

## CODE SCHOOL: A GAMIFIED LEARNING PORTAL FOR COMPUTER PROGRAMMING EDUCATION

KIRÁLY, Sándor – BALLA, Tamás, HU

**Abstract:** Today the IT industry provides an attractive career choice to novice software developers, but even then, majority of the students pursuing higher education in computer programming field are not going forward with enough competencies and capabilities to meet the industry expectations. It has been observed that such students are not sufficiently focused on computer programming during their school studies. The main reason for disinterest in computer programming is identified as the lack of motivation and engagement of students in learning the programming concepts. [kodolosuli.hu](http://kodolosuli.hu) is a learning portal that offers interactive programming courses and coding challenges in three different programming languages: C++, C# and Java. It has been developed for youngsters who are interested in computer programming but do not know where to start. The gamification in this portal is expected to increase students' engagement and motivation in learning. This paper aims to show how the gamification can be implemented in a curriculum of computer programming of an interactive portal.

**Key words:** gamification, interactive, computer programming, game-based learning, student engagement

### 1 Introduction

Today in Hungary, there are more than 20,000 unfilled IT jobs and most of them are software development, meanwhile, the IT sector could even be a key sector in Hungary since its value-added ratio is 90% and it produces 12% of the Hungarian GDP. That is why it would be particularly important that high school students choose this profession in larger numbers and, moreover, the demand for high-skill software developers is now growing faster than supply.

To achieve this, IT must be made more attractive for students, and it is very important that the high school students who are interested in this area learn to program. In our experience, students who have already learnt computer programming can work in the IT sector in their first academic years even as software developers, gain work experience and acquire professional status faster than those students who only start to learn programming in the first academic years.

Most Hungarian secondary schools prepare students for only the mid-level exam of informatics that does not include a knowledge of programming. The reduced 1 lesson per week is not enough to teach students both the usage of office programs and computer programming although there are thousands of talented students who are interested in programming but not able to learn it by themselves. Though, books and notes in Hungarian and courses in English are available it seems insufficient for most of them. Portals such as CodeAcademy, CodeSchool or Code Avengers that teach different programming languages in interactive way in English might be useful. In Hungary, this type of portal is not available, for example learning C# or C++ languages for secondary school students in Hungarian languages for free is impossible. For instance, [memmoc.hu](http://memmoc.hu) portal of University of Miskolc only offers Java and C languages. [1]

**kodolosuli.hu** portal wishes to solve this problem. In this website, students can learn how to code basic algorithms in a chosen language that can be C#, C++ or Java for free.

The main objective of this site is to teach students the basic programming structures that are necessary to be able to pass the advanced level exam of informatics. After completing the course of the website they will be able to use an IDE and solve programming tasks. The programming knowledge gained from this portal can be enough for students to understand programming resources on the internet and they can achieve more in this field.

Gamification applications provide motivation and make the understanding easier and faster. [2] The practical problems are mostly related to the field of making computer game programs.

## 2 Student activity, active learning and activity in this portal

In an online environment students' achievement can be influenced by several factors that stem from their features. These factors can be for example their ability to maintain their attention or their intrinsic motivation. One of the most important factors that must be considered in term of their activity is students' engagement: this can be defined as the student's cognitive process, active participation and emotional involvement in the learning process.[3] In an online environment it is also important to increase the student's cognitive involvement.[4]

According to various e-learning objectives e-learning environments can be differentiated.[5] In kodolosuli.hu directive e-learning is preferred since the material of this site is supposed to be new for the participants.

After login, students need to choose a language they wish to learn. The material to be learned can be found on the left side of the screen. The exercise belonging to the current topic is on the right side. (Figure 1)

The screenshot shows the main user interface of the Kódolósuli portal. At the top, there is a blue header with the site name 'Kódolósuli' and the author 'Sándor Király (Kijelentkezés)'. Below the header is a navigation menu with links: 'Tananyag kezelése', 'Tananyagok feldolgozása', 'Felhasználók kezelése', 'Tesztek készítése', 'Fórum', and 'Tesztek'. The main content area is split into two columns. The left column is titled 'Struktúrák - I' and contains a lesson titled 'A rekord'. The lesson text explains how to use a struct in C# to store data, with a sample code block:

```

struct esemeny
{
    int kezdet, veg, sorszam;
}

```

Below the code, there is a text input field for a list:

```

List<int> a=new List<int>();

```

The right column contains an exercise titled 'Deklarálj egy kemence nevű struktúrát két mezővel: az egyik mező berak, a másik kivesz, mindkettő integer! A kód 5 soros legyen, a kapcsos zárójelek külön sorban legyenek!'. Below the exercise is a code editor with line numbers 1 through 21. At the bottom right of the code editor are two green buttons: 'Elküld' and 'Segítség'.

