Preparing primary junior grade teachers to teach computational thinking: experiences from the GLAT project

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Abstract

This paper presents results of a study conducted within the Erasmus+ project GLAT which promotes the integration of activities for developing computational thinking and programming skills into daily teaching in primary school. The aim of the study is to identify to what extent are primary school junior grade teachers from Croatia prepared for developing these skills among their classroom students. Results have shown that there is a need for teacher training programmes on applying methods, activities and ICT tools for developing computational thinking in everyday teaching practice.

Keywords: computational thinking, digital games, GLAT project, ICT in education, primary junior grade teachers

Please cite this article as: Hoić-Božić, Nataša; Lončarić, Darko; Holenko Dlab, Martina. Preparing Primary Junior Grade Teachers to Teach Computational Teaching: Experiences from the GLAT Project // Mathematics and Informatics, 62 (2019), 5; 487-499

https://mathinfo.azbuki.bg/en/matematics/matharticles2016-4/preparing-primary-junior-grade-teachers-to-teach-computational-teaching-experiences-from-the-glat-project/

1. Introduction

In primary schools across Europe learning outcomes associated with Information and communication technologies (ICT) and the development of key digital competences are still not sufficiently represented as part of school curricula[1], although ICT today represents one of the most important areas of the economy and the development of society in general (Balanskat & Engelhardt, 2014; Slavova & Garov, 2019).

Besides ICT, the other important area is STEM (an acronym for Science, Technology, Engineering, and Mathematics). For both areas, it is important that the students not only learn the basic of programming but to develop algorithmic and computational thinking skills (Milková & Hulkova, 2013). Algorithmic thinking primarily develops the skill to solve various problems that reflect real issues and in which the application of knowledge from other areas, especially science, mathematics and logical disciplines is necessary (Grover & Pea, 2013; Shute, Sun, & Asbell-Clarke, 2017).

The school courses related to the programming or coding should be part of the school curricula, but it is also important to integrate algorithmic and computational thinking through different school courses starting already with the youngest age students (Angeli et al., 2016). To obtain such goal, it is important that besides the teachers of informatics/computer science, primary junior grade teachers be able to develop computational thinking skills among their students (Adler & Kim, 2018). However, in Croatia as well as in many other European countries this is not always accomplished during their formal education.

One of the projects about tutoring primary junior grade teachers to teach computational thinking is Erasmus+ GLAT project (Hoić-Božić, Holenko Dlab, Načinović Prskalo, Rugelj, & Nančovska Šerbec, 2018). The focus of this paper is to introduce the project and present the results of the research which deals with identifying to what extent are primary school junior grade teachers from Croatia familiar with the possibilities of using ICT in teaching and developing computational thinking and programming skills among their students.

2. Educating the teachers in the context of the GLAT project

Erasmus+ project *Games for Learning Algorithmic Thinking* – GLAT[2] deals with enhancing primary junior grade teachers' algorithmic skills as well as more general computational thinking skills and competences and to apply them with their students.

The project provides support to students and teachers for the adoption of relevant and high-quality digital skills and competencies, especially those relating to the field of digital content creation - coding, to foster employability, socio-educational and professional development.

Among primary junior grade teachers, a blended learning training programme, which promotes innovative methods and pedagogical approaches to the introduction of the teaching concepts related to coding and those that encourage the development of computational and algorithmic thinking of younger students, has been implemented. The training also provides support for the efficient use of ICT in education.

Syllabus and learning materials for blended learning model (Hoic-Bozic, Holenko Dlab, & Mornar, 2016) of education are developed as an e-course in learning management system Moodle at the beginning of the project, but one of the main projects results will be the improved version of the training programme upon completion of the project.

Within this e-course, teachers access all learning materials, submit created learning scenarios, and share their impressions regarding the implementation of learning scenarios in the classroom with other participants.

