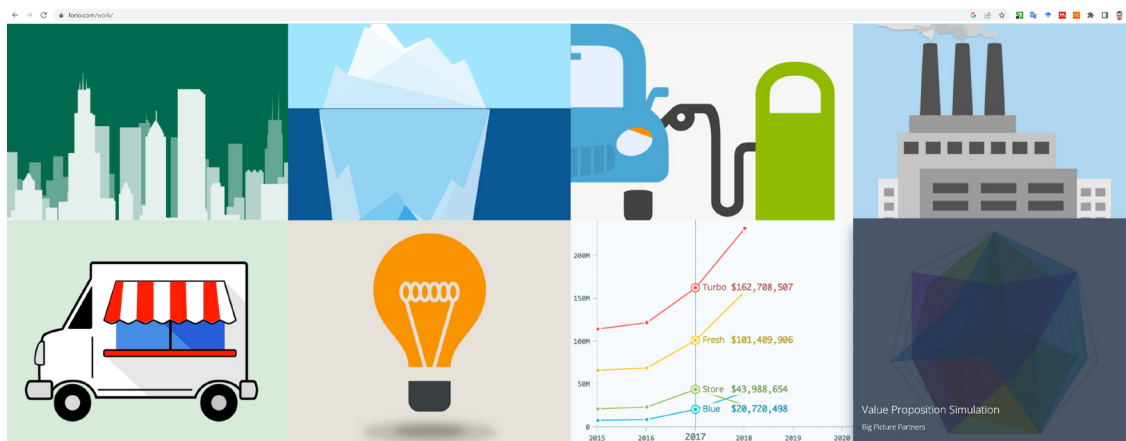


Pic.4. Microsoft certification mastery levels

At the same time higher education institutions need to create a policy to organically incorporate certification training and certification exams into their formal courses. It must preserve the purpose, ideas, value, and content of higher education to not become a vocational course. Numerous certifications from established institutions, such as corporations or worldwide recognized professional organizations provide certifications with a significant theoretical part in the area of their expertise. Some of these organizations provide certification possibilities for university students for a discounted price or for free.

Business Simulation. Business simulations took their roots in offline games, conducted by educators or consultants to imitate real-life processes, objects, or phenomena. Technological development, the growing complexity of the systems simulated, and the need for scalability and accessibility lead to the creation and development of computer-based simulations. Mobile, web or VR/AR-based simulations are the most common forms used in education now. Hybrid solutions, combining offline and online simulated experiences let the educators use the best advantages of both mediums in developing all the components of the competencies to be developed in the students and already working professionals. Numerous for-profit and not-for-profit organizations are developing it-based simulated experience applications and environments ranging from single-concept simulation to sophisticated imitations of real-world processes and environments.

Companies like Forio, Moblab, and Marketplace Simulations (ILS, Inc.) develop, market, support, and sometimes customize catalogs of the simulations for educational purposes. Pic.5 shows part of Forio's simulations catalog.



Pic.5. Part of the Forio simulation catalog.

Valuable catalogs of the simple simulations were also created by the groups of academics and are simple and comfortable to use as a digital education resource to support offline or online classes. Economic games are an example of the result of the academic's collaboration with

non-profit purposes. The catalog proposes single-player and multiplayer games. Pic.6 provides some overview of the areas of the economy, managerial study, game theory, etc., studying of which might be supplemented by the interactive collaborative game-based experience.

Ranking	Team	Year Profit	Average Price	Sales	Available Seats	Load Factor	Rndtz.	Plane Use	Average Cost / seat sold
1	Team 1	€33,353	€84	1,641	1,680	97.7 %	7	87.5 %	€63.3
2	Team 2	€16,129	€53	1,457	1,820	75.9 %	2	100.0 %	€41.8
3	Team 3	€15,656	€54	1,428	1,820	74.4 %	2	100.0 %	€42.6
4	Team 4	€14,621	€53	1,435	1,820	74.8 %	2	100.0 %	€42.4

