

How Game Design can enhance engineering higher education: focused IT study

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Abstract. This paper seeks to report on the current state and attitudes towards higher education (HE) curriculum for the creative (game) industry sector in Ukraine. It is based on preliminary findings from high education and industries surveys, which examined the competences, demanded by this important sector of the UA economy from one hand, and, from another, offers of HEs in developing them. Moreover, a review of the literature performed to define the core employees' profiles and their competences on the field job market. This paper explores competences, professional and transversal, that are important for the Ukrainian game industry and in what way should students be taught for "creative" tasks. This paper offers interested parties an analysis on how HE in Ukraine can develop relevant curriculum and deliver "industrial" education for students who intend to operate in this sector. The study results could be helpful for HE and policy makers to respond to current and future education needs.

Keywords: Engineering curricular, game design, game development, and creative industry

1 Introduction

The world IT market is growing annually on 5-20% including game industry [1]. According Global Games Market Report [2] worldwide game industry will generate a total of \$99.6 billion in revenues in 2016, what is increasing almost 8.5% compared to 2015. Moreover, it expects that global market will grow up to 6.6% toward 2020, eventually reaching \$118.6 billion. It is no surprise that IT products in whole and computer games particularly have become a major industry and are one of the fastest growing application markets in Ukraine [3]. The development scene of creative sec-

tor of world economy is expanding, therefore, amount of startups and companies based in European countries and worldwide are increasing. Such movement influences on accepting of new education policy which offers new grades, courses and curriculum according the contemporary challenges and demands. For example, every EU Technical university has at least one program devoted to the game design [4] and approx. 280 bachelor and master programs on game design are available at 385 USA colleges and universities [5].

A primary goal of the work presented in the paper is to figure out the required knowledge and skills on the local and national game sector market in Ukraine. A side benefit of this work will be a development of learning modules and an implementation them in a curriculum that meets the demands and interests of the future games engineers.

Games developers produce games for different operational system using existing engine machines or creating new one. A game production can involve from few employees to large studios and take several months or even years from creating ideas and characters to programming and testing. Each stage of digital game development involves various tasks for different roles, such as:

- designer – creates a game flow and how play in a game. The game could be original ideas or work from an existing concept
- artist – creates the game's visual characters, objects and scenery, and produces concept art and drawings (storyboards) at the planning stage
- animator – brings the characters, objects and scenery to life with computer modeling and animation software during the production stage
- programmer – creates the code to make the game work. On this stage the work could include graphics design, artificial intelligence, or gameplay software.

The literature review shows that the candidate on a position of a digital games developer needs to demonstrate follow competences:

- excellent computer skills
- a wide knowledge and understanding of computer games
- creativity and imagination
- a logical approach to problem-solving
- good teamwork and communication skills
- flexibility and adaptability
- the ability to work under pressure and meet deadlines
- patience and attention to detail
- willingness to keep up with industry developments and learn new skills

A survey consolidates and relates on above mentioned competences – knowledge and skills - needed from students of engineering schools dreaming to work in digital game industry. It was oriented mainly on a game sector as well as a high education in Ukraine and organized in all of parts of country and performed in frame of the Erasmus+ project “GameHub: University-enterprises cooperation in game industry in Ukraine”.

The analysis of the resent survey will result by an integration of computer game design with a software engineering course. The modules for the course will be implemented in next steps of the project performance, along with additional course material including syllabus, slides, projects, and other course materials specific to game design in software engineering.

This paper is presented as follows: Section 2 introduces the already mentioned GameHub Initiative as it is – the project goals and its wider and specific objectives, target groups, and partnership; Section 3 outlines a profile of the IT engineers working at game industry in Ukraine as well as development knowledge and skills of IT students using the potential of existing national higher education; Section 4 describes the study on the common (core) and specific (professional-oriented) competences for game industry job positions and discusses preliminary results; Section 5 introduces the didactic approach recommended for the use in GameHub pilot action and finally, Section 6 summarizes our conclusions and introduces possible future work.