The activities for the teachers during the training were organized in three modules (Fig. 1) with the following topics:

1. Game Based Learning and unplugged activities
2. Problem Based Learning, online quizzes and logical tasks
3. Inquiry based learning, games and tools for programming

In each module during two-day face-to-face (f2f) workshops teachers were introduced to theoretical topics as well as examples of learning scenarios, games, and tools. At the end of each workshop, teachers participated in the survey that was conducted to determine the level of their satisfaction with the presented topics and applied teaching and learning methods.

In the activities that followed the workshops, teachers were applying newly acquired knowledge during the development of learning scenarios. The learning scenarios consist of learning outcomes and activities for their realization by using contemporary teaching and learning methods and digital tools. They also implemented their scenarios in classrooms with their students (Mezak & Pejić Papak, 2018).

At the end of the last module, a final survey matched with the initial survey will be conducted in order to compare the results.

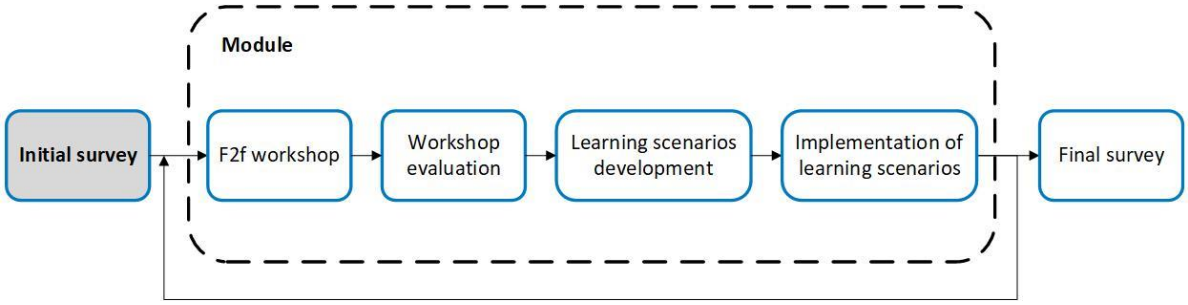

Figure 1 – The model of activities for participants during GLAT training

In addition to learning materials with the examples of best practices, during the GLAT project activities for the dissemination and popularization of the results have been carried out. It is expected that the teachers will promote the acquired skills and competencies among their students through teaching in primary schools and as a result students' digital competencies will also develop. The final goal of GLAT is to improve younger students' attitudes towards coding and the development of algorithmic thinking which will in the long term contribute to increasing students' interest in the selection of future career in the ICT and STEM areas.

3. The research methodology

3.1. Purpose of the research

The main aim of the research presented in this paper is to identify to what extent are primary school junior grade teachers from Croatia familiar with the terminology relevant to the use of ICT in teaching

and the possibilities of using ICT, especially games, to develop algorithmic thinking and programming skills.

The specific research questions in the context of the GLAT project are:

1. to what extent are teachers familiar with the terminology or the concepts related to using ICT in education that are relevant for the project,
2. to what extent are teachers familiar with the possibilities of adapting, creating and using specific content, methods, and tools important for the project outcomes,
3. how often teachers use teaching activities, methods and strategies that are not specifically related to the project,
4. do teachers have any experience with the use of programming languages and games for developing algorithmic thinking and learning programming skills.

The research results will help the experts from the GLAT project team to further improve the developed training programme in order to meet the prerequisite knowledge as well as the expectations of primary junior grade teachers in the best possible way.

3.2. Participants

Participants were 24 primary school junior grade teachers from Rijeka region (Croatia) gathered in the focus group at the beginning of the project (N=24, 1 male, 23 females). The mean age of participants was 43,167 years (SD=7,585) and mean work experience at school 18,458 years (SD=7,962).

Teachers were selected in cooperation with the Croatian Education and Teacher Training Agency (AZOO), and directly in contact with primary schools with which project partner Faculty of Teachers Education (UF) from University of Rijeka has established long-term cooperation in holding various workshops as a part of the professional development of the primary school junior grade teachers. Teachers attend these forms of professional development meetings and workshops in order to be able to advance in the profession.