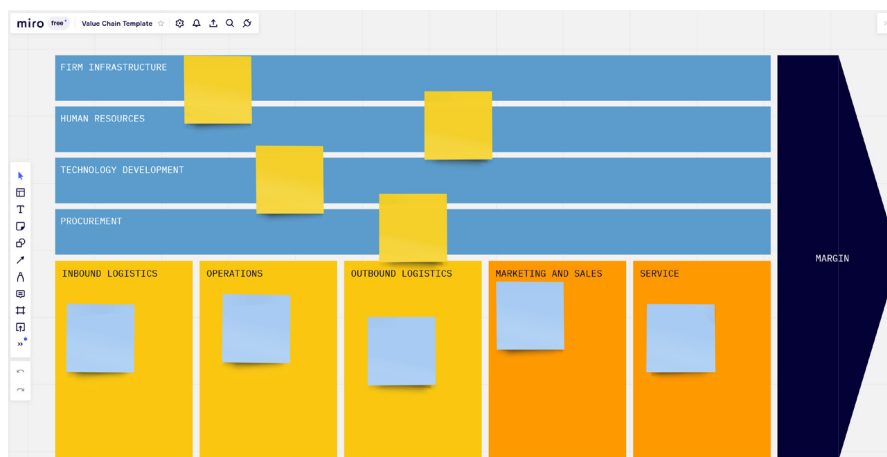
Pic.6. Part of the Economic games simulation catalog.

Templates for computer-based exercises and collaboration. Some active learning experiences might be effectively organized, using some form of computer-based templates. Those may be simple, pre-defined text documents or spreadsheet templates. In some cases, it might be specifically created simple software that works as a standalone application, in a web browser locally, or with the use of the server-side part. These templates are useful to work on some concept or narrow topic.

Miro.com is a descriptive example of this class of digital educational resources. The service significantly raised its user base during the work-from-home (WFH) regime of the COVID pandemic and took a significant place in the toolset of a wide variety of IT-related professionals. The service provides generic templates for exercise and collaboration as well as allows the creation of corporate and personal collections of this type of digital educational resources. Exercise template in Miro, describing Value Chain is presented on the pic.7. These

collaborative technics, enabled by digital resources improve visualization and collaborative learning in educational groups [9].

Serious games. This type of game is being used to introduce students to particular work- or live-related situations and develop awareness and skills, rather than provide theoretical knowledge. Serious games are valuable in developing safety, compliance, and customer interaction skills. They are usually developed in the form of video-enabled interactive dialogues. "JobPro: Get Prepared!" from SimCoachGames is an example of a serious game, aiming to develop the skills needed to prepare oneself for a job interview. This digital educational resource in the form of a serious game gives the possibility to introduce students to the process of job interviews [12]. The part of JobPro catalogue is shown on the pic. 8. This knowledge and skills are crucial for future IT specialists. The format enables the immersion of the students into the situational environment with its rituals



Pic.7. Value Chain description. Exercise template in Miro.

and specific and sometimes life-changing possibilities. The interactive realistic experience lets students practice

their experience, feelings, and behavior for future real and important situations in their professional careers.



JobPro: My Life

Players maintain their personal, work and financial well-being in this interactive and fun gamified experience. Start practicing decision-making skills important for your best life today!



JobPro: Get Dressed!

Players learn attire tips to be prepared and comfortable for job interviews! See how the right attire can help land a new job in this fun and dynamic game.



JobPro: Get Prepared!

Players practice how to best organize and prepare themselves for job interviews! See the importance of time management and organization in getting that job as you play this fast-paced and instructive game.

Pic.8. SimCoachGames collection of serious games.

Curated content sources. The modern, fast-changing world sets high requirements for the time-related relevance of the materials used in the educational process. Discussing managerial and economic areas of knowledge and experience, one year (standard time between course's provision to the different cohorts of students) might lead to the situation when some educational materials are outdated, or incomplete. This situation happens more often. Provision of the up-to-date content and the latest developments in the field of knowledge requires the usage of the sources of periodical content. In the case of the managerial and economic development of IT-related professionals, these sources are news sites, blogs, and expert company websites. To successfully navigate a quickly changing informational environment and deliver qualitative materials to the class activities, sources of curated content are in help. We may name the EconomicsOne blog of John B. Taylor, Mary and Robert Raymond Professor of Economics at Stanford University [13]. In this blog, the reputable author provides opinions on the emerging question in the area of micro- and macroeconomics. Another example of a reputable curated content source is the "Mind the Gap" project from the leading consulting company McKinsey&Company [6]. It generalizes the wide experience of McKinsey's consultants on "Generation Z",

its advantages, and specifics to leverage this possibility in academia and at work.

Curated content sources are a valuable tool to keep the course up to date in the fast-changing world and engaging to the students due to the high relevance and actuality of the materials studied and discussed in the class.