2 GameHub Initiative

The GameHub project was created to modernize the existing engineering education in Ukraine by enhancing students' knowledge and skills in creative game development sector. The project was started at autumn 2015 and is co-financed by ERASMUS+ programme, Cooperation for Innovation and the Exchange of Good Practices key action and Capacity Building in Higher Education action.

The main goal of the project is building a bridge to connect in mutually beneficial cooperation universities and game industry by fostering and human investing the Ukrainian emerging ICT creative business sector.

The paper delivers three main outcomes : (1) preliminary analysis of high education and industries surveys concentrating on the competences, both professional and common (core), important for this sector of UA economy; (2) a review of the literature performed to define the main employee's profiles and their competences on a job market of the field; (3) recommendations for HE in Ukraine concerning methods and instruments for the development of relevant curriculum and deliver of "industrial" education for students who intend to operate in this sector.

IT market in Ukraine is increasing every year and requires more and more qualified specialists. High salaries, great amount of working places, opportunity for career growth (including traveling abroad) attract many young professionals and unemployed persons to the IT industry. However, employees do not always meet the employers' needs and possess necessary knowledge and skills. The reason is that most educational programs in IT specialties are out of date, and, as a result, do not correspond to the labor market requirements in rapidly developing IT sector.

In order to understand the needs of the game market in Ukraine and build contemporary profile of the university IT student the several surveys were performed.

3 IT engineer profile in game industry, Ukraine

A complex analysis of IT specialist competences complemented by social portraits helps to determine employee's social and professional aspects needed in game industry in Ukraine as well as demanded main competence level in this field for the teaching staff, and students majoring in "Information Technologies"[6,7].

For receiving social and professional characteristics of IT specialist we used the results of social survey conducted by IT Outsourcing News (2015), platform Rabota.ua in IT sector, and Ukrainian community of programmers. These data draws the following portrait: mainly a man with the average age from 19 to 36, with higher education in science or computer sciences. He actively applies his knowledge and skills, constantly improves them with offered training, workshops or courses. His main job is software development in a position of a developer, manager or tester. Although appreciating the possibility to develop a high-tech field he works due to high salary and possibility of career growth. He is mobile, i.e. ready to change his living place. The average experience is from 3 to 5 years [8,9].

To study the state-of-the-art in digital game design in Ukrainian higher education two surveys have been conducted: (1) for academic staff; and (2) for University students majoring in "Information Technologies" or "Computer Sciences". Both of them cover the questioning of 100 University teachers and around 500 students from different regions of Ukraine such as Donetsk, Kharkiv, Odessa, Kherson, Kiev, and Ivano-Frankivsk.

Analysis of the academic staff competences and skills shows that training of future game design practitioners completely depends on their background in the field, applied teaching methods and tools that fit to constant changing IT market requirements. Therefore, the survey demonstrates that the average age of lecturers is around 49 with 20-years work experience. 67% of the academic staff is men while the majority of them work in the field of Information technology. Only half of the respondents have sufficient knowledge of foreign languages (mostly English). They have average mastering of Java, C++, PHP and SQL and basic level of Java Script, Python, Objective, Perl and Ruby[12]. Among graphic environments high level of skills is observed in Adobe Photoshop and Adobe Illustrator, average one is in 3dsMax and Blender, and basic is in Maya, Cinema 4d and Vux Stream. 27% of the respondents have previous work experience in digital game design. In conclusion, the academic staff of Ukrainian universities has some knowledge and skills in game design, programming languages, graphic environments.

The analysis of the University students' survey, with more than 500 respondents builds an average Ukrainian University student portrait - future game industry representatives. The common portrait includes basic knowledge of such programming languages as Java, JavaScript, C++, PHP, SQL (33%), usage of graphic environments: Adobe Ilustrator, Adobe Photoshop, 3ds Max, Blender, Maya, Cinema 4d (70%), work experience in game industry (26%). They consider game design industry as one of the most perspective for the employment and are interested in interface development, project design, programming and project development [12].

