Games for Learning Algorithmic Thinking

GLAT Project Dissemination

Co-funded by the Erasmus+ Programme of the European Union

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Preface

This publication was created in the context of the Erasmus+ project GLAT - "Games for Learning Algorithmic Thinking".

The general goal of the project is encouraging the integration of computational and algorithmic thinking, problem-solving skills, logic and creativity into the daily teaching through different subjects in students' younger ages in a fun and attractive way using Game Based Learning (GBL). One of the main activities of the project was the organization of education for primary junior grade teachers in the form of a blended learning e-course.

The emphasis in the education designed during the project GLAT is placed on the f2f (classroom-based) workshops, which are combined with online learning during which the teachers are mentored by the experts who conduct the education.

Results of the GLAT project include *Workshop Syllabus and Materials*, *Guide for Teachers* and *Learning Scenarios,* and *GLAT e-course.* Syllabus includes schedules for all workshop sessions with learning outcomes, topics, evaluation methods, and tasks for participants (teachers) as well as handouts of presentations that are used for lectures (all materials are available within GLAT Moodle e-course in MoD e-learning system as well). The *Guide for Teachers* brings lessons about relevant topics with examples of good practice, templates and tools for preparing or conducting learning activities. GLAT results also include a set of learning scenarios developed by the teachers – participants of the GLAT education.

The first part of this publication presents evaluation results regarding satisfaction of teachers included in the GLAT education about the f2f workshops as well as results of the survey conducted with the students from 1st to 4th grade of primary school who participated in the learning activities designed by their teachers – participants of the GLAT education. Team members from the Faculty of Teacher Education (psychologists and pedagogists) prepared questionnaires for teachers, and questionnaires and interview questions for students. Prepared questionnaires for teachers were supposed to check not only the satisfaction of teachers with the education, but also to collect suggestions for its improvement.

The second part of this publication presents details regarding dissemination activities. From the start of the project, dissemination activities have been carried out to inform target audience about the project and to raise interest for project activities and results. The project disseminated the project results to large number of different stakeholders at local, regional, national, EU and international level: primary school junior grade teachers, informatics teachers, student – future teachers, partner and regional education institutions, school headmasters, local, regional and national bodies, colleagues – specialists in the area, and broader audience.

To address a wide audience, all partners were included in the dissemination, which was carried out using various communication channels and activities. Overall, 2000 participants attended GLAT dissemination events described in this publication.

Additionally, members of the GLAT project team published 18 professional and research papers in conference proceedings and journals to disseminate the project and its results to the experts and the practitioners in the field. Published papers are included in the third part of this document.

Editors

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Part I:
Evaluation of GLAT Education

Introduction

In order to measures the GLAT project success qualitatively and to improve the quality, several types of surveys were conducted. Psychologists and pedagogists from the Faculty of Teacher Education team prepared questionnaires for teachers and questionnaires and interview questions for students. Prepared questionnaires for teachers were supposed to check not only the satisfaction of teachers with the education, but also to collect suggestions for its improvement. The questionnaire and interviews were also prepared for students who took part in testing of the last learning scenarios.

The evaluation of the teachers' satisfaction about the f2f workshops took place immediately at the end of each f2f workshop. The other more comprehensive research started at the beginning of the Workshop 1 when a survey about participants' expectations of the workshops was conducted. Those results were compared with the matched survey which were conducted at the end of the Workshop 3.

The goal of the survey conducted with the students from 1st to 4th grade of primary school who participated in the learning activities designed by their teachers – participants of the GLAT education, was to examine students' attitudes and impressions about performed activities. The evaluation was carried out by conducting a structured interview on a selected sample of students from first to fourth grade and an additional questionnaire with 3rd and 4th grade students.

Educating the teachers in the context of the GLAT project

In the context of the GLAT project 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 are developed as an e-course in learning management system Moodle. 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 (Figure 1) with the following topics:

1. Game Based Learning and unplugged activities
2. Problem Based Learning, online quizzes and logical tasks
3. Games and tools for programming

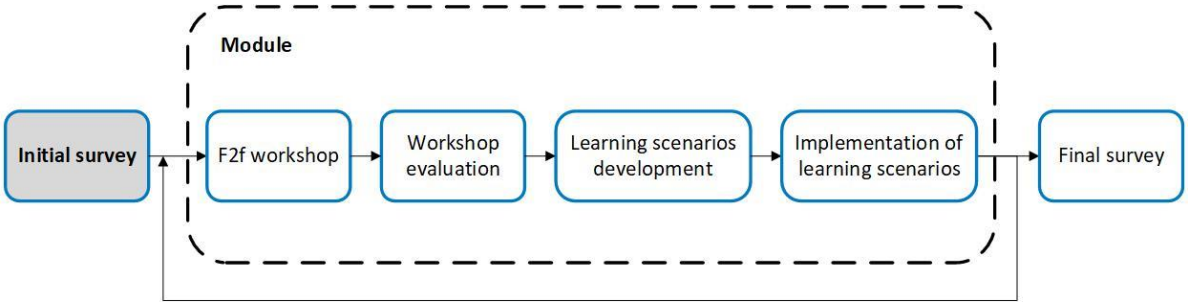

Figure 1: The model of activities for participants during GLAT training

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.

The evaluation of teachers' satisfaction

Prepared by: Darko Lončarić (*University of Rijeka, Faculty of Teacher Education*)

Teachers' expectations of the workshops

Purpose of the research

The main aim of the research 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 have helped 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.

Participants

A total of 24 male and female teachers (only one male participant) participated in an evaluation study of the effectiveness of education on the GLAT project (Age: M = 43,037, SD = 7,214; Mean work experience at school: M = 18,481, SD = 7,653). In both phases of the evaluation research, 17 teachers and teachers completed the initial and final questionnaire (Age: M = 43,471, SD = 7,584; Mean work experience at school: M = 19,000, SD = 7,866). A total of 7 participants participated only in the first phase by completing the initial questionnaire (Age: M = 42,429, SD = 8,142; Mean work experience at school: M = 17,143, SD = 8,668), while a total of 3 participants participated only in the second phase by completing the final questionnaire (Age: M = 42,000, SD = 3,606; Mean work experience at school: M = 18,667, SD = 5,686).

Given the relatively long duration of the project, regardless of the inevitable changes in the number of education participants, groups in the initial (N = 24; Age: M = 43,167; SD = 7,585; Internship: M = 18,458; SD = 7,962) and final phase of the evaluation (N = 20; Age: M = 43,250; SD = 7,078; Internship: M = 18,950; SD = 7,451), generally cover the same participants and are comparable in age and internship.

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 to 11 years old children) and the number of students in their classrooms is between 10 and 24.

Data collection

The assessment impact of the GLAT project was carried out using an initial and final questionnaire. The questionnaires were anonymous, and the comparability of the results was ensured by a unique code chosen by participants on the initial questionnaire and recorded to repeat the same code on the final questionnaire. Both questionnaires covered participants' basic sociodemographic data: age in years and experience in years of service, and the class in which the participant is currently teaching. Gender was not recorded on the questionnaires as this would impair their anonymity (only one participant was male).

The main aim of the initial questionnaire was 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 final questionnaire was designed to identify changes from the initial questionnaire and follow its structure.

The questionnaires consist 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.

Progress in the implementation and knowledge of the key terms of the GLAT project was determined by the participants' answers to a series of the same ten questions from the initial questionnaire as the Likert-type response format changed. Participants noted progress on the response format from 0 = not at all to 4 = to a great extent

Progress in the ability to create materials and apply different teaching tools and principles relevant to the GLAT project was determined by the participants' answers to a series of the same six questions from the initial questionnaire with the change in the Likert-type response already mentioned.

Increasing frequency of use of instructional forms, methods, and strategies was determined by participants' responses to a series of the same seventeen questions from the initial questionnaire as the Likert-type response format changed.

The final questionnaire also repeated a series of open-ended questions that examined the use of games for developing algorithmic thinking and the use of games for learning computer programming.

Results

An analysis of the responses and average values on the statements on which the participants in the initial questionnaire indicated their level of familiarity with the key terms of the GLAT project and the final questionnaire, showed teachers self-assessment as to whether they had made progress and how much progress had been made in applying and knowing the key terms of the GLAT project. Based on the descriptive indicators, conclusions were drawn about the self-assessment of progress that are contextualized with respect to the initial state established in the evaluated elements.

