SERIOUS GAMES EVALUATION METHODOLOGY

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Abstract

Using games is a new and a powerful way of learning in the classrooms, where students are active participants in the learning process. Educational games empower students' knowledge and skills, as well as educational value of the teaching process. There are plenty of serious games that can be used in education, but most of them simply do not hold interest among students. Thus, the students do not really accept them as games, which creates opposite effect than expected. There are other factors that influence the successful game's integration in the classroom - teachers' digital competences, technical (pre)requirements for the game, educational value of the game.

This paper presents a methodological tool based on an evaluation framework for integration of digital games into education (MEDGE). The evaluation framework uses different data gathering techniques such as: surveys, exams, observation, reflection, in order to obtain data. This methodological tool is simplified version of an evaluation framework, developed to act as a subjective, but efficient tool for teachers in order to make initial evaluation of the potential introduction of certain educational game in the classroom.

The tool establishes step by step methodology for evaluation of educational games. It starts with determining the technical requirements of a game, accordance to students' age and teachers' digital competences needed to play it in the classroom. If these conditions are met, the game evaluation continues by determining game's ease of use, its educational value, students' quality of experience, game's alignment with educational goals and teacher subjective preferences toward using the game in the classroom.

The proposed methodology was tested by more than 62 teachers from Croatia, Macedonia, Norway, Estonia, Germany and Poland. The teachers were asked to evaluate at least two educational games using this methodological tool. One of those games was Kahoot, a popular game within the teachers' community. Kahoot is a quiz based game that can be used for initial, formative and summative assessment of students' knowledge using individual or collaborative team work mode. The other game was selected by teachers based on their needs and experiences.

Using a survey with five-point Likert scale, information concerning teachers' attitudes towards usefulness of the methodology, its complexity, applicability in the classroom, and usefulness for evaluation of a game were obtained. The participants had the opportunity to give comments and express their opinion concerning the proposed methodological tool. The paper is consisted of detailed description of the developed methodological approach, together with the use cases and results of the survey on usage of the methodological evaluation tool.

Keywords: serious games, games evaluation framework, students' QoE, evaluation methodology.

1 INTRODUCTION

Teaching nowadays is represented by shifting to the learner-centered approach, where teacher is just guiding students in the learning process, enabling them to progress with their own pace, taking into account different learning styles of the students. Educators understand the importance of creativity and interaction in the learning process, so the use of interactive and innovative technologies can have a positive impact on the learning experience by allowing students to engage with topics in a personal and immersive way [1]. Today students are becoming increasingly dependent on technologies to communicate, gather information, extend social experiences, and be entertained [2]. They are exposed to digital information on daily basis, work interactively connected to each other via mobile technologies, perform several tasks simultaneously and enjoy playing digital games.

The fact that students often play different digital games (on a computer or mobile device) and during that time they are dedicated to the process of playing the game should be used in the educational

process. Students play digital games with a lot of focus, energy and enthusiasm. This commitment should be transmitted to the learning in the school. Enjoyment and fun as part of the learning process are important since the learner is then relaxed and motivated and therefore more willing to learn. In the attempts to address the challenge of making games for education enjoyable, yet effective, researchers and educational practitioners are increasingly turning their attention towards so-called serious games for education or games-based learning. Educational games are highly engaging, motivating and they offer many advantages as a supplementary tool for education. Maintaining motivation and student engagement in the classroom is a challenge for teachers in order to establish inspirational learning environment.

Based on the above, researchers and game developers are trying to integrate educational content within game based contexts, with the goal to transform the educational process into a fun and engaging activity for learning. The ever-increasing advancement in hardware and software along with the widespread use of mobile devices can provide the opportunity to rapidly increase students' learning participation through practical hands-on experiences [3]. Consequently, the paradigm could shift away from lecture-style and more traditional teaching pedagogy towards active learning.

The findings of a review study by Connolly et al., on empirical evidence for the potential positive impacts of gaming reveal that playing computer games is linked to a range of perceptual, cognitive, behavioural, affective and motivational impacts and outcomes [4]. Digital games have become powerful contexts for learning by providing students with the opportunity to join new worlds by thinking, talking and acting, taking roles otherwise inaccessible to them [5]. Educational digital games have the potential to be powerful learning tools, constituting supportive, engaging, and motivational contexts for learning, and substituting traditional teaching methods considered overly boring [6]. They offer students the opportunity for a more compelling, rich, exciting and personalized experience combined with efficient learning [7]. In the new game-based learning community, learners take a central position, are peer linked (work together, cooperate, network) and have mutual frequent interactions with teachers, who also work in teams, not in isolation [8]. Nevertheless, through the integration of the instructional content into the game framework of a well-designed computer game, abstract and complex learning subjects and ideas have the potential to become intuitive and clear to learners [9].

