Journal of ICT, Design, Engineering and Technological Science (JITDETS)
VOL. 4, NO. 1, pp. 12-15, 2020
DOI: https://doi.org/10.33150/JITDETS-4.1.3

ORIGINAL CONTRIBUTION

Integration of Technology Enriched Games with Classical Teaching Instruments for the Development of Technical Communication Competencies

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***Abstract*— This way, the paper aims to identify a balanced mix of technology-enriched games and classical teaching instruments that is well-suited for the efficient development of technical communication competencies by students or trainees. The paper addresses the issue of developing technical communication competencies, analyzing the competencies involved in a structured way and then proposing some enriched technology games as innovative instruments to be used by teachers and trainers together with the classical teaching instruments. For this purpose, classical teaching instruments are analyzed to identify their strengths and weaknesses when used to develop technical communication competencies. Then innovative complementary instruments – in this case, technology-enriched games - are identified and configured to address exactly the weak point of classical instruments in a better way. The aim of these technology-enriched games is not to replace classical teaching instruments but to be integrated as complementary instruments alongside them. This approach is a novelty in the context of actual research. The findings could be implemented in all courses containing technical communication – a field that is future-oriented and has a high potential for development in the near future.**

***Index Terms*— Serious Games, Education, Technical Communication, Development of Competencies**

Received: 12 December 2019; **Accepted:** 29 April 2020; **Published:** 19 June 2020

I. INTRODUCTION

The importance of technical communication competencies in the context of Engineering education, especially in the domain of engineering and management, is linked to recent research findings regarding the importance of the development of social competencies alongside professional and methodological competencies [1, 2, 3, 4, 5]. These studies done in Austria [1, 2] and Romania [3, 4] converge on the fact that social competencies have an equal or slightly greater importance in the context of engineering education compared to the other two relevant categories of competencies: professional and methodological competencies. As technical communication competencies combine all three kinds of competencies according to the European competency framework system for technical communication [6, 7], they become highly relevant in the context of the previously mentioned findings.

Competencies in technical communication refer to both general communication competencies and special technical communication-linked competencies. Selecting these competencies alongside the instruments to develop them is a challenge. Previous research showed that technology-enriched games could improve foreign language communication courses [8]. Exploring the possibilities of the involvement of technology-enriched games in a mix with classical instruments to strengthen and develop identified relevant technical communication competencies is the aim of the present paper. In order to reach this objective, two technology-enriched games, Quizlet and Kahoot, were implemented and analyzed in three courses at the University Politehnica of Bucharest. The focus lies on the three pillars of competence development: knowledge, the ability to use the knowledge as well as the motivation to learn, which is the fuel for the other two pillars. This approach is a novelty in the context of actual research. The findings could be implemented in all courses containing technical communication – a field that is future-oriented and has a high potential of development in the near future [9, 10].

II. LITERATURE REVIEW

The idea of inserting serious games in the educational process is not new, the educational purpose being one core element in the serious game definition by Michael and Chen [11]. Serious games have been successfully implemented in different educational fields ranging from engineering in the form of e-learning-based games in order to reach the high potential of elearning [12], to economics or the interdisciplinary field of engineering and management in the form of business simulations [4, 13, 14] as well as to foreign language learning [8].

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On the one hand, the implementation of serious games brings certain advantages like challenging student's creativity through increased visualization, a higher adaptability in the educational process [15, 16] or the setting of useful content based on educational material that is already known by the learners from previous learning phases [17].

On the other hand, there is also criticism related to students' results in this context [18] or to the way education is addressed at a strategic level in some European countries [19].

The domain technical communication is described through a relatively new redefined competency framework system, containing 7 competency domains and 27 competency areas [6] being used to design prototype curricula and learning outcomes [9, 10]. The main challenges reported in the field range from proper ways of structuring and formulating technical communication according to the used media [20, 21, 22, 23, 24, 25] to localisation and translation at a high quality of technical communication [26, 27], to optimising knowledge processes [28, 29] or to use rationalisation potentials resulting from today's smart technologies [29, 30] or tomorrow's technologies with their increased use of artificial intelligence [31].