Table 1 shows the results regarding Familiarity with the terminology in the initial questionnaire. The obtained results indicate that the most familiar term to participants was “digital competence/skills”, while they were least familiar with the term “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

The self-assessment of progress in the final questionnaire showed that the participants have made the most progress in applying and knowing the terms “learning scenario” and “Game-Based Learning”, while they have made the least progress in “basic programming concepts” (Table 2).

Table 2: Progress with the terminology

	To what extent have you ADVANCED in applying and understanding the term:	N	Minimum	Maximum	Mean	Std. Deviation
1.	digital competencies/skills	20	2	4	3,20	,616
2.	Problem Based Learning	20	2	4	3,25	,550
3.	Game-Based Learning	20	2	4	3,40	,598
4.	Digital Serious Games	20	2	4	3,30	,571
5.	Inquiry Based Learning	20	2	4	2,90	,553
6.	unplugged activities	20	2	4	3,05	,605
7.	algorithmic thinking	20	2	4	3,20	,616
8.	Web 2.0 tools	20	2	4	3,35	,587
9.	learning scenario	20	3	4	3,40	,503
10.	basic programming concepts	20	1	4	2,75	,786

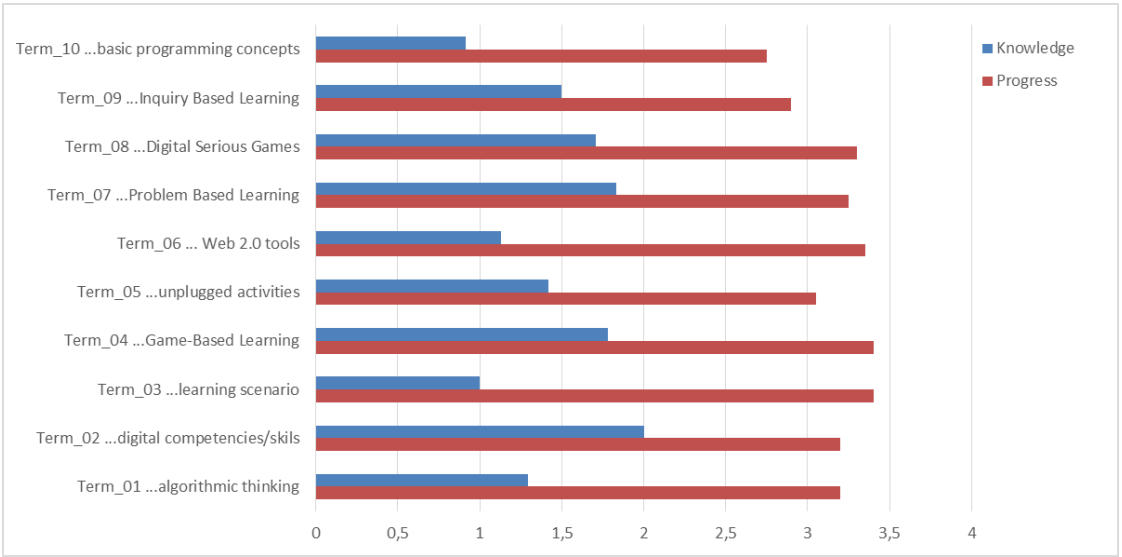

Figure 2: Comparison of the initial state and progress in the knowledge of the terms

A review of Figure 2 shows that the high indicators of progress are mainly related to the areas where the participants also showed relatively higher results of initial knowledge of terminology such as game based learning, digital serious games and problem based learning (questions 8, 7 and 4). The relatively lowest progress indicator was achieved on the question related to basic programming concepts, where participants also showed a relatively low initial knowledge of terminology. While these results indicate a dependency of progress on pre-existing knowledge, particular emphasis should be placed on questions with a relatively lower initial result that showed relatively high self-assessments of progress such as questions related to learning scenarios and Web 2.0 tools (questions 3 and 6). When contextualizing progress with respect to the initial state, we can say that it is precisely on these questions that the initial state improvement was realized to the greatest extent.

Table 3 shows the results regarding the initial *Familiarity with the possibilities of adapting, creating and using teaching contents and methods*, which indicate that "digital content creation" was the most familiar for the workshop participants while they were not familiar with the computer programming and possibilities of visual programming tools. Analyzing the frequency of individual responses, it can be observed that at all questions, at least three participants indicated the answer 0 = None. This was even the dominant response in questions 4, 5 and 6, in which no respondent indicated that he or she was familiar with using these tools to a greater extent or entirely, indicating that these were areas with relatively greater potential for progress.

Table 3: 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 4 shows the self-assessment of progress in the final questionnaire for the same terms. It can be seen that the participants made the most progress in the possibility of making online quizzes and logical tasks, while the least progress they have made is on the possibilities of computer programming and programming languages. On most elements, most respondents rated their progress as significant and analyzing the frequency of individual responses, it can be seen that there was no topic on which no progress was made.

Table 4: Progress 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	20	3	4	3,25	,444
2.	gamification	20	2	4	3,00	,324
3.	creation of online quizzes and logical tasks (Kahoot, Puzzlemaker, Word Search Labs…)	20	2	4	3,60	,598
4.	digital content creation using Web 2.0 tools (Glogster, Popplet, Canva, GeoGebra,…)	20	2	4	3,30	,657
5.	computer programming and programming languages	20	1	4	2,45	1,050
6.	tools for visual programming (Scratch, Scotty go, Sphero SPRK+,…)	20	2	4	2,85	,745

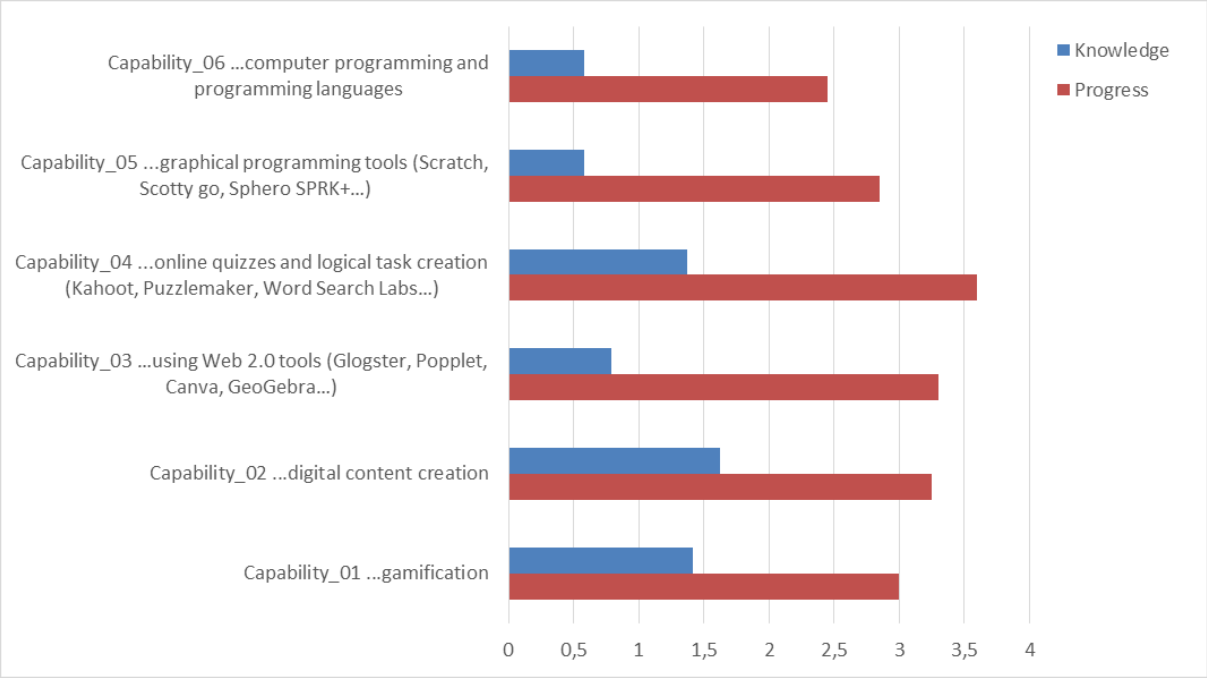

Figure 3: Comparison for initial status and progress in capabilities

Figure 3 reveals that the highest indicator of progress is related to the area in which the participants showed a relatively high score of initial opportunities: creating online quizzes and logical tasks. On the other hand, the lowest indicator of progress was achieved on the task related to computer programming and programming languages, in which the participants showed a relatively low initial capabilities. It is necessary to emphasize particles with a relatively lower initial result, on which relatively high self-assessment of progress was recorded, such as “digital content creation using Web 2.0 tools”. When contextualizing progress with respect to the initial state, we can say that it is precisely on this element that the initial state improvement is realized to the greatest extent.

