Univerzita Komenského v Bratislave

Fakulta matematiky, fyziky a informatiky

Mgr. Dana Šuníková

Autoreferát dizertačnej práce

Exploring Potential of Gamification
in Secondary and Higher Informatics Education

na získanie akademického titulu philosophiae doctor

v odbore doktorandského štúdia:

9.2.3. Teória vyučovania informatiky

Bratislava 2018

Dizertačná práca bola vypracovaná v dennej forme doktorandského štúdia na Katedre základov a vyučovania informatiky Fakulty matematiky, fyziky a informatiky Univerzity Komenského

Predkladateľ: **Mgr. Dana Šuníková**
Katedra základov a vyučovania informatiky
Fakulta matematiky, fyziky a informatiky
Univerzita Komenského
Mlynská dolina, 842 48 Bratislava

Školiteľ: **doc. RNDr. Zuzana Kubincová, PhD.**
Katedra základov a vyučovania informatiky
Fakulta matematiky, fyziky a informatiky
Univerzita Komenského
Mlynská dolina, 842 48 Bratislava

Študijný odbor: **9.2.3. Teória vyučovania informatiky**
Študijný program: **Teória vyučovania informatiky**

Predseda odborovej komisie:

prof. RNDr. Ivan Kalaš, PhD.
Katedra základov a vyučovania informatiky
Fakulta matematiky, fyziky a informatiky
Univerzita Komenského
Mlynská dolina, 842 48 Bratislava

Introduction

With the development of technologies and the Internet in the last decades, algorithmic thinking, searching and handling information seems to be more important than ever. These skills are part of the Informatics education. However, motivation to learn Informatics is fragile among different schools and their students.

To make the classes more attractive and engaging, we proposed introducing of gamification in Informatics education. At the present time, gamification is used mostly to motivate and engage people in various activities, including the educational ones. The current educational research focused on gamification states that the outcomes of gamification in education depend on context and learners. However, few research was conducted in the field of gamification in Informatics education and there is almost no research aimed at the gamification of Informatics classes or courses in our region. Thus we decided to test it in our settings to enrich the current knowledge of the topic.

The aim of our thesis was to investigate the potential of employing badges and gamified activities in Informatics classes. We explored how these gamification elements can influence the student engagement in the Informatics learning.

1 Statement of the research

1.1 Research problem

Motivation to learn Informatics in the secondary education is fragile among different schools and their students. Motivation is a predictor of student performance at school as important as intelligence [27], thus it should not be underestimated. Therefore, in our opinion, the teacher should use all available means to make their classes interesting and enjoyable for students.

To make the classes more attractive and students more engaged in them, we proposed to enrich the teaching and learning process with gamification. First cases of implementing game elements into everyday use showed up in the marketing to increase user activity and retention [13]. At the present time, gamification is used mostly to motivate and engage people in several activities including educational ones.

Gamification is often defined as ,,...the use of game design elements in non-game contexts" [13]. The first game element we decided to research in educational environment are badges. Our current grading system does not explicitly show students' abilities, it only splits them into categories varied

from ,,insufficient" to ,,excellent". Badges are able to show students' specific competences, which can be more engaging than the widely used grading system. Compared to the verbal assessment, which is a practice in several schools, the use of badges can be less time consuming for teachers, while keeping the assessment information-rich.

While the assessment by a teacher is predominant at schools, some teachers implement peer-assessment and peer-review into their classes. It has some advantages on its own, however, augmenting it with badges might enhance its qualities because of the aforementioned factors.

Another problem in Informatics education is that there are still topics which are taught in the transmissive way (the teacher presents the knowledge, the students memorize it) even though students could discover the knowledge on their own, which is how players usually learn in games. We decided to take challenging topics, which are usually explained by teachers to students, and enhance the lessons with game elements in a way that students can explore the topics and discover the knowledge by themselves.

1.2   Research objectives

The main objective of our research is to investigate the potential of employing badges and gamified activities in Informatics classes. We will explore how these gamification elements can influence the student engagement in the Informatics learning.