Finding the right sentences [23] and words [20] is a key element in the field of technical communication, which is becoming highly difficult to manage in the multilingual and multicultural context of globalisation [26, 27].

Especially in the fields of engineering and management, the smart technologies and their potential for process optimisation and rationalisation cannot be ignored by technical communication professionals, and pressure to better integrate these elements in technical communication has been identified [30]. This seems to be an ongoing trend, as these technologies will probably increase in use and complexity through the growing use of artificial intelligence that is expected in the future - a trend that has been also identified as being highly relevant for the future development of technical communication [31].

The way enterprises and organisations are structuring their knowledge processes and restructuring them in the process of optimisation is also influencing technical communication in various manners [28, 29].

Neglecting technical communication issues could result in costly litigations [32] that being another reason why the mastering of technical communication competencies is increasing in relevance.

III. METHODOLOGY

The choice of the present research regarding the scientific methods involved is the case study method. The method is using observation and/or surveys as its main instruments being recognized as a research method with high scientific standards [33].

One aim connected with the case study method was avoiding its common potential flaw - self-bias [34]. In this context, a better degree of objectivity was obtained through the external point of view provided by the technical communication competency framework system as well as the translation of technology-enriched games successfully used in other fields of communication [8].

The frame for the research consisted of analyzing the European competency framework system for technical communication in order to involve the right technical communication competencies [6].

The nature of the research is exploratory and not yet confirmatory, so it is based on observation [35], leaving future confirmatory research to complete the instruments with surveys that lead to confirmatory statistical analysis connected to a big sample of data. Between 2017 and 2019, the students of the Faculty of Engineering in Foreign Languages from the University Politehnica of Bucharest who took the courses Marketing, Moderation, and Presentation or Technical Documentation (all three courses were conducted in German and have a focus on technical communication) were observed by their professors regarding their reaction to the material of the courses including the weeks when two technology-enriched games were used during the three mentioned courses–Quizlet and Kahoot. Each course had in each year 20-30 students. The interviewed professors, from which one is the main author of the present research, were questioned about their perception about the effects of both technology-enriched games on increasing the information volume, training the use of technical communication and motivating the students to learn more. Because of the relatively small amount of students, the research was conducted in an exploratory manner and was limited to the observation and perceptions of the professors gathered through 6 interviews.

IV. FINDINGS/RESULTS

Technical communication competencies were defined related to the seven phases identified in the production process of information products in the competency framework system of technical communication [6]. The seven phases and the competencies related to each of them as a competency domain represent the 1st layer of the competency framework system: environment analysis, planning, concept development, content creation, media production, publication and distribution, and market evolution assessment [6]. The 2nd layer contains a total of 27 competency areas related to the seven domains, while on the 3rd layer and the 4th layer, the analysis becomes more detailed regarding the corresponding thematic blocks and learning units with specific learning contents and learning objectives [6].

The main problem is not to deliver the knowledge synthesized from the competency framework system for technical communication, but rather to improve the ability to use that knowledge and keep the students' motivation to learn at a high level.

The best results were gained by combining classical educational instruments like lectures and exercises with some technology-enriched games. Lectures covered the content to be transmitted, while the strength of exercises and games proved to be in developing the ability to use that knowledge as well as keeping students' learning motivation at a high peak.

In this context, two technology-enriched games were used: Quizlet [36] and Kahoot [37]. They both require that each student (or each group of students, if implemented as team games) has a smartphone or laptop with internet access.

"Quizlet" is a study application that is both online and mobile. It trains learners through flashcards and various quiz games. It can be used to fix new vocabulary elements of technical communication through the opportunity for professors or trainers to define their own selected keyword lists and to connect them with pictures. The students get access to the quizzes by social media, e-mail, or directly implemented inside learning platforms like Moodle. For both "Quizlet" and "ankiapp", their flashcard mobile versions enable learners to use the electronic version of classical flashcard boxes. The repeating mechanism is smart: unknown terms will be repeated with a frequency that is depending on the ratio of correct and incorrect answers given by the student, while words that prove to be known will no longer be repeated. The flashcard boxes learning mode is completed by other learning modes including a multiple-choice mode and different other quiz modes.