The third part was related to frequency of using teaching forms, teaching methods and strategies in classroom teaching, not specifically related to the GLAT project. As shown in Table 5, the obtained

results from the initial questionnaire indicate that games and individual work were the most often used while the debate is rarely used.

Table 5: 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

A review of Table 6 reveals the results of the final questionnaire for the same topics. Participants largely increased frequency of using games and creative thinking techniques, while the least increased the frequency of frontal work.

Table 6: Increasing frequency of using the 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	20	2	4	3,15	,745
2.	individual work	20	0	3	1,90	1,021
3.	demonstration	20	0	4	2,35	,933
4.	frontal teaching	20	0	3	,85	,988
5.	work in pairs	20	0	4	2,50	,946
6.	practical tasks	20	1	4	2,90	,718
7.	students self-assessment	19	1	4	2,79	1,084
8.	presentation of students' work	20	1	4	2,50	,761
9.	group work	20	0	4	2,35	,988
10.	discussion	20	0	4	2,40	,995
11.	creative thinking techniques	20	2	4	3,10	,641
12.	peer-to-peer learning	20	0	4	2,65	,933
13.	collaborative learning strategies	19	1	4	3,00	,667
14.	research tasks (research problems)	20	0	4	2,80	,951
15.	project-based tasks	20	1	4	2,55	,826
16.	role-playing	20	1	4	2,65	,933
17.	debate	20	0	4	1,75	1,209

According to the obtained results, it is evident that the highest increase in frequency was mainly related to using games as an area in which the participants showed the highest initial frequency score (Figure 4). The lowest increase in frequency was obtained on frontal work, the method which showed a relatively high initial frequency of use. Similar pattern of relatively low increase in frequency with high initial frequency has individual work, what confirms that the activities of the project were not aimed at increasing these forms of work.

In relative terms, the greatest impact of project participation was achieved on methods with a relatively lower initial frequency of use, with a relatively high self-reported increase in frequency of using such as items related to creative thinking techniques and collaborative learning strategies. When contextualizing the change in the frequency of using different forms, methods and teaching strategies with respect to the initial state, we can say that it was precisely on creative thinking techniques and collaborative learning strategies that the initial state improvement was realized to the greatest extent.

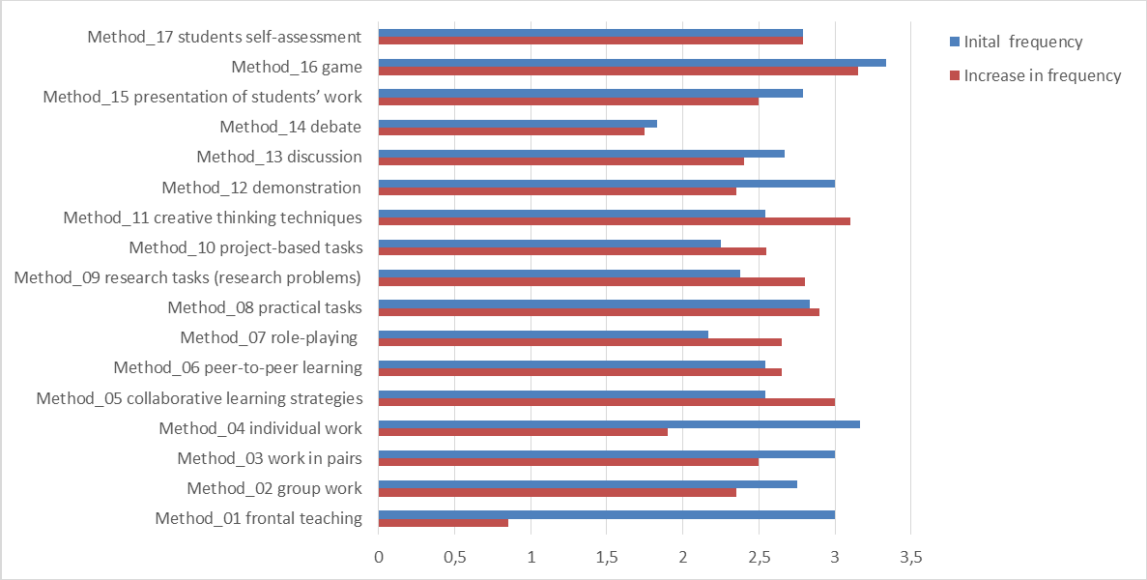

Figure 4: Comparison for initial status and increasing frequency of using teaching forms, methods and strategies

The last part was about the final review of the project. From a total of 24 participants who participated in the project, four gave a descriptive, mostly positive review of all three planned and implemented workshops, emphasizing satisfaction with the involvement in the project and the applicability of the acquired knowledge and skills (Table 7).

Table 7: Overview of the project as a whole regarding to all three implemented workshops

Overview of the project as a whole:	**N**	**%**
No reply	20	83,3
I am extremely pleased that I was given the opportunity to participate in the GLAT project. I learned a lot and improved my own competencies, but also refreshed my way of working.	1	4,2
Excellent! Sit down 5! Thank you.	1	4,2
I'm very glad I was involved in this project. I also recommend myself for the following activities. Thanks a lot to everyone for the effort!	1	4,2
Everything was excellent. Most of the learned games and knowledge in general, we will be able to apply and use in school if our technical conditions (computers, tablets, Internet, etc.) improve.	1	4,2

Findings

To sum up the results associated to the research questions, we can conclude that the teachers were not familiar with the most important concepts for the GLAT project education such as algorithmic thinking, learning scenario and basic programming concepts. Also, they did not use before some Web 2.0 tools for content creation and did 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 indicated that games have been the most often used. This is in line with the GLAT education because Game Based Learning was the most important strategy used in the context of the project and it is positive that the teachers have been 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 which was expected since they were no informatics teachers but primary junior grade teachers. Regarding this topic, the main goal of education was not to teach them how to programme but how to use game-based visual programming tools to indirectly introduce to students some concepts related to algorithmic thinking and programming.

Regarding the teachers' estimated progress with respect to the initial state, the elements that the initial state improvement was realized to the greatest extent are related to applying the learning scenarios and Web 2.0 tools for learning activities, creating digital content using Web 2.0 tools, and using in teaching practice with students creative thinking techniques and collaborative learning strategies.

The findings have shown that the topics of the GLAT workshops 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.

Teachers' satisfaction with the workshops

Besides before mentioned survey, an evaluation of workshops was conducted after each workshop to establish how teachers were satisfied with the workshop content and lecturers. They filled in a survey which was the adapted version of the standard AZOO - Croatian Education and Teacher Training Agency (cro. AZOO - Agencija za odgoj i obrazovanje) survey for measurement of the teachers' satisfaction with professional training events.

The evaluation in a form of an anonymous survey consisted of first part with Likert scale-based statements and second part with open ended questions. In the first part participants were asked to express their opinions on the applicability of the statement to the workshop using the Likert scale, where 1 refers to "extremely poor" to 5 - "exquisitely". In open ended questions in the second part, participants were asked to mention the topics for which they considered to be of most use in their job in school (the value of education), and to give some suggestions and proposals for the improvement of the workshops.

The survey was completed by 24, 22 and 19 participants respectively per each workshop which is 65 questionnaires overall for the whole education. As shown on Figure 5 participants highly evaluated six of eight items: the contemporary (up-to-date) content, importance of a workshop for personal professional development, communication and collaboration within a group, preparedness of lecturers, an opportunity to express their own opinions and general evaluation of the workshop. It is significant that all above mentioned statements had high marks (above 4,7) for each workshop separately.

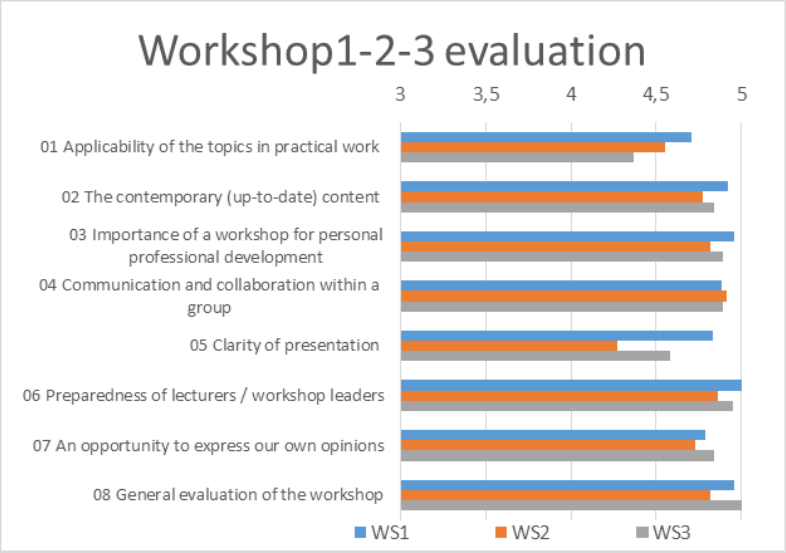

Figure 5: Evaluation items for three GLAT workshops

Generally, looking at the entire education of teachers through three workshops, participants highly evaluated all statements with means' value above 4,55 as shown in Table 7. Only two statements overall had standard deviation over 0,5.