Specific details of the main objective are as follows:

- to design, implement and evaluate a badge system for secondary school Informatics classes

- to design, implement and evaluate a peer assessment badge system for university courses

- to design, implement and evaluate several gamified activities for secondary school Informatics classes

1.3   Research question

We stated one central research question:

What are the advantages of implementing gamification into the secondary and higher Informatics education?

This question is divided into the following specific items:

1. How does the gamification in Informatics classes affect student satisfaction with the Informatics classes?

2. How does the gamification in Informatics classes affect student engagement during the Informatics classes?

3. How can gamified activities influence student learning?

4. What kind of feedback is useful to represent by badges?

1.4   Research design

According to the scientific literature known at the moment, the success of gamification process depends on the specific gamified system and on the users (learners) [18]. Since there is no research known to us that explores the research problems we have stated above - the particular uses of gamification which can be applied to our local settings, we have decided to navigate our research this direction and explore it deeper.

Since we aim to produce few systems and activities, which will be used to help us to understand processes behind the central phenomenon - gamification in education, we have decided that the best idea would be to develop it iteratively with respect to the teachers' and students' feedback, possibly in collaboration with them.

We decided to use the design-based research design [29], which is ,,...a systematic but flexible methodology aimed to improve educational practices through iterative analysis, design, development, and implementation, based on collaboration among researchers and practitioners in real-world settings, and leading to contextually-sensitive design principles and theories."

1.5   Research methods for collecting and analysing data

The research design we have chosen uses both qualitative and quantitative methods. It is also iterative and flexible, which means that if new findings emerge, the methods might be adjusted according to the current needs with respect to the research goals.

Considering the possible sample size and the nature of our research, we have been collecting these types of information:

- Student questionnaires – we asked questions about these topics:

    - student satisfaction
    - student engagement

- how much students had learned during the lesson (only for gamified activities)
- students' perception of the system/activity – to help us design the next iteration or to confirm that the current iteration is already good enough
- other – we asked additional questions related to the particular systems/activities

- Interviews with teachers – we mostly used unstructured interviews, since we wanted to cover all topics that could emerge in the conversation

- Observations – we conducted quite a many of these, since we wanted to gain deep understanding of ongoing processes

- Students' results and other data available in the systems we developed - we tried to collect as much data as possible to assess how teachers and students used the proposed systems

1.6   Sample specification

Most of our research took place in two secondary schools in Bratislava, both of them are grammar schools with students aged 15 to 20. We also conducted research in three university courses. We have chosen are samples based on the availability and the willingness of teachers to cooperate on a long-term basis. Our research covers few systems/activities and our sampling is closely tied to those activities.

1.7   Research quality

In evaluating the quality of our research we follow the criteria defined by Creswell [10]:

- **Does the research meet the standards for publication?** We have already published three papers on local conferences (one more is in review process) and three papers on international conferences (one more is already accepted) and we are also planning to publish at least one more paper from the previously unpublished parts of the research.

- **Will the research be useful in our school?** Two out of three university courses in which our research was conducted were parts of applied informatics and teaching informatics study programs at our faculty. Considering the results and the way the teachers perceived our

systems/activities, we believe that they will use it in the future as well. On the top of that, we believe that some of our activities which were examined at secondary schools can be incorporated into the curriculum of future Informatics teachers studying at our department.

- **Will the research advance policy discussions in our region?** The solutions we proposed are on the level which is not currently regulated by laws or policies, they are rather on a teacher's consideration (and we believe that should not change). However, the teachers in our research were mostly very positive about our outputs, which means that they can spread it to other teachers and schools. We plan to publish the lesson plans for free on the Internet in English and in Slovak as well and spread it through the social networks to other teachers. We are also going to offer the lesson plans to local non-governmental organizations active in the educational fields.

- **Will the research add to our scholarly knowledge about a topic or research problem?** Since there is still little knowledge about how to use gamification in education in the context in which we have used it, we believe that our research is filling a part of this gap.

- **Will the research help address some pressing educational problem?** Engagement in secondary school Informatics classes is actual, pressing problem, especially in Slovakia. As we know from the (informal) conversations with students from several secondary schools in our region, big part of them does not feel engaged in and satisfied with Informatics classes. We have proven that the systems/activities we developed are helping in this area.