4 Professional competency based on gaming industry analysis

In order to create the knowledge and skills needed by game studios, the questionnaires were designed. 41 game business representatives were interviewed and questioned. The respondents evaluated common (core) and specific (professionally-oriented) knowledge and skills which are necessary for the digital game design employee [10]. To simplify the process, we suggested to evaluate the most popular eight job positions: content manager, storyteller, scriptwriter, sound programmer, web-client programmer, sketcher, 3D Character Artist/3D Environment Artist, QA tester, JS programmer [11].

For each job positions the presented below knowledge and skills were voted on the scale not important at all and very important. The common capacity includes, e.g., to identify and solve problems; to work in team and achieve mutual goals; to apply gained knowledge and understanding of subject area/profession in practice; to adapt to different situations and flexibility; to work independently; to accept constructive feedback on the work; to pay attention to details and quality evaluation; for creative and imaginative capabilities; for self-education and self-development; for diversity sensitivity; for effective communication/ interpersonal skills; for analysis and synthesis; task planning and time management; for excellent verbal and written communication in foreign languages; for leadership and decision-making.

#	SPECIFIC KNOWLEDGE AND SKILLS
1	Ability to apply the principles, methods and algorithms of computer graphics
2	Ability to apply object-oriented approach for design of complex systems
3	Ability to use technology and tools for intelligent systems building
4	Ability to design rules and mechanics of a game
5	Ability of scriptwriting, storyboarding and concept art
6	Knowledge of drawing techniques both traditional and digital
7	Deep understanding of capabilities and benefits of different hardware platforms
8	Knowledge of various programming languages
9	Knowledge and working skills with databases
10	Knowledge and skills in system programming.
11	Basic understanding of compilers, linkers and interpreters
12	Build automation and test automation skills
13	Knowledge and working skills in algorithms, dynamic programming tasks
14	Ability and skills in code organization within file and between files
15	Skills in problems and systems decomposition
16	Other (please specify)

Table 1. Specific knowledge and skills necessary for game development

For each job position we created two competence profiles for common knowledge and skills, the other for specific ones (Table 1). As an example, diagram on the Figure 1 shows that leadership and decision-making as well as teamwork are dominated over the work independently for a content manager (common knowledge and skills).

In addition, the study of curricular of the GameHub European academic partners demonstrates that all competences may be compiled in four clusters: Design, Programming, Creative skills, and Transversal skills.

Design combines competences used for preparation of the preliminary models and sketchers for digital game, planning of digital game form and structure.

Programming includes competences necessary for computer programming, software development, analysis, content development, algorithm generation, testing algorithm requirements, algorithm/architecture solution.

Creative skills describe competences used for the development of digital game sketch, image, music due to aesthetic principals and high level attraction.

Transversal skills include traditional knowledge and skills that contribute to the IT specialist's personal fulfilment, such as: communication skills; foreign language proficiency; basic knowledge in mathematics, physics, natural sciences; ability to study, for social responsibility; ability for entrepreneurship, cultural literacy, creativity. Here can be also referred skills in project management, knowledge of planning and control methods, project monitoring and analysis.