Table 7: Overall evaluation of the education

	N		Mean	Median	Mode	Std. Deviation
	Valid	Missing				
01 Applicability of the topics in practical work	65	0	4,55	5,00	5	,613
02 The contemporary (up-to-date) content	65	0	4,85	5,00	5	,404
03 Importance for professional development	65	0	4,89	5,00	5	,312
04 Communication and collaboration within a group	65	0	4,89	5,00	5	,312
05 Clarity of presentation	65	0	4,57	5,00	5	,585
06 Preparedness of lecturers / workshop leaders	65	0	4,94	5,00	5	,242
07 An opportunity to express our own opinions	65	0	4,78	5,00	5	,450
08 General evaluation of the workshop	65	0	4,92	5,00	5	,269

The second part with open ended question confirmed the satisfaction of participants. As the value of education, participants emphasized contemporary topics, applicability of presented topics, unique education opportunity, very good organization and preparedness of lecturers, great communication and collaboration with lecturers and colleagues. To point out some of the comments:

„I would emphasize the value of teaching about the use of digital tools; we use them more and more in teaching, especially in the experimental program of curricular reform 'School for life'."

„Getting acquainted with new ways of learning that is much more interesting to children because it includes what is close to them, namely, the games and technology. "

„Excellent preparation and expertise of lecturers, the ability to develop creativity, encourage to continuous participation and learning, interesting content, pleasant lecturers, very responsive. Excellent education! Thank you!"

There were not many suggestions and proposals for the improvement of the education. After the first workshop titled "Game based learning and unplugged activities" there was no suggestions at all, probably because teachers were familiar with topics in general. The last two workshop were more demanding for teachers because they were not familiar enough with digital tools that can be used in classroom, so they stated that there were too many tools to upskill. The comments were:

"More time for a particular application. More details on using a particular tool."

„The pace of presenting new content is too rapid. "

As presumed, our participants had no additional prior knowledge about using and implementing digital tools and game-based tools for learning programming concepts, so they found these tasks demanding.

The findings have shown that the topics of the GLAT project were well chosen, and their usefulness for participants has been confirmed as well as teachers' satisfaction with the project as a whole.

Analysis of students' experiences in the GLAT project

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In evaluating the activities designed by teachers who participated in the GLAT project and performed with their students from 1st to 4th grade of elementary school using computer tools, the following goal was set: To examine students' attitudes and impressions about performed activities.

The evaluation was carried out by conducting a structured interview on a selected sample of students from 1st to 4th grade and an additional questionnaire with 3rd and 4th grade students.

Analysis of conducted interviews with students

For the purposes of evaluation, a structured interview was designed for students from 1st to 4th grade that consisted of four groups of questions with a total of 23 questions.

The interview covered topics that were analyzed separately: computer use and playing computer games, students' impressions of solving quizzes and logical tasks during class, students' impressions of designing a computer game, and experiences and impressions of playing own game in the classroom. Interviews were conducted individually with each student after playing a game designed by the class. Conversation was recorded and transcripts were made which were used for data processing.

The research included six first-grade classes, six second-grade classes, four third-grade and four fourth-grade classes of elementary school. The teachers of the 1st and 2nd grades randomly selected a third of their students, and the teachers of the 3rd and 4th grades selected a quarter of their students, evenly the girls and the boys. The sample of respondents from a total of 100 children consisted of 31 1st grade students, 36 2nd grade students, 15 3rd and 18 4th grade students.

Analysis of the respondents' answers

Frequency of using a computer and playing a game

This topic was not directly connected to a GLAT project, but it was useful to establish contact with children and start talking about things they usually do. Few students, only four answered that they rarely or never play games on a computer/tablet/mobile. When asked how often they play games, 40 respondents said they play every day, usually between one and two hours a day, 38 respondents play several times a week, and 18 sometimes or only on weekends. Thus, two-thirds of the respondents play games several times a week or every day. When asked about the most commonly played games, students pointed out the following games: Fortnite, Brawl stars, Minecraft and Call of Duty. Almost all boys declared themselves playing war games, while more girls than boys did not point out the games they play most often. "And there are many, I don't know…"

Students' impressions of solving quizzes and logical tasks during class

In the "Solving quizzes and logical tasks during class" section, students recalled classes with the tasks they had solved on computers a few months ago as part of the GLAT activities that their teachers designed. The questions were: Did you solve the quiz alone or with your friends? What was interesting to you? Do you remember how successful you were in solving the quiz/worksheet? (if yes, what was difficult?) Did you ever solve similar tasks on your computer before? Which quiz/worksheet would you like to repeat? (Why exactly that one?)

By looking at the answers of students who remembered solving quizzes and tasks, almost all students stated that they had fun working that way and that they would like to repeat the tasks because they enjoy learning in that way. Most of the students replied that they did not find it difficult to handle, while some students stated that their tasks were difficult, that is, they had difficulty because of the short available time to solve the tasks. Half of the students responded that they had not encountered this type of task before. Almost all students expressed interest in this type of problem solving and stated that they liked it and that the tasks were interesting. When asked which quiz/ worksheet they preferred five respondents named Kahoot quiz, and 18 Memory game. Most respondents did not name the tool, but they briefly described the content of the quiz/worksheet they would like to repeat.

Students' impressions of designing a computer game

In the topic "Designing a Game" the respondents were asked the following questions: What did you particularly like about creating a class game? Did you easily agree on what your game would look like? (If not why?) What did you or your group propose to be in the game?

In designing the game, the 1st and 2nd grade students mostly liked agreeing on what would be in the game, they gladly got involved in the process and gave their ideas for the characters, tasks and layout of the game. Teachers encouraged student collaboration, students provided ideas, followed by a vote. Most of the students responded that they brought ideas together, while individually the girls emphasized more on what they personally suggested. For the most part, the students responded that they easily agreed on what would be in the game. Individuals added that there were small disagreements over a lot of ideas, but they quickly agreed.

The students in 3rd and 4th grade especially liked the creation of the class game, because they suggested their own ideas and designed the characters and their appearance. However, some of them pointed out that they did not like when their ideas were disregarded. In addition, some students liked that they could transfer the learned knowledge into the game and thus learn and repeat. More than half of the respondents said that it was easy to agree on what their game would look like, but seven respondents said they had trouble agreeing on specific parts of the game, such as scoring or punishing for incorrect answers.

Students' impressions of playing own game in the classroom

In the part "The game playing experience" the respondents were asked the following questions:

Did you find the game interesting? Why? What did you like the most about the game? What did you learn from playing this game? Did you play the game alone or with your friends? Do you think it would be better if you played (as opposed to answering)? How did you feel while playing? Was there any difficulty while playing the game? Is your game better than the game the teacher showed you before you designed yours? What would you change in your game? Why?

All the students answered that the game was very interesting to them. The most common reasons why a game was interesting are their ideas that are visible in the game, interesting activities and tasks, and learning opportunities. The students showed great interest and excitement even before playing the game because they were interested in how the game would eventually look like, after collecting their ideas. The students most often stated that the playing game was used to repeat the lesson. Some students pointed out the messages that they felt the game had taught them. Most students responded that playing a game was more interesting to them than quizzes or solving tasks on computer because of the characters, story, game design, and different tasks in the game. Except the entertainment, other reasons for choosing to learn through play are easier learning, visual presentation and less writing.

Depending on the number of students and the equipment of the computer classrooms, it differed whether the students had the opportunity to play alone or in pairs. When asked "How did you feel playing the game?" All students responded positively. The most common answers were: I felt good, I was happy, I had fun. When asked what they would change in the game, the most common answer was that they would not change anything in the game because it is great. Some students stated that they would add more tasks and levels to make the game longer, some would change the characters, the game design, more difficult tasks... All the students gladly got involved in playing the game, and many of them stated that their game was better than other examples precisely because they themselves participated in its creation. It is clear from the students' responses that the experience of playing the game is positive and that students have very well accepted such a mode of learning.