1.8   Ethical issues

To gather all of the data we have used questionnaires, interviews, observations and we have gathered certain study results of the students. Due to the necessity to pair certain types of data, we have collected either students' names and surnames or their nicknames. The only people with access to the raw data are researchers.

We have reported our findings sensitively in a way that the report is information rich, but no one can track the participants back from it.

We have obtained permissions from the management of the secondary schools to conduct our research there and to visit the schools to observe.

At the beginning of each phase, we communicated to the participants that they are part of the study and after the particular study we answered

all of their questions about it honestly.

We have been working with the teachers closely, they have been helping us to improve our systems/activities. We navigated this cooperation in a way that we provided them with the content and the teacher was the one who decided how the lessons look like in the end, which we documented afterwards. This way none of the teachers have been forced to do anything they do not like or do not believe in and the lessons were smooth and natural for students as well.

2 Gamification

To understand the term gamification correctly, it is essential to define the term ,,game" first. According to Kapp [20]: ,,A game is a system in which players engage in an abstract challenge, defined by rules, interactivity, and feedback, that results in a quantifiable outcome often eliciting an emotional reaction."

There have been few different ways of combining games with education. For the term serious games many definitions exist, they vary depending on different perspectives and interests. One issue most definitions agree upon is that serious games are concerned with the use of games for purposes other than mere entertainment [28]. Another term related to serious games is game-based learning, which is considered to be the same as serious games by certain authors [28].

For the term ,,gamification", more valid definitions can be found. Part of them is focused on game design elements, like the definition from 2011 by Deterding et al. [13] ,,Gamification is the use of game design elements in non-game contexts". Other definitions stress out the outcomes of gamification. As Huotari and Hamari [19] proposed in 2012, it is ,,a process of enhancing a service with affordances for gameful experiences in order to support user's overall value creation." This definition highlights the role of gamification in invoking the same experiences as games do. Kapp [20] defines gamification as ,,... using game-based mechanics, aesthetics and game thinking to engage people, motivate action, promote learning, and solve problems."

On the topic of serious games, Kapp [20] argues that games built on the content to be learned can be seen as a specific sub-set of gamification, because considering the definitions, process of creating a serious game falls under the process of gamification.

3 Gamification in education

A lot of research was done in the field of gamification in education in the past few years. Researchers try to align the use of game elements with existing educational and motivational theories. Kapp [20] points out that ,,a key concept of game play is motivation" and describes how certain theories impact gamification design. He focuses on these theories: *Social learning theory* [5], *Cognitive apprenticeship* [8], *Flow* [11], *Operant conditioning* [17], *ARCS theory of motivation* [21], *Malone's theory of intrinsically motivating instruction* [24], *Lepper's instructional design principles for instrinsic motivation* [23], *The taxonomy of intrinsic motivations for learning* [20], *Self-determination theory* [26], *Distributed practice* [9], *Scaffolding* [17], *Episodic memory* [24].

Bíró [6] proposes the idea to classify gamification as a learning theory. He compares it to four estabilished learning theories – behaviourism, cognitivism, constructivism and connectivism – in terms of the learner; motivation; knowledge; the learning process; what the teaching focuses on; engagement; which is the learning path guided by; the attitude of teacher; the attitude of learner; feedback. However, he claims that the further research is needed on the topic.

The study conducted by de Sousa et al. [12] shows the current state of the gamification in education research. This overview suggests that most studies focus on investigating how gamification can be used to motivate students, improve their skills, and maximize learning. The most studies were conducted in the higher education area, the others used gamification in training and tutorials, teaching and learning languages, elementary education area and lifelong learning. None of the selected studies described gamification approaches whose target audience is preschool or high school.

One of the game elements which we used predominantly in this theses are badges. Digital badges are used in education for a few reasons - they might be used as a motivation, as a recognition of status, clear, evidence-based credentials, a visual evidence of achievement easily communicated and understood by observers and as a guide or a signpost communicating relevant targets to learner [16, 25]. As with the other game elements used in non-gaming contexts, studies prove that the outcome of incorporating badges into education depends on how they are being used [2]. Apart from other factors, it was shown that the results are dependent on the level of learner prior knowledge, on the type of the badge (e.g. participatory badge, skill badge, etc.), on the learner motivation, and on the badge presentation [1, 3].