Conclusion. The work provided an initial study of the overview and classification of the digital educational resources for economic and managerial education of master's degree students majoring in IT. The main sets of the observed digital resources are considered. Examples of the use of such digital educational resources in global institutions of higher education are given. Authors were using a significant part of the types of digital educational resources, described in the article and are discovering the possibility to use others. Serious games are under consideration by the authors now. According to the study, some digital education resources are being actively used in the educational process of higher education institutions, some are being piloted and some are still to be discovered on the question of effective and efficient inclusion to the formal educational process. The search for productive collaboration of higher education institutions, providers of certifications-based credentials, and commercial practice-based educational resources

is ongoing for the latest decade. The dynamic nature of the appearance, development, and evolution of digital educational resources and the providing organizations is colliding stable and rather tradition-based nature of the higher education institutions to ensure the evolutionary development of the studied phenomenon. Studied digital educational resources for economic and managerial education are already being used to enable and improve motivation to and outcome from the study of master's degree students majoring in IT. These resources provide the possibility to motivate technically oriented students to get interested in studying more behavior-based areas of professional competence. The digital educational resources make a bridge technical connection of the students in the IT major with the problems of behavioral

nature, that were less desirable for a study for such students. Further research requires the analysis of the effective implementation of the latest solutions in the area of generative machine learning models. These technologies are reaching the levels of development when they become useful in the technologically-aided work of humans in routine as well as in creative jobs. Some time is needed to see the first results of the usage of generative models in educational activities, such as the parts of digital educational resources and their role in the digital transformation of educational institutions. As further research, we also see the development of criteria and indicators for the expert selection of digital educational resources for the economic and managerial training of masters in the field of "Information Technologies".

Конфлікт інтересів. Автори підтверджують відсутність фінансових, особистих чи інших інтересів, що можуть розглядатися як потенційний конфлікт інтересів щодо публікації цієї статті.

Фінансування. Робота виконана за відсутності фінансової підтримки з боку будь-яких організацій.

Доступність даних. Це теоретичне дослідження не передбачає використання додаткових наборів даних.

Використання штучного інтелекту. Інструменти штучного інтелекту не використовувались при написанні цієї роботи.

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Антонюк Дмитро

кандидат педагогічних наук, доцент
доцент кафедри інженерії програмного забезпечення
Державний університет «Житомирська політехніка», м.Житомир, Україна

Вакалюк Тетяна

доктор педагогічних наук, професор
професор кафедри інженерії програмного забезпечення
Державний університет «Житомирська політехніка», м.Житомир, Україна

ОГЛЯД ТА КЛАСИФІКАЦІЯ ЦИФРОВИХ ОСВІТНІХ РЕСУРСІВ ДЛЯ ЕКОНОМІЧНОЇ ТА УПРАВЛІНСЬКОЇ ОСВІТИ МАГІСТРІВ У ГАЛУЗІ ІТ

Анотація. На сьогодні наявний широкий спектр форм і змісту цифрових освітніх ресурсів, при цьому також регулярно з'являються нові форми. Над класифікацією ресурсів працюють заклади освіти, наукові установи та неформальні організації. Країни та міжнародні організації створюють ініціативи для підтримки розробки, спільного використання та використання цифрових освітніх ресурсів. Деякі з цих ресурсів є відкритими, тоді як інші доступні лише для певних громад або географічних регіонів. Оскільки COVID-19 сприяв цифровій трансформації, у тому числі й розробці все нових цифрових освітніх засобів, їх кількість постійно зростає, внаслідок чого потребує ґрунтовного дослідження порівняння таких цифрових освітніх ресурсів не лише загального призначення, а й для економіко-управлінської підготовки зокрема. Окрім того, цифрові освітні ресурси загального призначення знайшли своє відображення у багатьох наукових працях, що ще раз підтверджує необхідність розгляду цифрових освітніх ресурсів вузького спрямування. Саме тому дане дослідження спрямоване на вивчення цифрових освітніх ресурсів, які можуть сприяти розвитку управлінських та економічних знань, умінь і навичок у підготовці магістрів у галузі «Інформаційні технології». Для опису запропонованих цифрових освітніх ресурсів та їх класифікації використано такі методи як аналіз, систематизація, узагальнення та класифікація. У роботі подано огляд та класифікацію цифрових освітніх ресурсів для економічної та управлінської підготовки магістрів у галузі «Інформаційні технології». Розглянуто основні різновиди запропонованих цифрових освітніх ресурсів. Наведено приклади використання таких цифрових освітніх ресурсів у світових закладах вищої освіти. Описано можливості застосування таких цифрових освітніх ресурсів у економіко-управлінській підготовці ІТ магістрів. У якості подальших досліджень вбачаємо також розробку критеріїв та показників для експертного добору цифрових освітніх ресурсів для економіко-управлінської підготовки магістрів у галузі «Інформаційні технології».

Ключові слова: цифрові освітні ресурси, економічна та управлінська освіта, магістр у галузі ІТ, класифікація.