"Kahoot" is another useful program when trying to keep the motivation of students in technical communication at a high peak: its competitive approach while using tests proved to be a motivation star when used live in class. The quizzes should be either based on an already achieved material or structured as a repetition for the material that is going to be taught. The game requires, in addition to the smartphones with an internet

connection of the students, an internet-connected computer and a projector for the professor, as well as some preparation in advance: the professor or trainer is designing quizzes with a single correct choice out of four and receives a pin as the access code for students. Thus, when the game starts, students only need to navigate the website and type in the pin provided by the professor on the projector to start the game without further registration or other complications. For each question, the students will see four different coloured squares with the four answer alternatives set by the professor before the game. After everybody chooses their answer on their device, the right solution will be shown on the projector via the professor's device. In the meanwhile, the number of correct and wrong answers is tracked by the program for each device (for each student at the individual playing and for each team at team playing). Another tracked parameter is the speed of delivering the answers. When the game ends, the program calculates and displays the ranks of all participating students based on their ration of right answers and their speed. The ranking and a resulting winner at the end of the game can bring students' motivation at very high peaks – this fact has been observed by the research team in the form of intense enthusiasm on the side of the students when the authors experimented in the classroom the live implementation of "Kahoot" games.

V. DISCUSSION

As the research on implementing serious games in the field of technical communication is a novelty, there is no other comparable research to relate to while assessing the nature of the findings. However, there are some similarities to the results of inserting serious games in the context of foreign language education [8] and management [4]:

- The motivational factor is the main observed advantage, as learners' involvement rises through the use of serious games [8].
- Other elements are needed in order to keep the volume of delivered knowledge high, e.g., lectures [8, 4].
- The ability to use the knowledge needs further exercises and training methods that cannot be replaced by serious games [8].

There are also relevant differences, based on the lower complexity of the used serious games compared to research findings derived from the analysis of the implementation of business simulation games: while a business simulation is succeeding to train the knowledge of its field and to develop the ability to use it, the chosen technology-enriched games Quizlet and Kahoot only manage to consolidate the knowledge, without training the ability to use it in a relevant manner. Their value is not denied by this lack of ability development but points out to the requirement to complete it with lectures in order to have the knowledgebase that can be consolidated and with other exercises that ensure the development of using that knowledge in a practical way.

VI. CONCLUSION AND IMPLICATIONS

The implemented technology-enriched games in education related to technical communication had a contribution to the consolidation of technical communication knowledge on the one hand and preserving and boosting learners' motivation on the other hand. The findings point to the fact that these instruments do not work alone. They are very good at increasing the learners' motivation, but their contribution to the knowledge volume is small and specialized in the consolidation phase, while the training of the use of technical communication competencies is close to zero. So the two analyzed technology-enriched games need other elements with the capacity to deliver high amounts of knowledge on the one hand and to train the ability to use that knowledge on the other hand.

In this regard, they can be combined with lectures for their high potential to deliver a high amount of knowledge as well as with exercises for their high potential of training technical communication competencies.

The two technology-enriched games are fruitful starting experiments and show that the potential through the use of serious games in technical communication is by far not used close to its real capacity and that such elements have a very good potential, especially for fuelling learners' motivation in the process of developing technical communication competencies.

VII. LIMITATIONS AND DIRECTIONS FOR FUTURE RESEARCH

The nature of the present research doesn't allow universal conclusions about the use of technology-enriched games for the development of technical communication competencies. It rather draws a path of success in the form of a case study. Starting from this point, wider research could be implemented at the European level to determine which other game-based solution is implemented for the development of the named competencies.

Also, after reaching more students with the concept, a confirmatory survey with participants could be implemented in order to confirm the success assessed from the professors' point of view. Such an approach would further limit potential self-bias through the observation team.

Declaration of Competing Interest

The authors declare that there is no conflict of interest.

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