Till now, very little research was conducted in gamification in education in our geographic area. Most of it are bachelor theses [22, 4, 7, 14].

4 Main results

In this thesis, we proposed several ways of implementing gamification into the Informatics education.

First, we implemented the badges into the secondary school assessment and tested it three times at several schools. Partial findings of this research phase were published in various conferences [Own3, Own7, Own4, Own5]. The results showed that the badges as we defined them were attractive for students and students tended to be more active in lessons if they had a possibility to earn this virtual reward. Students viewed the badges as a sign of appreciation or reward from their teachers, a lot of them considered the badges to be motivational. They either wanted to earn the badges or did not mind them, very little students despised them. In the last run of this part of our research, we developed an online system for assessing with our set of badges. The teacher admired it, because it reduced her work and gave her a possibility to personalize the feedback for students in a quick, easy way.

The second version of badges in education we developed was tested in a university course. It served as a summative peer assessment of a project students were developing throughout the course. Overall, it proved to be successful in terms of student satisfaction. The results were published in two papers [Own1, Own8].

The third and final part of the research on badges was conducted in another university course. Students were given a set of badges to assess their peers in each of four phases of the team project development. We concluded from the results that students were much more active in awarding badges when compared to the past experience with open questions; to a limited extent, students were able to recognize the utility of the badges as a form of formative feedback; and to a slightly higher extent the badges served to the instructors as a form of validation of the primary numeric ratings assigned during the peer assessment. After successful research, we published the results in a paper [Own6].

After the successful use of the badges we decided to test more game elements at once. Thus we iteratively developed five gamified activities, each enhanced with several game elements.

The first activity we developed was the Encrypted map, which teaches the principles of the summed-area table data structure and algorithm. From the three tests of the activity, we concluded that most of the students enjoyed it, were engaged in the lesson and learned something new, even though not everyone was able to name what they had learned.

We named the second activity the Hardware search, because the students were supposed to search the Internet for the names of hardware components.

The three tests proven that the students enjoyed the lesson, they actively participated in it and they perceived to learn knew knowledge throughout the lesson. Moreover, they enjoyed the competition in the pleasant atmosphere and appreciated new informations, part of which they had found by themselves.

The third activity we developed is a gamified simulation of a computer network. Although we ran several tests of the activity itself, only one was the full lesson at secondary school. From this test, we concluded that the students enjoyed the activity, they were working during the lesson and they have learned new knowledge.

The fourth product of this part of our research is the Hidden image – a gamified way of assigning tasks to students. We supervised a bachelor thesis, which was designated to develop a software solution for this concept [15]. The results showed that students enjoyed the activity and engaged in it.

In the last part of our research we developed a mobile game for teaching AVL trees. Our first tests imply that the game can facilitate student learning, however, further research is still needed to explore greater consequences of employing it into the teaching process. A conference paper with our preliminary results is currently in a reviewing process [Own2].

4.1 The answer to the research question

In our research, we intended to answer the following research question:

What are the advantages of implementing gamification into the secondary and higher Informatics education?

In order to answer it in more detail, we defined a set of four sub-questions, which we answer here:

How does the gamification in Informatics classes affect student satisfaction with the Informatics classes?

From the research results, we can clearly conclude that the students enjoyed the gamified activities we proposed. There is also certain evidence that implies that those activities were received in a positive way because of the gamification.

Considering the badges, we were not able to deduce if their use affect student perception of the classes, however, we have proven that the badges were attractive for students and they certainly enjoyed earning them.

How does the gamification in Informatics classes affect student engagement during the Informatics classes?

The research shows that our set of badges used as an additional assessment at secondary schools had impact on student engagement – the students

were more active at the lessons and were willing to work more to earn the badges.

Our badges used in the Romanian university course were generally not designed to encourage increased student engagement in the course. They were used as a summative assessment, thus the students did not have a chance to improve their involvement in the course activities. However, they actively participated in the peer assessment of the projects where the badges were used as part of assessment strategy.