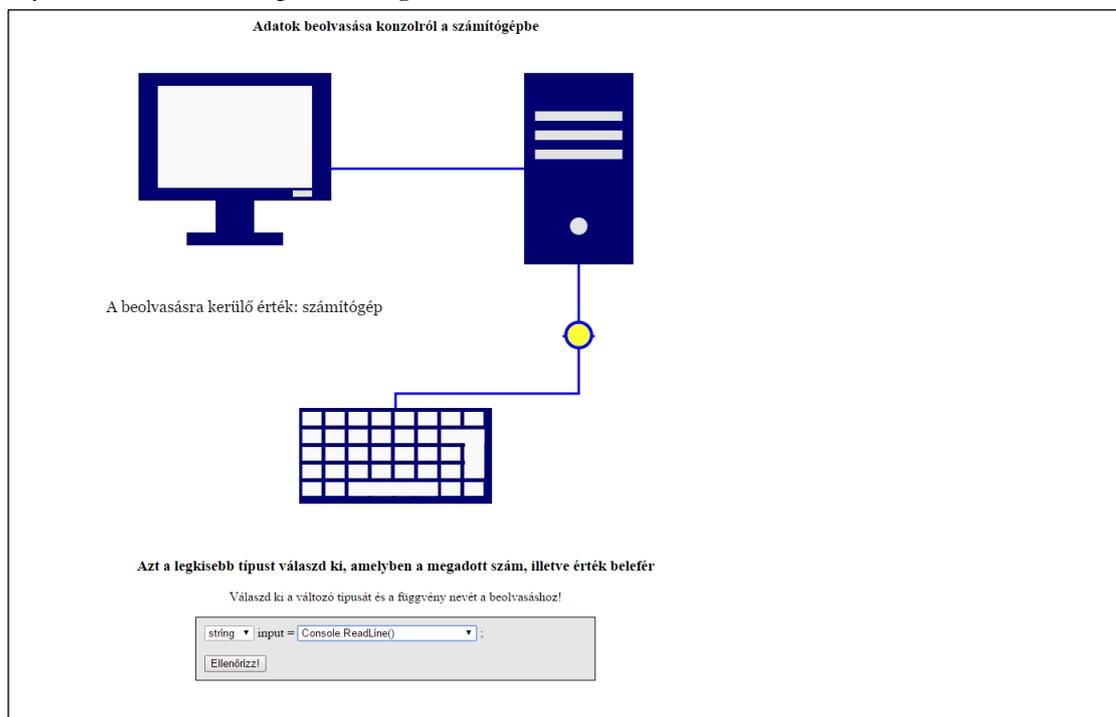
**Figure 1:** The main user interface of the portal. The curriculum is on the left side, the exercise and the code panel are on the right side.

Students are asked to write the proper code in the panel on the right side. After the coding is completed, clicking on the Send button uploads the solution. If it is correct the next unit will be displayed. If the code is not correct a message including the number of line that contains the error will be displayed. By clicking on Help button, the program makes instructions available for the student to be able to correct the mistake. If the student fails an exercise he can move on to another unit and later he can try it again. Typically, there is more than one exercise for each topic. Students' attempts are stored in a database so teachers can even help them in the solution.

### 3 Gamification in this portal

Students sometimes find it hard to learn a programming language. They often confront unfamiliar programming terms and are required to visualize the processes that happen in computer memory. Others find this a burden and end up memorizing the processes without understanding them. This situation invariably leads students to get low grades in their programming subjects and abandon learning programming. Studies have shown that applying gamification elements in websites engage users. Games are engaging because they have the potential to satisfy basic psychological needs for competence, and autonomy [6][7]

19 games have been developed for this site which also offers a guided discovery environment and requires high interactivity due to the developed games and the linked URL-s where students can find other information useful to solve the current problem. For example, in a game (see Figure 2) students need to direct the yellow ball into the computer by finding the proper type and input statement to the given input type. Before starting this game, an URL is available for them where they can find all the conversion functions that may be needed to complete this game.



**Figure 2:** Direct the ball into the computer finding the correct reading statement

Games in this site not only motivating but also filled with education content. The experience gained from the current game is not enough, this experience must be

transformed to educational experience.[8] After games the site offers real coding task relating to the game.

In an e-learning environment the applicability of the materials to real life must be considered. It can be increased if the practical exercises are applicable to real life for students to feel the usefulness of the portal.[9] Practical exercises, such as writing a code that can control the descent of a spacecraft onto a planet; finding the closest defibrillator to save a life; how to move an object from a given X,Y coordinate to another position as fast as possible or controlling the parking sensor of a car increase the efficiency of the e-learning environment.

Games accompany the entire learning process. Students who complete each unit and task of the curriculum can download a game program for both Android and Windows platforms and they are notified about this after completing the different sections of the curriculum.

Traditional games such as Hangman, Board games and Memory cards have also been implemented. These games not only amuse students but deepen their skills. [10].

**Írasd ki a "Hello vilag!"-ot 3 alkalommal!**

```

public class gyakorlas {
    public static void main(String[] args) {
        short a = 3 ;
        hellotIr(a);
        System.out.println("Program lefutott");
    }

    public static void hellotIr( short db) {
        for(int i = 0; i < db; i++)
            System.out.println("Hello vilag!");
    }
}

```

```

Hello vilag!
Hello vilag!