The invitations to participate in the GLAT project was prepared and sent at the beginning of the project by UF and directly distributed to schools with the help of AZOO. Participation in the project has been voluntary and the teachers themselves applied. They were all highly motivated to enroll in workshops on the development of algorithmic thinking and coding skills of their students. They teach students from first to fourth grade (6^{th} to 11^{th} years old) and the number of students in their classrooms is between 15 and 20.

3.3. Data collection

To answer the research questions, an initial survey was conducted at the beginning of the training organized for the focus group of teachers within the GLAT project. For the initial survey, a questionnaire has been developed and used as an evaluation instrument. The questionnaire consists of four parts (corresponding to research questions): 1) familiarity with the terminology, 2) familiarity with the possibilities of adapting, creating and using methods, contents and tools, 3) using non-specific forms, methods and teaching strategies, and 4) experience with programming languages and games for developing algorithmic thinking and learning programming skills.

The part regarding the *familiarity with the terminology or the concepts related to using ICT in education* consists of 10 statements with 5-point Likert scale response format with values ranging from 0 (not at all familiar) to 4 (very familiar). It was used in order to examine the extent to which participants are familiar

with the terms like “algorithmic thinking,” “digital serious games”, “learning scenario”, etc. Most of the terms are listed in Croatian and English version.

The part examining the extent to which participants are familiar with *the possibilities of adapting, creating and using teaching content and methods* contains 6 statements with the same response format as in the previous part (for example "possibilities to create digital teaching materials with Web 2.0 tools"). Most of the terms are also listed in Croatian and English version.

The third part consists of 17 statements with a 5-point Likert scale response format with values ranging from 0 (never) to 4 (always). These statements are used to examine how often participants use teaching activities, methods and strategies that are not specifically related to the GLAT project, such as frontal or group work, collaborative learning strategies, etc. in their practice with students.

At the end of the questionnaire, participants provided information on their previous education and experience in using programming languages and games for developing algorithmic thinking and learning computer programming skills.

The same questionnaire will be used after the 3rd workshop. Therefore, it was composed so that changes and participants’ progress after attending the GLAT training can be determined using quantitative and qualitative analysis of their responses.

3.4. Results

The analysis showed that all workshop participants answered all questions except for the 3rd, 4th, and 6th question in the first part of the questionnaire (*Familiarity with the terminology*) which were not answered by one respondent. Therefore, the total number of collected results for each question is 24, except for these three questions for which the number of collected results is 23.

Table 1 shows the results regarding *Familiarity with the terminology*. The obtained results indicate that the most familiar terms to participants are “digital competence/skills” and “Problem Based Learning” while they are not familiar with the terms “Web 2.0 tools”, “learning scenario” and “basic programming concepts”.

Table 1: Familiarity with the terminology

	To what extent are you familiar with the term:	**N**	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**
1.	digital competencies/skills	24	1	3	2,00	,780
2.	Problem Based Learning	24	0	4	1,83	1,049
3.	Game-Based Learning	23	0	3	1,78	1,043
4.	Digital Serious Games	24	0	4	1,71	,955
5.	Inquiry Based Learning	24	0	3	1,50	1,063
6.	unplugged activities	24	0	3	1,42	,881
7.	algorithmic thinking	24	0	2	1,29	,751
8.	Web 2.0 tools	23	0	4	1,13	1,014
9.	learning scenario	23	0	3	1,00	,953
10.	basic programming concepts	24	0	3	,92	1,060

Table 2 shows the results regarding *Familiarity with the possibilities of adapting, creating and using teaching contents and methods* which indicate that digital content creation is the most familiar for the workshop participants while they are not familiar with the computer programming and possibilities of visual programming tools.