In the other university course, the students perceived the badges as a formative assessment only to certain extent. However, the students engaged in the team assessment activity, even though it was optional. They were much more willing to award badges to the other team members than to write verbal comments (as they were supposed to in previous runs of the course).

The research on the gamified activities showed that the students engaged in the lessons and they were working hard even though the teachers were not pushing them.

How can gamified activities influence student learning?

Our study suggests that the activities we developed and tested facilitated the student learning. In most testings, the students perceived that they learned knew knowledge and we were able to observe students' reactions that confirmed they were learning. The teachers affirmed our observations as well.

What kind of feedback is useful to represent by badges?

We tested three different badge sets in the different scenarios. The best results were obtained at the secondary schools where we used the badges to assess student behavior. The other badges that were assessing the knowledge the students learned were not as successful in the terms of teachers' use. A possible reason is that these badges were assessing the outcomes of the educational process that are being assessed by grades as well.

The second set of badges used as a summative peer review was successful in a way that students were able to obtain their peers' opinion on their work.

The third set of badges, which represented the team work of the students, obtained positive feedback from the students as well, however, the students were missing a way how to assess negative behavior of their team mates. We can see from the badges that the students used it consciously to give feedback to their peers and the behavior the teachers perceived correlated with the obtained badges.

Therefore, we can sum, that it can be useful to use badges to represent both summative and formative feedback to the students' work. However, according to our findings, the formative way of use is better accepted by the students.

From another point of view, results of our research show, that the badges may not only represent a feedback for the students, but they can also help the teachers to reveal the student engagement in and their contribution to the team work activities.

The third perspective of useful feedback represented by the badges is related to what is assessed by the badges. Besides their use to evaluate the acquired knowledge (as an additional evaluation) they may be used to evaluate student behavior during the lessons, particularly those ways of behavior that are desired for developing certain skills in students.

4.2   Limitations of the study

Since our study took place in the particular secondary schools and university courses, we cannot generalize its findings in a way that we would be able to predict the outcomes of the use of the products in different settings.

We are also aware of the fact that even though we obtained positive results in terms of student satisfaction and student engagement, we are not able to identify how much of it was caused by the novelty effect of our activities.

Our research has two parts – in the first part, the badges were developed and used, and in the second part, gamified activities were developed and tested. There are two main differences between these two parts of the research. The first one is that the gamified activities use more than one game element and gamify the specific topic in Informatics education (except for the activity Hidden image). The second difference is that the badges were designed to be used during the half school year or semester (except from the badges used to peer assess the project at the end of the semester) and the activities were to be used at one lesson in the particular student group. These differences make it difficult to summarize the results from the both parts into one whole.

The last limitation is that some of the products we developed still need at least one more iteration of tests to improve them to the greatest extent possible. However, most of the badge sets and activities can be already used in education in their present form.

4.3   Implications for the future research

In the first part of our research, we proved that the badges assessing student behavior in Informatics classes can be beneficial in our educational system in which only knowledge is currently being assessed by grades. We also tested badges in peer review scenario and team review scenario, both tests indicates

that the badges can be beneficial, however, further research in this area is needed to grasp all of the nuances of such use.

We also developed few gamified activities for teaching certain Informatics topics. Some of them were already polished, the others need further improvements and research. In general, more research on gamifying Informatics topics is needed, as there is still only a few of it in the present literature.

Conclusion

Student motivation to learn is still persistent problem at schools in Slovakia. To make the classes more attractive and students more engaged in them, we proposed to enrich the teaching and learning process with gamification.

The first game element we decided to research in educational environment were badges. We used them in three different scenarios. The first badge set we designed and implemented was used at several secondary schools to assess student behavior. The next badge set was developed for summative peer assessment in a university course. The last badge set was used in the team review scenario in another university course.

All three badge sets were attractive for students for particular reasons. The students at secondary schools enjoyed the badges as signs of rewards and appreciation from their teacher and also as a motivational element. The badges in the peer assessment scenario showed students feedback from their peers and the last set of badges helped to simplify the process of team assessment. In general, the badges were successful as a tool for assessment which is both information rich and easy to use.