Analysis of the results of the questionnaires

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

- analyze students' assessment of fun with tools: Match the Memory, Kahoot!, Wizer.me, LearningApps and Scratch.
- make students' assessment of the computer tool they have learned the most from

Sample of respondents

The sample of respondents consisted of 3rd and 4th grade students from six elementary schools. A total of 114 students were included in the analysis from which 55.26% (N=63) were girls, and 44.74% (N=51) boys.

Data collection and analysis

For the purpose of analyzing the success of implementation of GLAT activities with students, a questionnaire was designed for students in 3rd and 4th grade and used as an evaluation instrument for assessing the level of fun and learning using digital tools during the teaching process. The 1st and 2nd grade students were not included since they are too young for evaluating and assessment of tools.

The questionnaire for this purpose has been developed. It consisted of 5 statements with list of tools students practiced in class and 5-point Likert scale response format with values ranging from 1 - "I didn't have fun at all" to 5 - "I had a lot of fun". Then, the students had to round up one of the digital tools they think they learned the most from. To assess the level of entertainment of digital tools by gender and grade, a T-test was performed.

Table 8: The estimated level of entertainment of the digital tools

Tool	N	Minimum	Maximum	Mean	Std. Deviation
Match the Memory	111	0	5	3,26	1,818
Kahoot!	113	0	5	4,67	,881
Wizer.me	114	0	5	2,86	1,886
LearningApps	98	0	5	1,97	1,976
Scratch	114	0	5	4,30	1,212

The results in the Table 8 show that Kahoot! is the best-rated tool in the entertainment level assessment, followed by the Scratch. The lowest rated tool is LearningApps.

Analyzing the level of entertainment of computer tools by gender of students, it is shown that girls rated all computer tools with a higher average score than boys (Table 9).

Table 9: Assessing the level of entertainment regarding to gender

	Gender	N	Mean	Std. Deviation
Match the Memory	female	61	3,54	1,757
	male	50	2,92	1,850
Kahoot!	female	62	4,73	,772
	male	51	4,61	1,002
Wizer.me	female	63	3,06	1,865
	male	51	2,61	1,898
LearningApps	female	53	2,00	1,941
	male	45	1,93	2,038
Scratch	female	63	4,54	,964
	male	51	4,00	1,414

The results of the T-test show that there are no statistically significant differences between male and female respondents in assessing the entertainment level of the tools Match the Memory, Kahoot!, Wizer.me and LearningApps (Table 10).

Table 10: T-test results for independent samples with respect to digital tools and gender

	Leven test		T-test	
	F	p	t	p
Match the Memory	,636	,427	1,809	,073
Kahoot!	1,866	,175	,707	,481
Wizer.me	,920	,339	1,287	,201
LearningApps	,563	,455	,166	,869
Scratch	8,885	,004	2,323	,023

Only the Scratch tool showed a statistically significant difference in estimates of entertainment level with respect to gender (F = 8,885, p 0.023), what is shown in Table 2: female respondents rated the Scratch computer tool with a higher score (M = 4.54) than male respondents (M = 4.00).

Analyzing the level of entertainment of computer tools by grade of students, it is shown that 3rd grade students rated the Match the Memory and Wizer.me computationally statistically significantly higher scores than 4th grade students, while Kahoot! quiz was statistically significantly higher rated by 4th grade students than the 3rd grade students (Tables 11 and 12).

Table 11: Assessing the level of entertainment regarding to grade

	Grade	N	Mean	Std. Deviation
Match the Memory	3.	51	3,90	1,418
	4.	60	2,72	1,949
Kahoot!	3.	52	4,44	1,195
	4.	61	4,87	,386
Wizer.me	3.	53	3,36	1,582
	4.	61	2,43	2,029
LearningApps	3.	39	2,21	1,720
	4.	59	1,81	2,129
Scratch	3.	53	4,47	1,137
	4.	61	4,15	1,263

The results of the T-test identifying the differences between 3rd and 4th grade students in assessing the level of entertainment for the LearningApps and Scratch computer tools do not show statistical significance.

Table 12: T-test results for independent samples with respect to digital tools and grade

	Leven test		**T-test**	
	F	p	t	p
Match the Memory	13,849	,001	3,698	,001
Kahoot!	24,092	,001	-2,466	,017
Wizer.me	14,098	,001	2,753	,007
LearningApps	17,542	,001	1,002	,319
Scratch	,641	,425	1,431	,155

In the tool that students find to be the most learned through its application, it is evident that in 73.42% (N = 58) it is Kahoot, solving a computer quiz.

In choosing the tool that they have learned the most from, students mostly select Kahoot! 73.42%, while LearningApps and Match the Memory were least selected with 1,26%.

As the modern educational process is student-centered, it is very important to adapt educational process to students' needs and interests. Therefore, examining students' attitudes and opinions is very important in order to improve the quality of educational practice. The results of future research on this topic can contribute to the change and innovation in teaching practice.

Some of children were already involved in solving logical tasks before via *Mathematical Kangaroo* or *Bebras* competitions, but the vast majority wasn't (Table 13).

Table 13: Students' participation in competitions

	Never	Once	Several times
Have you participated in the Mathematical Kangaroo competition?	57	26	31
	50%	23%	27%
Have you participated in the Bebras competition?	89	14	11
	78%	12%	10%

As shown in Chart 1, 50% of respondents never participated in the *Mathematical Kangaroo* competition, while 78% never participated in the *Bebras* competition (Chart 2).

Chart 1: Students' participation in the *Mathematical Kangaroo* competition

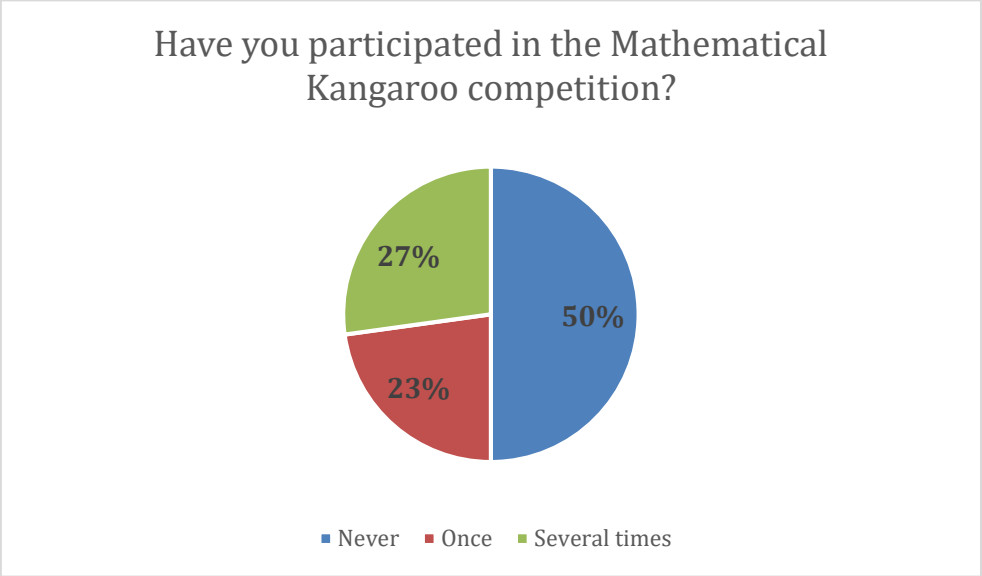
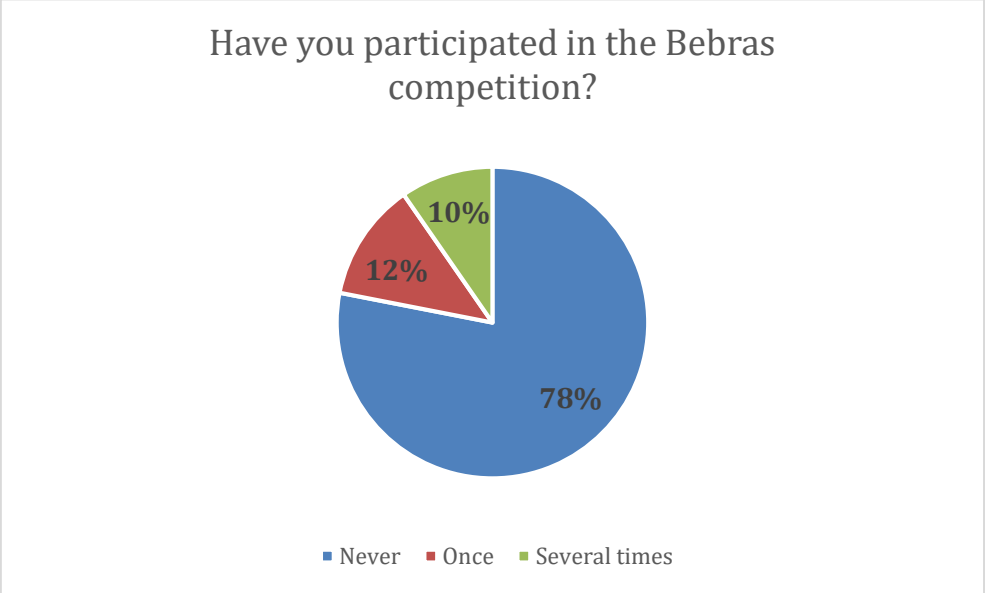