Using educational games to assist the learning process offers a wide range of possibilities that can be difficult to attain in a traditional classroom; for example, game based learning gives players the possibility of going at their own pace and learning through trial and error in a controlled and safe environment. Assessment is fundamental in teaching and learning. Learners rely on it to receive feedback on their progress, and educators need assessment to determine whether their learning goals have been achieved. However, many games are developed with a very basic assessment and no feedback [10]. Besides giving players the opportunity to learn through gameplay activities with clear goals, games also provide immediate feedback to the players' actions, which can have a positive effect on their performance [11].

There are a lot of games that can be used in educational context, but not all are enjoyable for the students. From the other side that are a lot of popular game but they don't have educational value. It is very difficult to match popular games to the curriculum in order to use them in educational process. There are other factors that influence the successful game's integration in the classroom, too. Some of them are: teachers' digital competences, technical (pre)requirements for the game, educational value of the game etc. Therefore, there is urgent need to have some tool that will help teachers in the process of evaluation game's suitability for the classroom activities.

This paper presents methodological tool based on evaluation framework for the integration of games into education. This methodological tool is simplified version of an evaluation framework, developed to act as a subjective, but efficient tool for teachers in order to make initial evaluation of the potential introduction of certain educational game in the classroom. The detailed description of this methodological approach, together with the use cases and results of the survey on usage of the methodological evaluation tool is presented in the paper.

In the next section, the simplified game evaluation framework is elaborated in more details. The case study for evaluating the proposed framework is described in the same section. The third section presents both results and discussion of the results concerning the evaluation of the framework. The last, fourth section, draws the conclusions.

2   METHODOLOGY

2.1   Simplified game evaluation framework

In order to choose which game is the most suitable to be used in particular context, the game evaluation framework has been developed. The purpose of the serious game evaluation framework is to identify different parameters that influence on qualitative integration of educational games in the classroom and investigate their interconnections. The parameters refer to students' attitudes, opinions and interactions during the game. They also include educational value of the game and the ability to reach learning outcomes with different complexity. Teacher's opinion about the game and the established learning environment is another important parameter. The serious game evaluation framework uses different data gathering techniques such as: surveys, quantitative measures, observation, analyze and self-assessment reflection in order to obtain data. Each of these techniques is used for gathering information concerning educational, technological and subjective aspect of game's integration in the classroom (Fig. 1).
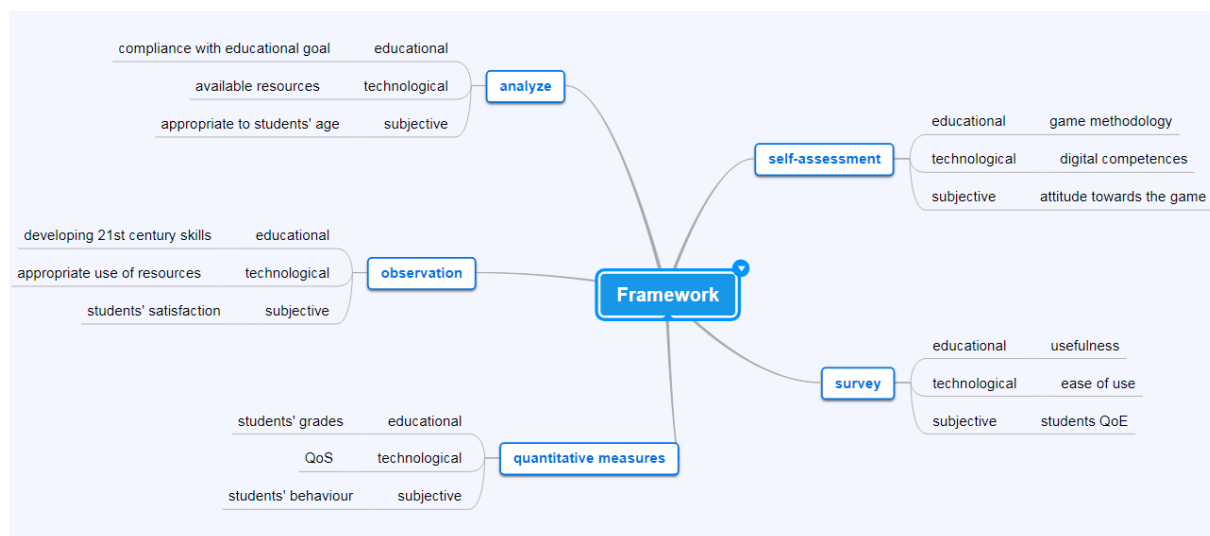

Figure 1. MEDGE evaluation framework - mind map.