In the other part of the research, we developed four gamified activities and corresponding lesson plans for secondary schools and one for university courses. The results of the tests showed that students were enjoying these lessons, they were engaged in them and they learned knew knowledge throughout the use of our activities.

In this research, we developed several badge systems and activities for secondary schools and university courses together with the methodologies of their implementation into the classroom teaching. We have learned a lot about gamification and its effects on education and we answered our initial research question. We also implemented three online plug-ins for the badge assessment, one online educational game and we co-authored one mobile game. All online plug-ins for the badge assessment can be used in the future within the systems for which they have been developed and both games are already published for free on the Internet.

We believe that our research results enriched the overall knowledge of

gamification in Informatics education and that the tools we developed on the way will be beneficial for teachers and their students in future.

References

[1] Samuel Abramovich, Christian Schunn, and Ross Mitsuo Higashi. Are badges useful in education?: It depends upon the type of badge and expertise of learner. *Educational Technology Research and Development*, 61(2):217–232, 2013.

[2] Ashton Anderson, Daniel Huttenlocher, Jon Kleinberg, and Jure Leskovec. Steering user behavior with badges. In *Proceedings of the 22nd international conference on World Wide Web*, pages 95–106. ACM, 2013.

[3] Ashton Anderson, Daniel Huttenlocher, Jon Kleinberg, and Jure Leskovec. Engaging with massive online courses. In *Proceedings of the 23rd international conference on World wide web*, pages 687–698. ACM, 2014.

[4] Zita Bajúszová. Metody pro výuku programování na základních školách. Univerzita Tomáše Bati ve Zlíně, 2015.

[5] Albert Bandura and Richard H Walters. *Social learning theory*, volume 1. Prentice-hall Englewood Cliffs, NJ, 1977.

[6] Gábor István Bíró. Didactics 2.0: A pedagogical analysis of gamification theory from a comparative perspective with a special view to the components of learning. *Procedia-Social and Behavioral Sciences*, 141:148–151, 2014.

[7] Gabriel Branderský. Webový nástroj pro tvorbu a správu činností a cílů projektů. Vysoké učení technické v Brně. Fakulta informačních technologií, 2014.

[8] John Seely Brown, Allan Collins, and Paul Duguid. Situated cognition and the culture of learning. *Educational researcher*, 18(1):32–42, 1989.

[9] Ruth C Clark and Richard E Mayer. *E-learning and the science of instruction: Proven guidelines for consumers and designers of multimedia learning*. John Wiley & Sons, 2016.

[10] John W Creswell. Educational research: Planning, conducting, and evaluating quantitative. *New Jersey: Upper Saddle River*, 2002.

[11] Mihaly Csikszentmihalyi. Play and intrinsic rewards. *Journal of humanistic psychology*, 1975.

[12] Simone de Sousa Borges, Vinicius HS Durelli, Helena Macedo Reis, and Seiji Isotani. A systematic mapping on gamification applied to education. In *Proceedings of the 29th Annual ACM Symposium on Applied Computing*, pages 216–222. ACM, 2014.

[13] Sebastian Deterding, Dan Dixon, Rilla Khaled, and Lennart Nacke. From game design elements to gamefulness: defining gamification. In *Proceedings of the 15th international academic MindTrek conference: Envisioning future media environments*, pages 9–15. ACM, 2011.

[14] Richard Filipčík. Vyhodnocovanie aktivity a motivácia vo webovom výučbovom systéme. Fakulta informatiky a informačných technológií, STU, 2014.

[15] Patrik Furmánek. Moodle doplnok s prvkami gamifikácie. Comenius University in Bratislava, 2018. to appear.

[16] David Gibson, Nathaniel Ostashewski, Kim Flintoff, Sheryl Grant, and Erin Knight. Digital badges in education. *Education and Information Technologies*, 20(2):403–410, 2015.

[17] Margaret E Gredler. *Learning and instruction: Theory into practice.* Macmillan New York, 1992.

[18] Juho Hamari, Jonna Koivisto, and Harri Sarsa. Does gamification work?–a literature review of empirical studies on gamification. In *System Sciences (HICSS), 2014 47th Hawaii International Conference on*, pages 3025–3034. IEEE, 2014.