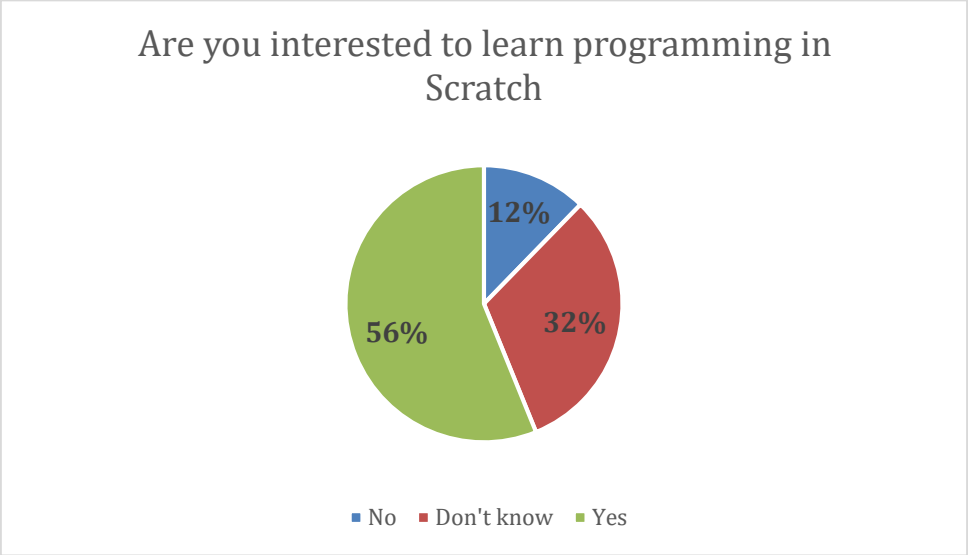
Chart 2: Students' participation in *Bebras* competition



One of the indicators of students' satisfaction with using games in learning was response to question Are you interested to learn programming in Scratch?

As shown in Chart 3, 56% of children (64 of 114) expressed a desire to learn programming in Scratch.

Chart 3: Students' desire to learn programming



Part II:
Dissemination Activities

Introduction

From the very beginning, dissemination activities have been carried out to inform target audience about the project and to raise interest for project activities and results. The project disseminated the project results to large number of different stakeholders at local, regional, national, EU and international level.

Locally, main target group include primary school junior grade teachers who could use created learning materials for their professional development, apply ready-made learning scenarios in their daily teaching, or use the available examples as inspiration for designing their own scenarios with activities for development of algorithmic thinking. Besides primary school junior grade teachers, the other persons with whom they work and collaborate have been targeted as well: headmasters of primary schools, parents, and other teachers. Dissemination activities at the UNIRI and partner institutions were also directed to university students, especially to future teachers, who will have chance to promote the algorithmic thinking and learning programming from the earliest school age.

Project activities and results have been also presented at the UNIRI and partner institutions to university teachers, and other relevant stakeholders that could have influence on changes in curricula of study programmes and university courses, especially aimed for future teachers and courses related to the use of ICT.

Most of the above-mentioned groups were targeted at regional level as well. The dissemination was done to teachers from Primorsko-Goranska county, to representatives from AZOO, universities, local and regional bodies, leaders of EU programmes as well as to school teachers in all partner countries.

Nationally, the dissemination was done to all target groups that could help promoting and implementing project results in practice: primary school junior grade teachers, informatics teachers, student – future teachers, partner and regional education institutions, school headmasters, local, regional and national bodies, colleagues – specialists in the area, and broader audience.

GLAT education are fully in line with the learning objectives of the cross-curricular theme “The use of information and communication technology (ICT)” and the new curriculum of Informatics for primary school (the domain “Computational thinking and programming”) and therefore results of the GLAT project represent valuable resource to Croatian teachers.

Experts from all partner institutions presented project goals, activities and results to their colleagues - specialists in the field of education and e-learning, as well as to broader audience in their countries, other EU countries, and internationally to ensure efficient dissemination.

To address a wide audience, the project and its results were disseminated at all levels using various communication channels and activities:

- presentations
- workshops and events
- e-course
- online dissemination activities
- leaflets
- press releases
- published papers.

Overall, 2000 participants attended GLAT dissemination events at all levels and had chance to get information about the project and its results:

- about 170 participants (university teachers and students) at the dissemination events organized locally in all participating countries
- about 370 of teachers at the dissemination events organized regionally in all participating countries
- about 270 of other participants (researchers, students, representatives of local bodies, brother audience) at the dissemination events organized regionally in all participating countries
- about 360 of teachers at the dissemination events organized at the national level in all participating countries
- about 200 of other participants (researchers, students, representatives of local bodies, brother audience) at the dissemination events organized at the national level in all participating countries
- about 680 of participants (researchers, university teachers and students, teachers) at the conferences, workshops and other events on EU or international level

For dissemination purposes, visual identity and logo of the project were created at the beginning of the project.

Dissemination activities were carried out by all partners and according to the dissemination plan made at the beginning of the project:

- University of Rijeka, Department of Informatics (UNIRI), project coordinator
- University of Rijeka, Faculty of Teacher Education (UF)
- Tallinn University, Centre for Educational Technology (TU)
- Ss. Cyril and Methodius University in Skopje, Faculty of Computer Science and Engineering (UKIM)
- University of Ljubljana, Faculty of Education (UL)
- South-West University „Neofit Rilski", Faculty of Mathematics and Natural Sciences (SWU)

At all levels, the dissemination activities will continue, and the results will be presented to the relevant stakeholders in order to enable implementation of changes to the education system and encourage the innovative education.

Presentations

The project and its results were presented by experts from the project team at local, regional, and national level as well as at EU an international level. Presentations were held on scientific and professional conferences in the field of education, workshops, seminars, and panel discussions. Promotions were also organized at regional events such as European Researchers' Night, Open Days of EU Projects, Lifelong Learning Week in Primorsko-Goranska County in Croatia.

Especially important were the presentations to teachers (who are the main target group) and presentation to students – future teachers who will have chance to apply project's results in their daily teaching.

The reminder of this chapter include description of presentations for teachers, presentations for students as well as all other presentations held to promote the project and its results.

Presentations to teachers

Fourth EduConference in Struga, Macedonia

Level: National

Partner: UKIM

Month: M6 – 31st of March, 2018

Number of participants/type of audience: 100 educators from primary schools in Macedonia and the region

GLAT project was presented by the members of UKIM team at the Fourth EduConference, organized by Friends of Education and Scentix (http://www.friends-of-education.org/fourth-educonference/info-5/) that took place on the 31st March and 1th April, 2018 in hotel Drim, Struga, Macedonia. Eminent presenters from Macedonia and abroad shared their experiences and ideas with all the conference participants on topics of interest for the educational process and the teachers' professional development.

The presentation of GLAT as well as the presentation about HOW to prepare and choose educational games that promote algorithmic thinking raised great interest among the participants of the conference, around 100 educators from primary schools in Macedonia and the region. The presenters were prof. Ana Madevska Bogdanova and prof. Vladimir Trajkovik.

Presentation for teachers in Informatics at Sofia University

Level: Regional

Partner: SWU

Month: M10 – 1st of July, 2018

Number of participants/type of audience: 12 teachers

Assoc. prof. Daniela Tuparova held a presentation about the GLAT project at Sofia University on 1st of July 2018. The presentation was held in front of post-diploma qualification course for teachers in Informatics.

Besides presenting planned activities and expected results of the GLAT project, the aim of this presentation was to motivate teachers to apply approaches like Game Based Learning for the introduction of the concepts related to coding and algorithmic thinking into the daily teaching.