This serous game evaluation framework is very complex and takes into account different aspects from the game integration in the classroom. In order to reduce its complexity and to start initial evaluation of the games, simplified version is proposed. The evaluation of the educational game according to this simplified methodology is implemented in two steps. In the first step, the necessary conditions to start with the game use in educational context are checked and in the second one, the evaluation of the game is done.

Necessary conditions to start with the game integration are meeting the technical requirements of the game, in accordance to students' age and teacher digital competences. First, the teacher should check if the necessary hardware and software requirements or Internet connection availability are in accordance with the game. Teacher's digital competences for using the game in the proper way in the classroom must be on some satisfactory level in order to start with the integration of the game in this environment.

The simplified game evaluation framework is based on the evaluation of the different aspects concerning game's use in the classroom: game's ease of use, its educational value, students' quality of experience, game's alignment with the educational goals and teacher's subjective attitudes toward using the game in the classroom. In order to do this evaluation, the following questions should be asked:

- Is the game easy to use? (EASY)
- What is the educational value of the game? (VAL)
- Is the game adaptable to the educational goals? (ADT)
- What is the students Quality of Experience? (QoE)

– What is the teacher subjective opinion about the game? (SUBJ)

Game's ease of use will contribute to the raised students' interest in playing it. If the game is very complicated and students can't pass in the next level, playing the game will be frustrating and demotivating. Matching educational goals with the game is very important for giving proper educational value of the game, which will contribute to the easier achievements of the learning outcomes. In order to have a good alignment with the educational goals, different complexity levels of learning outcomes should be considered. Educational goal complexity should determine the number of levels in the game and how they should be passed. Namely, each level of learning outcomes should be appropriate level of the game which will motivate students for playing it. This can be implemented by indicating different degrees of success which could be achieved while mastering a given level [12]. The game must also support the development of problem solving skills, critical thinking and producing of "deep learning".

The quality of students learning depends on quality of experience (QoE) while playing the game and quality of the achieved knowledge. Students' QoE is important factor for qualitative integration of the game in the education. The International Telecommunications Union defines Quality of Experience as "the overall acceptability of an application or service, as perceived subjectively by the end-user" [13]. In this evaluation framework, QoE is recognized as a multidisciplinary concept about students' acceptance of using games in education based on game popularity, cognitive experience and subjective feeling. Different factors influence on students QoE like cooperative and competitive elements of the game, progress in the game, ease to use, given awards during playing etc. Teacher's subjective opinion about the game and its suitability is very important for creating stimulating and inspiring learning environment.

Having all this in mind, the most important aspects for successful game's integration in the classroom, games' ease of use, educational value, games' adaption to educational goals, students QoE and teachers' subjective opinion should be evaluated. In the proposed evaluation framework, each of these aspects is represented on the evaluation axis where the values for each aspect are ranged from "not satisfactory" to "excellent".

When evaluating a game, each of this axes will be graded from 1 (not satisfactory) to 5 (excellent). Sum of the values of the aspects will give the game's overall value. If needed, some of the grades can by multiplied by some factor in order to emphasize that evaluation element. The greater the game's overall value, the more suitable will the game be for the educational process.

2.2 Case study

The subjective simplified game evaluation framework was presented to 62 teachers from Croatia, Macedonia, Norway, Estonia, Germany and Poland. They were introduced with the framework for serious games' evaluation and used the simplified framework for initial evaluation of two games.

At the beginning, teachers were asked to plan the integration of two popular games in their classes. One of them was Kahoot! (widely used by teachers) and the other one was chosen by the teachers themselves, individually. They were asked to find appropriate place for the game in the classroom, with whole class or just part of it and to link it with the current educational goals. Depending on the purpose of using the game and type of evaluating the students (diagnostic, formative or summative) they planned the use of the game at the beginning, during or at the end of the class. Individual or team work was planned based on the students' skills that was supposed to be developed - teamwork for developing cooperative skills and individual for competitive skill.

Kahoot! was chosen for its popularity. It is a quiz game (www.getkahoot.com) developed at the Norwegian University of Science and Technology. According to their website, Kahoot! is used in all countries in the world and at the end of 2017 they had 70 million monthly users.

Kahoot! is a game-based learning platform, used as educational technology in schools and other educational institutions. Its learning games, "kahoots", are multiple-choice quizzes that allow user generation and can be accessed via web browser. The Kahoot! game based learning platform offers opportunity for creating quizzes or finding and adopting a quiz to particular audience. The creator of the quiz game gives a code for playing and it can be played in single mode or team mode. The game can be played as a pre-generated quiz or in a classroom with the teacher as a "game master". The students can access the game by logging on from a pc, iPad or mobile phone. By entering a game pin generated by the quiz game, the "game master" can start the quiz and decide on when to display the next question.