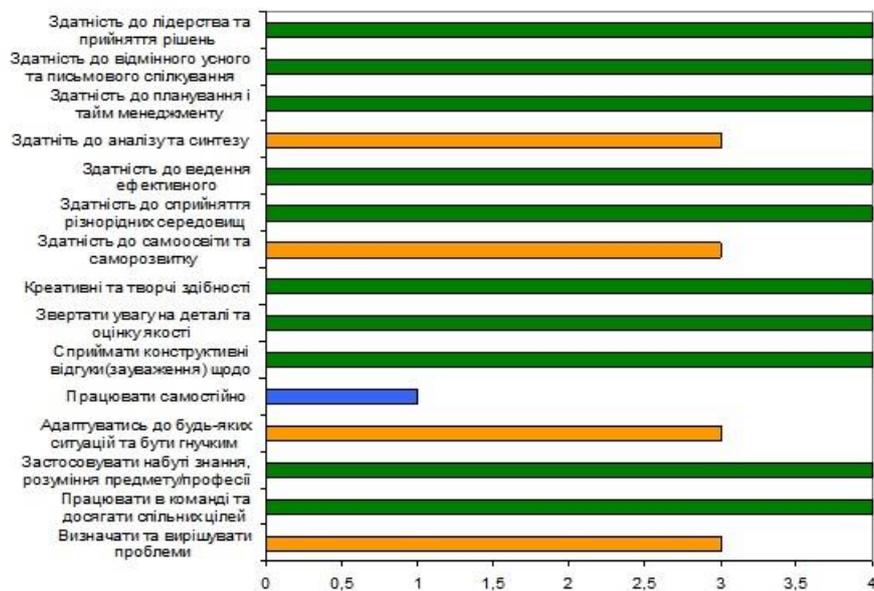


Fig. 1. Content Manager: competences (very important – green, important – yellow, slightly important –red, and not important at all – blue)

Based on the above-mentioned GameHub surveys and conducted analyses the competence profile of IT specialist in digital game industry is created. It includes but not limited to:

Common competences.

- Responsibility, care about quality of work;
- Adaptability and interpersonal skills;
- Efficiency and ability to self-improvement;
- Creativity, ability to system thinking;
- Focus on achieving a success

Instrumental competences.

- Capacity for research work, analysis and synthesis of technical information;
- Teamwork;
- Outstanding computer/programming skills;
- Capacity for written and oral communication in their native language.

Specific/professionally-oriented competences.

- Ability to develop user’s requirements specifications to software;
- Ability to perform requirements analysis, develop specification of software requirements, conduct their verification and certification;
- Basic understanding of the fundamentals of software simulation/design, types of models, main concept of unified modeling language UML;
- Ability to simulate different system aspects for which the software is developed;
- Ability to develop algorithms and data structures for software products;
- Understanding of current tendencies in software structure and architecture, software design methods;
- Basic understanding of modern psychological principals of human-machine interaction, methods of human-machine interface development;
- Ability to human-machine interface analysis, design and creation of prototypes;
- Ability to reusable components development and application;
- Knowledge of basic methods and techniques of visual programming;
- Ability to solve mathematical, physical and economic problems via development of appropriate applications;
- Ability to use hardware possibilities;

The obtained competence profile allows to establish methodic approaches for the development of didactic base for the curricular modification. In other words, conducted competence analysis of employers’ requirements in digital game industry makes it

possible to justify the preliminary structure of training-methodic supply of GameHub laboratory.

5 Didactical approaches and methods

The GameHub project devoted to develop modern IT educational programs at partners Ukrainian Universities based on successful European experience and directed to the acquiring skills and knowledge on digital game design that completely corresponds to the needs and requirements of IT employers. This part of paper explains the innovative teaching methods and tools that fit to the Ukrainian HEI style of lecturing.

For this purpose, the currently applied didactic methodology and instruments used at Ukrainian Universities for training IT disciplines were studied at six Universities. The study was performed considering from the point of view of main tendencies in the development of innovative teaching tools and complex methods application. It has determined the peculiarities, advantages and disadvantages of the full-time, part-time, distance, online and blended forms of studies. Based on the analysis results we can say that all these forms of studies are suitable for training of our modified educational program, although the teaching methods and instruments should be revised and added in order to fulfill various creative tasks [13].

The review of innovative teaching methodology successfully applied in European Universities as well as didactic approaches offered by Tuning Academy [15] provides a great number of various techniques that could be used teaching practical skills in digital game design. On our opinion, the most suitable could be a project-based teaching that efficiently develops several competences at the same time. The project may incorporate a teamwork involving creative capacity and directing to the real-life problems, e.g., production of working prototype of STEM game for secondary education level.

6 Conclusion

In the paper we presented the obtained results that allow to create a set of common and specific (professionally-oriented) competencies, and to determine methodical approaches for the development of didactic base to improve the engineering curricula in Ukrainian technical schools and universities. The conducted competence analysis of employers' requirements in digital game industry makes it possible to establish a GameHub laboratory [14] - the structure of education equipment for building meaningful final students projects with cooperation of national and international creative industry.