Table 2: Familiarity with the possibilities of adapting, creating and using teaching contents and methods

	To what extent are you familiar with the following:	N	Minimum	Maximum	Mean	Std. Deviation
1.	digital content creation	24	0	3	1,63	1,013
2.	gamification	24	0	3	1,42	,830
3.	creation of online quizzes and logical tasks (Kahoot, Puzzlemaker, Word Search Labs…)	24	0	3	1,38	,970
4.	digital content creation using Web 2.0 tools (Glogster, Popplet, Canva, GeoGebra,…)	24	0	2	,79	,833
5.	computer programming and programming languages	24	0	2	,58	,717
6.	tools for visual programming (Scratch, Scotty go, Sphero SPRK+,…)	24	0	2	,58	,776

Table 3 shows results regarding how often participants use teaching activities, methods and strategies that are not specifically related to the GLAT project. The obtained results indicate that games and individual work are the most often used while the debate is rarely used.

Table 3: Forms, methods and teaching strategies

	How frequently do you in your teaching practice with students use the forms, methods, and teaching strategies listed below:	N	Minimum	Maximum	Mean	Std. Deviation
1.	game	24	3	4	3,33	,482
2.	individual work	24	2	4	3,17	,482
3.	demonstration	24	2	4	3,00	,511
4.	frontal teaching	24	2	4	3,00	,417
5.	work in pairs	24	2	4	3,00	,417
6.	practical tasks	24	2	4	2,83	,565
7.	students self-assessment	24	2	4	2,79	,721
8.	presentation of students' work	24	2	3	2,79	,415
9.	group work	24	2	3	2,75	,442
10.	discussion	24	1	4	2,67	,702
11.	creative thinking techniques	24	1	4	2,54	,721
12.	peer-to-peer learning	24	2	4	2,54	,588
13.	collaborative learning strategies	24	2	4	2,54	,588
14.	research tasks (research problems)	24	1	4	2,38	,647
15.	project-based tasks	24	1	3	2,25	,737
16.	role-playing	24	1	3	2,17	,702
17.	debate	24	0	3	1,83	,702

Fig. 2 shows results regarding previous education about computer programming. 37.5% of the participants had courses that include learning at least the theory of computer programming during their education. Most of them stated that this was within a school subject or university course "Informatics".

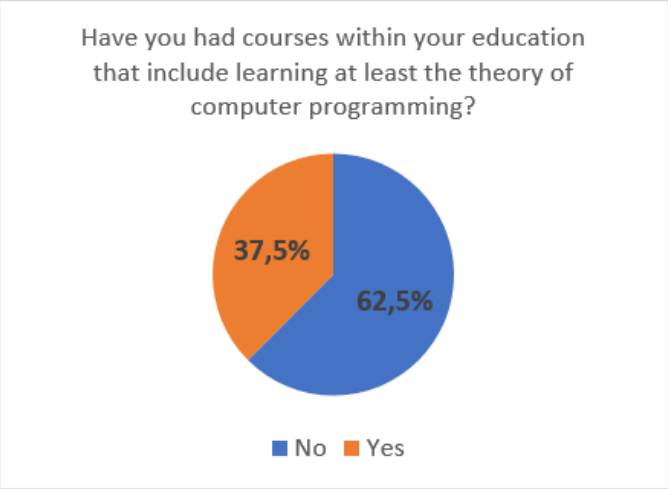

Figure 2 – Previous education about computer programming

Fig. 3 shows results regarding experience in using programming languages. According to the results, only 2 workshop participants (8.3%) used programming languages to create at least a simple program. In response to the open-ended question, one participant indicated using the programming language Basic.