After choosing the most appropriate place for integrating a particular game in the classroom, teachers started the evaluation of the games according to the proposed methodology. Since they were asked to choose Kahoot! and some other popular game that they already have used, the first step about necessary conditions was skipped and teachers started evaluation of the game according to the proposed measures. The grading was subjective due to the subjective opinion of the educator, because they were not doing the evaluation in the classroom. They evaluated both games, giving grades for each aspect and evaluating overall (total) grade. Also, they represent this evaluation on a chart. According to the overall grades and game's chart area, teachers had the opportunity to decide which one is more suitable for the learning process. One possible representation of the evaluation of the two games is given in fig. 2.

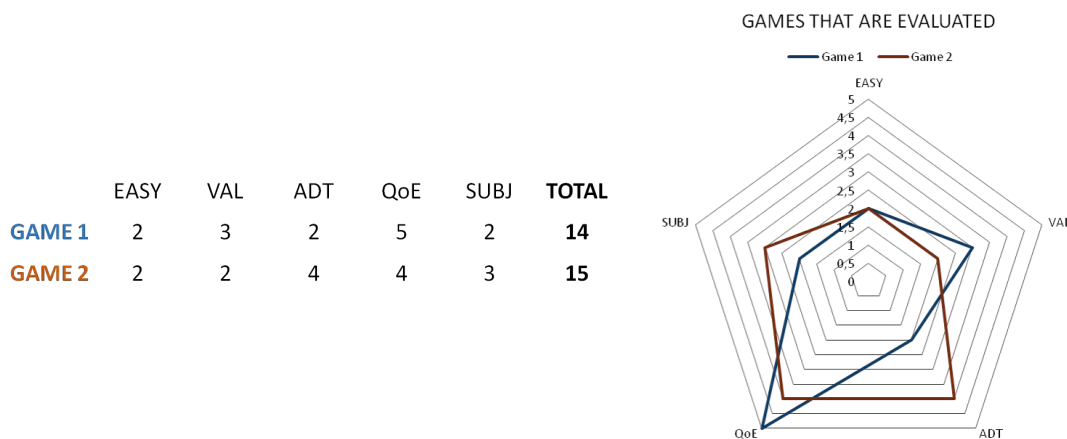|	EASY	VAL	ADT	QoE	SUBJ	TOTAL
GAME 1	2	3	2	5	2	14
GAME 2	2	2	4	4	3	15

Figure 2. Example of MEDGE comparison between two games' evaluation.

After completion with the game evaluation and discussion about the meaning of each grade and influence in total game's value, the participants were asked to evaluate the proposed simplified game evaluation framework.

The survey consisted of two parts. The first one was aimed to gather demographic information about the participants: country, gender, age and type of school. Information about teacher's confidence in using digital tools and especially digital games in the classroom were gathered by five-point Likert with answers ranged from "not at all confident" to "very confident".

In order to get information concerning teachers' attitudes towards using this simplified game evaluation framework in the classroom, different aspects were measured using five-point Likert scale, with answer from "strongly disagree" to "strongly agree". Information concerning teachers' attitudes towards usefulness of the methodology, its complexity, applicability in the classroom, and usefulness for evaluation of a game were obtained. Using two open ended questions at the end of the survey, the participants had the opportunity to give comments and express their opinion concerning the proposed methodology.

3 RESULTS AND DISCUSSION

Most of the teachers that were introduced with the simplified game evaluation framework were from Macedonia (53,23%) and Croatia (37,10%). But we also have a small number of teachers from Poland, Estonia and Germany that tried to use this methodology for evaluation of games in education. Most of them were female (87,10%) and only 12,90% were male teachers. A good demographic distribution is present since 74,19% of the teachers were from the urban schools and 25,81% of them teach in rural schools which corresponds with this distribution in reality.

Concerning teacher's confidence in using digital tools and games in the classroom we can say that the surveyed teachers are with an average confidence in ICT area. 40,32% of them are partly confident in using different digital tools and 38,71% feel confident in using those tools. More than half of them (58,06%) sometimes use digital games in the classroom, and during this they feel confident very often (40,32%) or sometimes (38,71). Since the surveyed teachers ranked themselves as "average" in using digital tools, and especially games in the learning process, we can conclude that the gathered results about evaluation of the framework will apply on wider educational community.