Moreover, based on the above-mentioned analyses, studies and surveys we have developed recommendations how to apply innovative teaching methods for the development of needed common and specific competences in digital game design for training specialists for appointed job position.

In the paper we show the required knowledge and skills on the local and national game sector market in Ukraine is settled. The paper offers to apply "creative" tasks

and project-based approach as most effective methods for teaching students in this field.

In the future the consortium is planning to create the learning modules and materials in format of open education resources to modernize the engineering curricular matching and satisfying to real-life tasks and objectives in creative sector of Ukraine. The developed open education resources will be tested and evaluated through the pilot action at six engineering schools. The results of this trial will be published on the project website (<http://gamehub-cbhe.eu/>) and in the facebook group discussion wall.

The study results could be helpful for HE and policy makers to respond to current and future education needs.

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8 References

1. PwC forecasts , 2016, [Online]. Available: <http://venturebeat.com/2016/06/08/the-u-s-and-global-game-industries-will-grow-a-healthy-amount-by-2020-pwc-forecasts/>. [Accessed: 10- Aug- 2016]
2. Global Games Market Report, 2016, [Online]. Available: <https://newzoo.com/insights/articles/global-games-market-reaches-99-6-billion-2016-mobile-generating-37/>. [Accessed: 20- Aug- 2016]
3. International Factfile 2015: Ukraine, Games industry news, The Market for computer & video games, November 9th 2015 [Online]. Available: <http://www.mcvuk.com/news/read/international-factfile-2015-ukraine/0158786>. [Accessed: 20- Aug- 2016]
4. Animation Career Review, 2016, [Online]. Available: <http://www.animationcareerreview.com:8080/careers-animation>. [Accessed: 20- Aug- 2016]
5. The 2016 Essential Facts About the Computer and Video Game Industry, Entertainment Software Association (ESA), April 2016, Ipsos MediaCT for ESA, [Online]. Available: <http://essentialfacts.theesa.com/Essential-Facts-2016.pdf>. [Accessed: 20- Nov- 2016]
6. Official data of the State Statistic Service of Ukraine. [Online]. Available: <http://www.ukrstat.gov.ua>. [Accessed: 03- Nov- 2016]
7. IT specialist portrait in Ukraine/[Online]. Available: <https://dou.ua/lenta/articles/it-portrait-2015/>. [Accessed: 12- Aug.- 2016]
8. Official data of the Association of the Ukrainian Outsourcing Companies. «Exploring Ukraine. IT Outsourcing Industry» [Online]. Available: <http://hi-tech.org.ua/exploring->

ukraine-it-outsourcing-industry-the-volume-of-it-outsourcing-services-provided-in-ukraine-has-grown-by-a-factor-ten/. [Accessed: 15- Nov- 2016]

9. Official data of the Association "Information Technologies in Ukraine". [Online]. Available: <http://itukraine.org.ua/analitychni-materialy> [Accessed: 03- Nov- 2016]
10. International standard of education classification. [Online]. Available: <http://www.uis.unesco.org/Education/Documents/isc-ed-fields-of-educationtraining-2013RU.pdf>. [Accessed: 03- Nov- 2016]
11. National standard of education classification (project) [Online]. Available: <http://naps.gov.ua/uploads/files/sod/NSKO.pdf>. [Accessed: 03- Nov- 2016]
12. GameHub report "Task Analysis; Development of Competence Profiles" [Online]. Available: <http://gamehub-cbhe.eu/project-results/>. [Accessed: 20- Nov- 2016]
13. GameHub report "Developed Didactical Approach in Training" [Online]. Available: <http://gamehub-cbhe.eu/project-results/>. [Accessed: 20- Nov- 2016]
14. GameHub report "Eleborated Technico-Pedagogical Requirement on game Laboratory" [Online]. Available: <http://gamehub-cbhe.eu/project-results/>. [Accessed: 20- Nov- 2016]
15. Tuning Academy, [Online]. Available: <http://www.unideusto.org/tuningeu/publications.html> . [Accessed: 20- Nov- 2016]