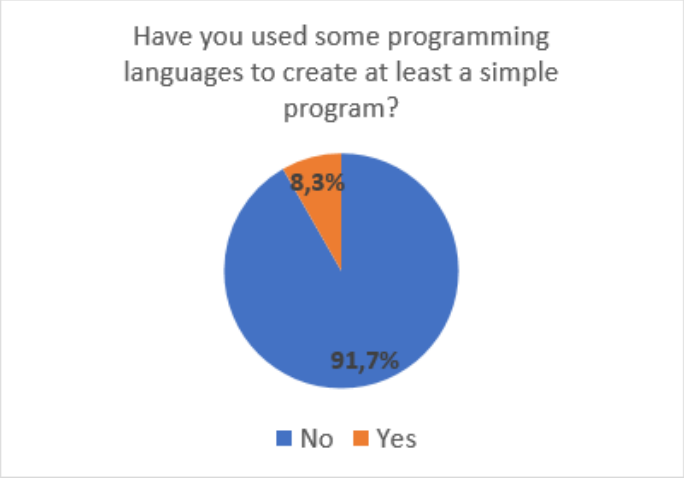

Figure 3 - Experience in using programming languages

The results regarding experience in using games to develop algorithmic thinking (Fig. 4) show that only one workshop participant (4.2%) used games for that purpose. In an open-ended question, the participant clarified the response: "I didn’t use games, but I used math tasks (problems) that stimulate algorithmic thinking."

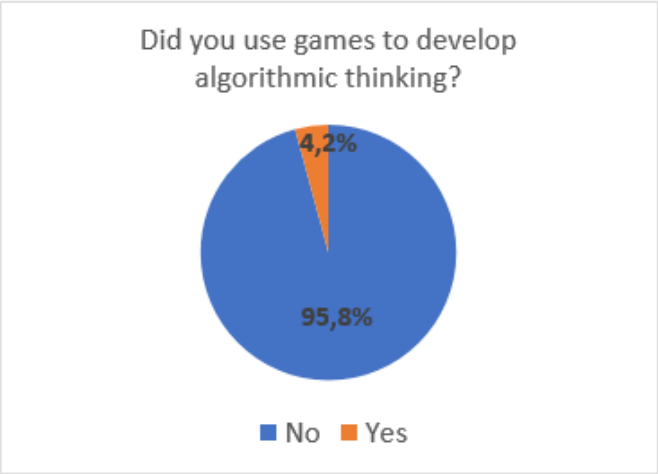

Figure 4 - Experience in using games for developing algorithmic thinking

Workshop participants have not used games for teaching computer programming.

4. Teachers' satisfaction with the workshops

Besides before mentioned initial survey, an evaluation was conducted after each workshop to establish how teachers were satisfied with the workshop content. An anonymous survey consisted of Likert type 5-level response statements with values ranging from 1 (extremely poor) to 5 (exquisitely). The second part of this survey contained open ended questions. Participants were asked to mention the topics for which they considered to be the most helpful in their job in schools, and to give some suggestions and proposals for the improvement of the workshops. As shown in Fig. 5 participants highly evaluated: the contemporary (up-to-date) content, importance of a workshop for personal and professional development, communication and collaboration within a group, preparedness of lecturers, an opportunity to express their own opinions. The general evaluation of the workshops was also very positive. The teachers' comments in the second part of the survey confirmed the satisfaction of teachers. As the most significant elements for their job in schools, teachers emphasized modern topics, the applicability of presented topics in school practice, very good organization and preparation of lecturers, great communication and collaboration with lecturers and colleagues.