```

Újra! Start

**Figure 3:** Writing a parametrised procedure

Our games possess the following features:

- They give the students a purpose of being involved in the system and interacting [12]
- They include challenging tasks that are scaffolded and customised to a participant's skill level as to not be too easy or too difficult to achieve;
- They provide include clear instruction to provide rules, guidelines and scope to the system;
- They provide rapid feedback to maintain constant communication with participants about their status and behaviours (see Figure 3)

- They include curiosity and novelty that provide intrinsic motivation to explore and push the boundaries of the system.
- They do not offer points, badges but show different screenshots of the game can be downloaded after the course is completed.

These items can be considered key attributes of engagement in a gamified learning environment.[11]

## Conclusion

The aim of this study is to demonstrate a novel website, kodolosuli.hu, that is an online interactive platform that offers free coding classes in 3 different programming languages including C#, Java and C++.

This website offers gamified curriculum. Gamification refers to the use of game elements in a non-game context to increase engagement between humans and computers. The implemented game programs not only increase the effectiveness of learning and but enhance students' understanding. As the more complicated exercises are related to the implementation of different game programs they also increase the engagement of students in learning programming. The successful students who complete the course of a given computer language are allowed to download a game program for both Android and Windows platforms that is not available anywhere else.

## Bibliography

- [1] KUSPER G., PERCZE G., KOVÁCS L., NEHÉZ K., RADVÁNYI T., KIRÁLY S., *A MeMOOC online informatikai egyetem koncepciója, The concept of the MeMOOC Online IT University*, Networkshop 2016 (CD). Budapest: Nemzeti Információs Infrastruktúra Fejlesztési Intézet (NIIFI), 2016. p. CD. (ISBN:978-963-88335-6-3)
- [2] M. SAILER, J. HENSE, H. MANDL and M. KLEVERS, *Psychological Perspectives on Motivation through Gamification*, Interaction Design and Architecture(s) Journal - IxD&A, N.19,, 2013, pp. 28-37.
- [3] PELLAS, N., *The influence of computer self-efficacy, metacognitive self-regulation and self-esteem on student engagement in online learning programs*. Evidence from the virtual world of Second Life Computers in Human Behaviour, 35, 157-170, 2014.
- [4] WOLF, M., Learning to Think in a Digital World. In: Bauerlein, M. (ed.) (2011): *The digital divide: arguments for and against Facebook, Google, texting, and the ages of social network*. Jeremy P. Tarcher/Penguin, New York. 34-37., 2007.
- [5] CLARK, R.C., MAYER, R.E., *E-learning and the science of instruction*. Pfeiffer, San Francisco, 2011.
- [6] P. FOTARIS, T. MASTORAS, R. LEINFELLNER, Y. ROSUNALLY, *Who want to be Pythonista? Using Gamification to Teach Computer Programming* (2015), 7th International Conference on Education and New Learning Technologies, Pages: 2611-2619.
- [7] C. LI, Z. DONG, R. H. UNTCH, and M. CHASTEEN, *Engaging Computer Science Students through Gamification in an Online Social Network Based Collaborative Learning Environment*, International Journal of Information and Education Technology, Vol. 3, No. 1, February 2013
- [8] GARRIS, R., AHLERS, R., Driskell, J.E, *Games, motivation and learning*, A research and practice model, Simulation and Gaming, 33(4), 441-467.

- [9] JOO, Y.J., JOUNG, S. KIM, E.K.: *Structural Relationships among E-learners' sense of Presence, Usage, Flow, Satisfaction, and Persistence*. Educational Technology and Society, 16(2), 310-324., 2013.
- [10] B. KUMAR, *Gamification in education - learn computer programming with fun*, International Journal of Computers and Distributed Systems, Vol. No.2, Issue 1, December 2012, pp. 46-53.
- [11] P. de BYL, J. HOOPER, *Key Attributes of Engagement in a Gamified Learning Environment*, In H. Carter, M. Gosper and J. Hedberg (Eds.), Electric Dreams. Proceedings ASCILITE 2013 Sydney. (pp.221-230)
- [12] F. L. KHALEEL, N. SAHARI, T. S. MERIAM, A. Ismail, *The study of gamification application architecture for programming language course*, ACM IMCOM 2015 - Proceedings. Association for Computing Machinery, Inc, 2015. a17.

**Lectured by:** HORNYÁK, Olivér, Dr. Ph.D.

**Contact address:**

Sándor Király, Dr. Ph.D.,

Institute of Mathematics and Informatics, Eszterházy Károly University of Applied Sciences, H-3300 Eger, Eszterházy tér 1, Hungary,  
phone: +36-36-520-400 / 4224, e-mail: ksanyi@aries.ektf.hu

Tamás Balla,

Institute of Mathematics and Informatics, Eszterházy Károly University of Applied Sciences, H-3300 Eger, Eszterházy tér 1, Hungary,  
phone: +36-36-520-400 / 4137, e-mail: balla.tamas@ektf.hu