[19] Kai Huotari and Juho Hamari. Defining gamification: a service marketing perspective. In *Proceeding of the 16th International Academic MindTrek Conference*, pages 17–22. ACM, 2012.

[20] Karl M Kapp. *The gamification of learning and instruction: game-based methods and strategies for training and education.* John Wiley & Sons, 2012.

[21] John M Keller. Development and use of the arcs model of instructional design. *Journal of instructional development*, 10(3):2, 1987.

[22] Ján Kováč. Vývoj virtuálnej edukačnej hry o solárnych článkoch. Slovenská technická univerzita, 2018.

[23] Mark R Lepper. Motivational considerations in the study of instruction. *Cognition and instruction*, 5(4):289–309, 1988.

[24] Thomas W Malone. Toward a theory of intrinsically motivating instruction. *Cognitive science*, 5(4):333–369, 1981.

[25] Răzvan Rughiniş and Stefania Matei. Digital badges: Signposts and claims of achievement. In *International Conference on Human-Computer Interaction*, pages 84–88. Springer, 2013.

[26] Richard M Ryan and Edward L Deci. Intrinsic and extrinsic motivations: Classic definitions and new directions. *Contemporary educational psychology*, 25(1):54–67, 2000.

[27] Ricarda Steinmayr and Birgit Spinath. The importance of motivation as a predictor of school achievement. *Learning and Individual Differences*, 19(1):80–90, 2009.

[28] Tarja Susi, Mikael Johannesson, and Per Backlund. Serious games: An overview. Institutionen för kommunikation och information, 2007.

[29] Feng Wang and Michael J Hannafin. Design-based research and technology-enhanced learning environments. *Educational technology research and development*, 53(4):5–23, 2005.

Author's publications

[Own1] Sabin Simionescu, Dana Šuníková, and Zuzana Kubincová. Gamification of peer assessment in learning management system. In *Carpathian Control Conference (ICCC), 2017 18th International*, pages 571–575. IEEE, 2017.

[Own2] Dana Šuníková, Miroslav Byrtus, and Zuzana Kubincová. Mobilná hra na výučbu AVL stromov. to appear.

[Own3] Dana Šuníková and Zuzana Kubincová. Čo sú Open Badges a ako ich použiť? *DidInfo 2015, Banská Bystrica: Univerzita Mateja Bela*, pages 181–186, 2015.

[Own4] Dana Šuníková and Zuzana Kubincová. Odznaky ako forma hodnotenia na strednej škole. *DidInfo 2016, Banská Bystrica: Univerzita Mateja Bela*, pages 124–129, 2016.

[Own5] Dana Šuníková and Zuzana Kubincová. Badges as a complementary assessment at secondary schools. In *EDULEARN17 : 9th International Conference on Education and New Learning Technologies*, pages 411–420. IATED Academy, 2017.

[Own6] Dana Šuníková, Zuzana Kubincová, and Martin Homola. A badge for reducing open answers in peer assessment. to appear.

[Own7] Dana Šuníková, Zuzana Kubincová, and Miroslav Navrátil. How to use open badges? *Information and Communication Technology in Education 2015, Ostrava: University of Ostrava*, pages 222–230, 2015.

[Own8] Dana Šuníková, Zuzana Kubincová, Sabin Simionescu, and Elvira Popescu. Peer assessment augmented with digital badges: A first experience report. In *Information Technology Based Higher Education and Training (ITHET), 2017 16th International Conference on*, pages 1–5. IEEE, 2017.

Summary

To make the Informatics classes at secondary schools and university courses in Informatics more attractive and engaging, the use of gamification is proposed. Three different badge systems and five gamified activities were designed, developed and examined in this study.

The first badge system was used at secondary schools to assess student behavior, the other two badge systems were used in the peer assessment and team assessment scenarios in university courses. Results showed that the badges were attractive for students and they were successful as a tool for assessment which is both information rich and easy to use.

Five gamified activities and corresponding lesson plans for secondary schools and a university course were designed, developed and examined. The results showed that students were enjoying these lessons, they were engaged in them and they learned knew knowledge throughout the use of the proposed activities.

Keywords: gamification, gamification in education, digital badges, peer assessment, secondary education, higher education, Informatics education