AZOO teacher training seminar
for teachers of Informatics/Computer Science at UNIRI

Level: Regional

Partner: UNIRI

Month: M11 – 30th of August, 2019

Number of participants/type of audience: 150 teachers of Informatics/Computer Science and representatives of the Education and Teacher Training Agency (AZOO)

GLAT project was presented at Professional development training for teachers of Informatics/Computer Science organized by the Education and Teacher Training Agency. The presentation was held on the 30th of August 2018 at Department of Informatics University of Rijeka and was attended by 150 teachers and representatives of the Agency.

The main topic of the Symposium was related to the planning of learning activities in line with the new National Curriculum for the teaching subject Computer Science/Informatics. One of the structural domains of the Curriculum – Computational Thinking and Programming is related to the GLAT project. Therefore, teachers were introduced to the main objectives of the GLAT project, planned activities, and expected results.

It has been announced that teachers will have access to materials and learning scenarios developed by participants of GLAT Workshops and that, hopefully, those resources will be useful to them in the process of designing learning activities for their students.

Conference "STEM Area in the Educational System: Today for Tomorrow"

Level: Regional

Partner: UF

Month: M13 – 22nd of October, 2019

Number of participants/type of audience: 20 school and pre-school teachers

The GLAT project and results achieved so far were presented at the professional-scientific interdisciplinary conference „STEM Area in the Educational System: Today for Tomorrow". The aim of this conference is to promote the popularization of science and encourage the development of critical thinking in pre-school and early school-age children, with the aim of directing children toward STEM areas and creating a society of knowledge.

The conference was held on Monday, October 22nd, 2018 in Rijeka. The conference was organized by the UNIRI Department of Biotechnology, UNIRI Faculty of Teacher Education and UNIRI Faculty of Humanities and Social Sciences.

The conference was attended by school and pre-school teachers. The presentation held by Dr. Jasminka Mezak (UF) raised interest among participants, especially announcement of life-long learning programme based on the GLAT project results which start is planned after the completion of the project.

Presentation to the teachers
during the course "Computer games in education" at SWU

Level: Regional

Partner: SWU

Month: M15 – 1st December, 2019

Number of participants/type of audience: 17 teachers

Assoc. prof. Daniela Tuparova presented the project and its results to the school teachers during lectures of a Master degree course - Computer games in education at the South-west University "Neofit Rilski".

Besides presenting the goals of the project, she also presented developed learning scenarios and tried to motivate teachers to apply them in teaching in order to develop algorithmic thinking among their students.

The presentation was held on December 1st, 2018.

AZOO teacher training seminar
"Digital competences and computational thinking in your class"

Level: Regional

Partner: UKIM

Month: M16 – 11th of January, 2019

Number of participants/type of audience: 200 primary school junior grade teachers and students

Prof. Vladimir Trajkovik, a member of GLAT project team from UKIM, held lecture entitled "Digital competences and computational thinking in your class / Challenges of 21st century education" on 11th of January 2019. The lecture was held at Faculty of Teacher Education, University of Rijeka and was organized in cooperation with AZOO.

Apart from the teachers involved in the education within the GLAT project, the lecture could be attended by all interested teachers and students. The lecture raised great interest and was attended by 200 primary school junior grade teachers and students.

During the lecture, prof. Trajkovik emphasized the importance of establishing a framework for digital competences and the need to analyse the existing teaching practice. Ideas for changing the existing teaching practice were suggested and examples of good practice for developing computational literacy skills among students of the 21st century were presented.

AZOO teacher training seminar
"Development of teachers' competences: Evaluation and assessment"

Level: National

Partner: UNIRI

Month: M20 – 23rd and 24th of April, 2019

Number of participants/type of audience: 100 primary and secondary school teachers from Croatia, representatives from AZOO

Martina Holenko Dlab (UNIRI) participated at the national teacher training seminar "Development of teachers' competences: Evaluation and assessment" organized for Croatian teachers of Informatics/Computer Science. This seminar for professional development of teachers was held on 23rd and 24th of April 2019 in Terme Tuhelj and was organized by the Croatian Education and Teacher Training Agency (AZOO). Around 100 teachers from all parts of Croatia attended the seminar.

Martina Holenko Dlab held a lecture about using games for developing algorithmic thinking and programming skills in younger age (in junior grades of primary school). During the lectures, she presented examples of game based activities and tools that teachers can use in their everyday teaching. She also introduced the teachers to the main objectives of the GLAT project, project activities and results as well as activities to be carried out at UNIRI after the end of the project. Both presentations raised interest among the listeners.

It was emphasized that teachers could use materials developed during the GLAT project to plan and perform various activities in collaboration with primary school junior grade teachers to encourage development of students' algorithmic thinking skills. All interested teachers were given access to the materials and learning scenarios developed by the participants of the GLAT Workshops in the system MoD.

Presentation to teachers at Euneous Erasmus+ Teacher Capacity Development training

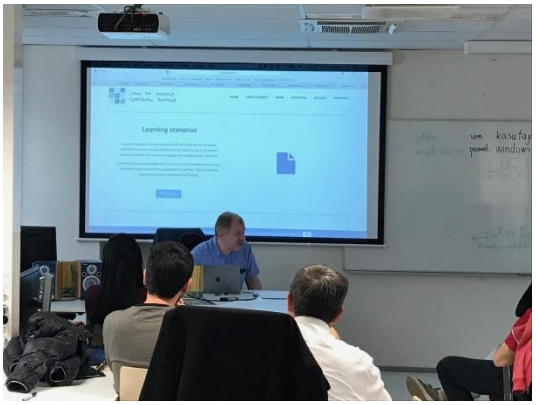
Level: EU and international

Partner: TU

Month: M20 – 19th of April, 2019

Number of participants/type of audience: 30 teachers and school leaders

The GLAT project and results achieved so far were presented to a group of teachers and school leaders who came to Tallinn University for the Euneous Erasmus Plus Teacher Capacity Development training. The presentation was held on April 19th, 2019 by Dr. Mart Laanpere and supported by Dr. James Sunney Quaicoe.



TeachMeet webinar

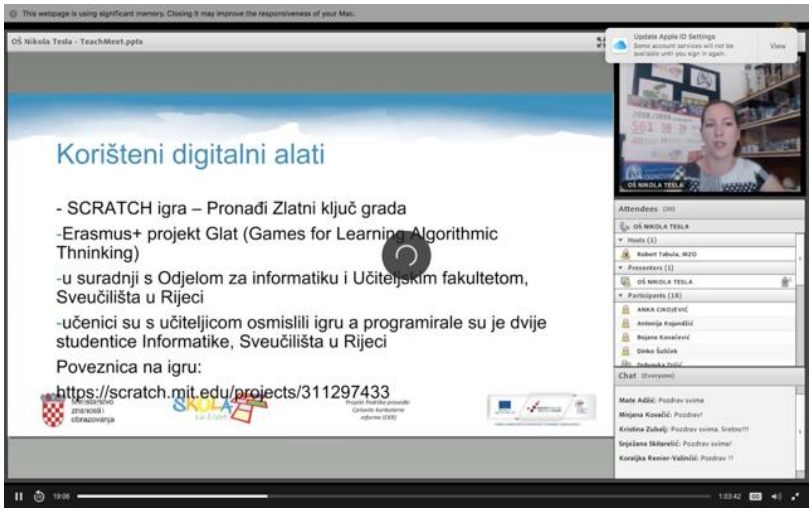
Level: National

Partner:

Month: M21 – 14th of June, 2019

Number of participants/type of audience: 47 teachers

On 14th of June, a teacher form GLAT focus group Petra Kapović Vidmar from primary school "Nikola Tesla" Rijeka presented the results of her work during the GLAT project at the TeachMeet webinar. She presented Scratch game "Find the Golden Key of the City" that she designed with her students. She also described the process of designing Scratch games, carried out after the third GLAT workshop, during which many other interesting games were created.