Results concerning their attitudes towards using this simplified game evaluation framework are presented in Table 1. Mean values of their attitudes towards using simplified evaluation framework is calculated as the mean value from the answers, where "strongly agree" is equivalent to 5 and "strongly disagree" is equivalent to 1.

Table 1. Teachers' attitudes towards using MEDGE - simplified version.

Item concerning teachers' attitudes/ N=62	Strongly agree	Agree	Neutral	Disagree	Strongly disagree	Mean
MEDGE is easy applicable for evaluation of educational games	12,90%	75,81%	11,29%	/	/	4,02
MEDGE helps me in evaluating whether the game can be used in the classroom by technical point of view	22,58%	67,74%	9,68%	/	/	4,13
MEDGE helps me to involve students' and teachers' opinion in games' evaluation	16,13%	74,19%	9,68%	/	/	4,06
By using MEDGE I can evaluate whether the game contributes in achieving learning outcomes	14,52%	69,35%	16,13%	/	/	3,98
All the aspect concerning appropriate use of educational game are taken into account in MEDGE	14,52%	56,45%	29,03%	/	/	3,85
MEDGE is useful for evaluation of educational games	24,19%	61,29%	11,29%	/	/	4,00

The interesting fact when analyzing teachers' answers was that there are no disagreements at all with the benefits from using simplified game evaluation framework. Almost 90% of the teachers think that this framework is useful and easy applicable for evaluation of educational games. There is no difference in teachers' attitude toward the methodology concerning the country of origin or teacher's gender.

More than 90% of the surveyed teachers think that this framework can help them in evaluating whether the game can be used in the classroom by technical point of view. The same number of teachers are certain that by this framework students' and teachers' opinions are taken into account during the process of game evaluation.

Teachers have some concerns when educational elements of the game should be evaluated - 83,87% of the surveyed teachers strongly agree or agree with the fact that this framework helps them to evaluate whether the game contributes in achieving learning outcomes. But the number of the teachers that are not sure about this is not small. Namely, 16,13% of them are not quite sure that by using this framework they can link achieving learning outcomes with the integration of the game in the classes. One possible reason for this is that the teachers for the purpose of this particular evaluation have only given subjective grades and they didn't have much time to connect the game and its levels with educational outcomes.

Teachers are not quite sure that all the aspect concerning appropriate use of educational game are taken into account in simplified game evaluation framework. 29,03% of the surveyed teachers think that maybe some other aspect may influence on successful game integration in the classroom, but they can't state it. The reasons may be the teacher's insufficient experience in using games in the classroom, or reviewing for the first time this kind of evaluation framework without previous consideration of the most important factors for achieving successful integration of games in the classroom.

Open ended questions gave us information concerning teachers' subjective opinion about this framework. As the main benefits from using this simplified game evaluation framework, teachers stated the applicability, differentiation and selecting among a lot of offered games, opportunity to choose the most suitable game for the whole class or as a part of a class and a possibility to see which aspect of the game contributes the most in the overall game value.

Surveyed teachers think that this simplified game evaluation framework is good structured overview for game evaluation which can serve as a guidance for determining game quality. By using this approach teacher can be sure that the chosen game is the most appropriate for his class.

Concerning the question about what and how can be improved in this framework, answers didn't lead to some concrete change of the framework. Teachers stated that they need more pre-knowledge about this topic in order to give constructive feedback or they need more experience (time) in using this framework and then to conclude what can be improved.

4   CONCLUSIONS

There are a lot of games that are fun and motivational for the students but don't have satisfactory educational values. On the other side, there are a lot of educational games that are boring for the students and they don't like to learn that way. Most of the time teachers choose the educational game intuitively and after the class they evaluate what was good and what can be improved. This simplified game evaluation framework offers the possibility to quantitatively evaluate the games and to choose the most appropriate one according to its ease to use, student's and teacher's opinion and correspondence to educational goals and their complexity.

Results from the testing of the applied evaluation framework on two games indicated that teachers needed some kind of methodology which will help them to evaluate certain game. There are a lot of games, especially online, and they feel confused when the choice of the appropriate game should be done. They liked the fact that there is some guideline that will help them in the determination of the good educational game.

Surveyed teachers stated that this simplified game evaluation framework is easy applicable and is very useful for evaluation of educational game. They find this methodological tool easy to apply and comprehensive including technical requirements and students' and teachers' opinion concerning the game at the same time. They were not quite sure that this framework lead to appropriate evaluation of the connection between the game and the educational goals. More frequent use of this framework will lead to more successful evaluation and constructive feedback about its completeness. These results will be used in the further research concerning development of a guidelines for applying a more complex game evaluation framework in practice.

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