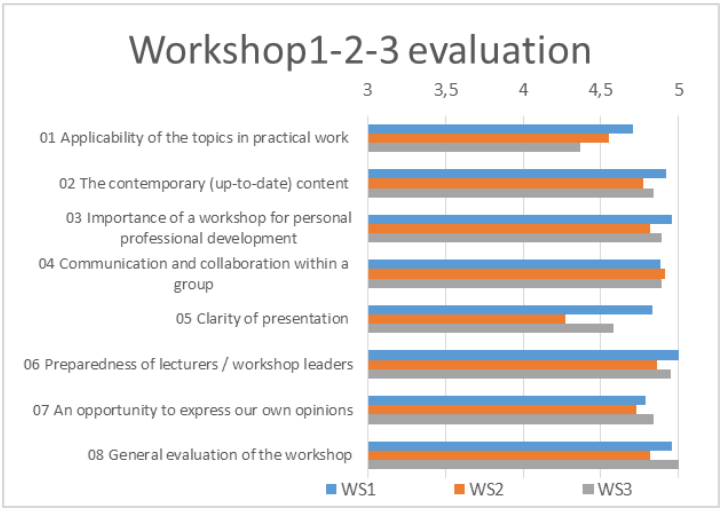

Figure 5 - Evaluation items for three GLAT workshops

5. Findings

To sum up the results associated to the research questions, we can conclude that the teachers are not familiar with the most important concepts for the GLAT project education such as algorithmic thinking, learning scenario and basic programming concepts. Also, they do not use some Web 2.0 tools for content creation and do not know about the possibilities of visual programming tools. On the other hand, the results regarding how often they use teaching activities, methods and strategies indicate that games are the most often used. This is in line with the GLAT training programme because Game Based Learning is the most important strategy used in the context of the project and it is positive that the teachers are familiar with it. Regarding previous education about computer programming, it was confirmed that during their formal education most of the participants did not attend courses that include learning computer programming.

The findings have shown that the topics of the GLAT modules are well chosen, and their usefulness for participants has been confirmed based on the evaluation of the teachers' satisfaction conducted at the end of each workshop.

6. Conclusions and future plans

Computational and algorithmic thinking skills are recognized among the fundamental skills needed for education in ICT and STEM areas but also for the jobs that today's students will perform in the future. Since students should start to acquire these skills as early as possible, it is important to educate primary junior grade teachers to include appropriate activities in different school courses.

The project GLAT, presented in this paper, has been directed towards strengthening the profile of the teaching profession in the field of primary school education and enhancing the occupational profile of teachers, especially regarding the development of computational thinking and programming skills among students. The focus of this paper was on one of the project activities - an initial study conducted to identify to what extent are primary school junior grade teachers familiar with methods, activities and ICT tools that can be used. The results have shown that organization of training courses like the one within the GLAT project are needed in order to introduce primary school teachers with adequate methods and ICT tools and to encourage them to include activities for the development of computational thinking in different school courses.

The obtained results will be compared with the results of a matched survey conducted at the end of the 3rd workshop and then used to create an improved version of syllabus and learning materials for blended learning model of education. This improved version, as one of the project intellectual outputs, will be complemented with the best examples of learning scenarios and translated into English. It will be published online in the system for e-learning through which it will be available to all interested teachers and the general public. The competencies of primary junior grade teachers in Croatia will be further improved through the possibility of additional professional training by means of lifelong learning for acquiring modern knowledge and skills aimed at innovative teaching in the field of ICT.

The research started under the Erasmus+ GLAT project will continue in the University of Rijeka's scientific project Digital games – *"Digital games in the context of learning, teaching and promoting inclusive education"* which has been started in 2019. Several studies will begin in the context of the project. The common theme for all of them is using digital Game Based Learning (GBL) in school education and developing pedagogical-technological frameworks based on GBL. One of the studies is about encouraging the integration of computational thinking into the daily teaching of different courses

in the lower grades of primary school using GBL, with the special attention on the education for computational thinking of future primary junior grade teachers to enable the transfer of knowledge and skills to their students. In that way progress towards the development of computational thinking and improvement of students' attitudes towards programming will be made which will have a long-term impact on the increase of their interest in the selection of the future occupations in the ICT fields.

Acknowledgments

The research has been co-funded by the Erasmus+ Programme of the European Union under the project „Games for Learning Algorithmic Thinking“ (2017-1-HR01-KA201-035362) and by University of Rijeka (Croatia) under the project “Digital games in the context of learning, teaching, and promoting inclusive education” (uniri-drustv-18-130).

Notes

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