Presentation during Erasmus+ Teacher Training Programme

Level: EU and international

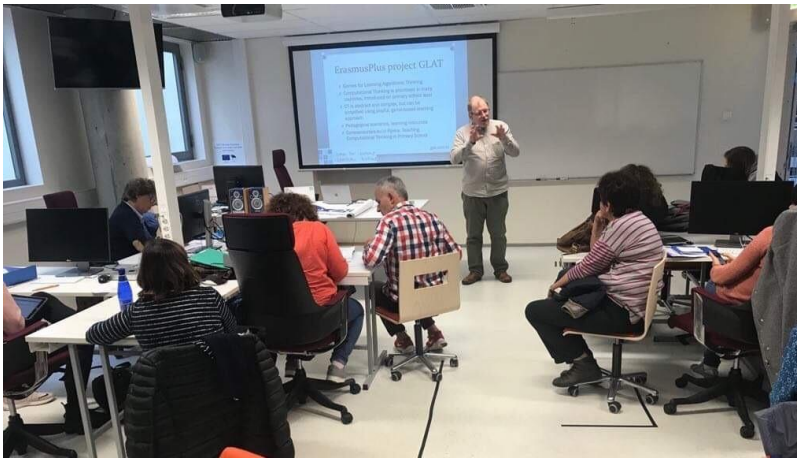
Partner: TU

Month: M24 – 14th of September, 2019

Number of participants/type of audience: 30 teachers

GLAT project results were presented by dr. Mart Laanpere and dr. James Sunney Quaicoe to 30 teachers – participants of the Erasmus+ Teacher Training Programme. The presentation took place at the Tallinn University Campus on the 14th of September 2019.

Participants from 10 different European countries had the opportunity to explore the materials and learning scenarios created during the GLAT project.



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Co-funded by the Erasmus+ Programme of the European Union

Presentation at the Conference of Science Teachers – NAK 2019: Education for the Present and the Future

Level: National

Partner: UL

Month: 24th of October, 2019

Number of participants/type of audience: 30 teachers

Members of the GLAT project from University of Ljubljana participated at the 5th Conference of Science Teachers – NAK 2019: EDUCATION FOR THE PRESENT AND THE FUTURE that was held from 23rd to 24th of October 2019 in Laško, Slovenia and presented project results to Slovenian teachers and future teachers.

Jože Rugelj held lecture „Development of computer thinking through project work in Scratch“ about teaching and learning in digital age while Irena Nančovska Šerbec organized a workshop „Development of “ together with Špela Cerar and Alenka Žerovnik. The workshop was about development of computer thinking through project work in Scratch.

Presentations to students – future teachers

Presentations to the students at South-West University „Neofit Rilski“

Level: Regional

Partner: SWU

Month: M4 – 18th and 19th of January, 2018

Number of participants/type of audience: 17 master degree students

Two presentations of GLAT project were held at South-West University „Neofit Rilski“ (SWU), Blagoevgrad, Bulgaria.

Assoc. prof. Daniela Tuparova, the coordinator of the project for the SWU, presented main objectives of the project, partners, planned activities and expected results to Primary school teachers who study in Master degree program “Information technology in primary school” and to students in Master Degree Program “Technology of education in mathematics and informatics”. The presentations were held on 18th and 19th of January 2018.

Research Class seminar at UNIRI

Level: Local

Partner: UNIRI

Month: M6 – 5th of March, 2018

Number of participants/type of audience: 12 students teachers from Department of Informatics, University of Rijeka

Martina Holenko Dlab presented the GLAT project at Research seminar in Informatics – Research Class. The emphasis of the presentation was on the current activities of project team members. Those are workshop syllabus and materials development and preparation of lesson plans for the 1st GLAT workshop: Game based learning and unplugged activities.

The presentation was held on 5th of March 2018 at Department of Informatics University of Rijeka and was attended by teachers from the Department of Informatics and students of the graduate study programme in Informatics (Business Informatics module and Information Communication Systems module).

Presentation to students of the graduate study programmes in Informatics

Level: Local

Partner: UNIRI

Month: M8 – 10th of May, 2018

Number of participants/type of audience: 15 students from Department of Informatics

Prof. Natasa Hoić-Božić presented the main information about the GLAT project and current activities of team members to students of the graduate study programmes in Informatics.

The presentation was held on 10th of May 2018 at Department of Informatics University of Rijeka for students enrolled in courses Multimedia an Hypermedia Systems and Hypermedia Systems in Education 2.

Presentation to students of the Faculty of Teacher Education

Level: Local

Partner: UNIRI, UF

Month: M9 – 6th and 13th of June, 2018

Number of participants/type of audience: 30 students of the Integrated undergraduate and graduate study of Primary School Education.

Prof. Nataša Hoić-Božić and dr. Jasminka Mezak held presentations about the GLAT project and Game Based Learning to students of the Faculty of Teacher Education, University of Rijeka. The presentations were held on 6th and 13th of June 2018 and attended by students of the Integrated undergraduate and graduate study of Primary School Education.

Planned activities and expected results of the GLAT project promote innovative methods and pedagogical approaches and tend to provide support for the introduction of the teaching concepts related to coding and those that encourage the development of algorithmic thinking of younger students. Therefore, it is important to introduce future primary junior grade teachers with the main concepts of Game Based Learning, gamification, and algorithmic thinking in order to motivate them to apply these approaches in teaching students.

Presentation to future teachers
during the course "Teaching Methods in Informatics"

Level: Local

Partner: UNIRI

Month: 28th of October, 2019

Number of participants/type of audience: 40 students

Prof. Nataša Hoić-Božić presented the GLAT project and project results to students - future teachers of Informatics during the course "Teaching Methods in Informatics".

The emphasis was on materials and developed learning scenarios that can be used for achievement of education and training outcomes of the domain „Computational Thinking and Programming“, provided in the National curriculum for the teaching subject of Computer science/Informatics.

The presentation took place at Department of Informatics, University of Rijeka on 28th of October 2019.

Other presentations

Presentation to the Council of Department of Informatics

Level: Local

Partner: UNIRI

Month: M1 – 26th of October, 2017

Number of participants/type of audience: 15 members of the Council of the Department of Informatics

Prof. Nataša Hoić-Božić, the leader of the GLAT project, presented the project at the session of the Council of the Department of Informatics, University of Rijeka, held on 26th of October 2017.

Prof. Hoić-Božić presented general information about the project as well as main objectives of the project, partners, planned activities and expected results.

Presentation at Faculty of Teacher Education

Level: Local

Partner: UF

Month: M1 – 23rd of October, 2017

Number of participants/type of audience: 26 members of the Council of the Faculty of Teacher Education

GLAT project was presented at the session of the Council of the Faculty of Teacher Education, University of Rijeka that was held on 23rd of October 2017. Assistant professor Jasminka Mezak presented general information about the project, main objectives, partners, planned activities and expected results.

Presentation at Faculty of Education, University of Ljubljana

Level: Local

Partner: UL

Month: M2 – 3rd of November, 2017

Number of participants/type of audience: 7 members of the Chair of Computer Science and Computer Science Didactic

Associate professors Irena Nančovska Šerbec and Jože Rugelj presented the GLAT project at Faculty of Education, University of Ljubljana.

The presentation was held on November 3rd at the meeting of the Chair of Computer Science and Computer Science Didactics. The general information about the project was presented as well as main objectives of the project, partners, planned activities and expected results.

Meeting with the AZOO senior advisor for primary school junior grade teaching

Level: Regional

Partner: UNIRI, UF

Month: M2 – 15th of November, 2017

Number of participants/type of audience: members of the GLAT project and senior advisor for primary school junior grade teaching Ms. Ivana Jurjević Jovanović

The meeting with the representative of the Croatian Education and Teacher Training Agency (cro. AZOO – Agencija za odgoj i obrazovanje) was held at the University of Rijeka, Department of Informatics on 15th of November.

The information about the GLAT project was presented to the senior advisor for primary school junior grade teaching Ms. Ivana Jurjević Jovanović, mag. prim. edu. from AZZO Regional office for Primorsko-Goranska County in Rijeka. The AZOO will help in selection of the teachers for the focus group. The invitations to participate in the workshops will be distributed to schools and announced at the AZOO web site. This participation will represent a form of professional development for teachers.

Presentation at Faculty of Computer Science and Engineering, Sts Cyril and Methodius University in Skopje

Level: Local

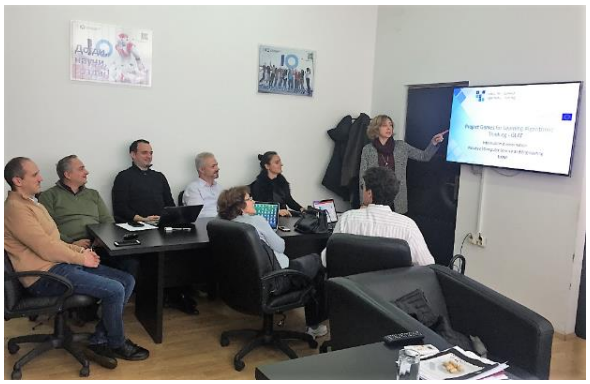
Partner: UNIRI

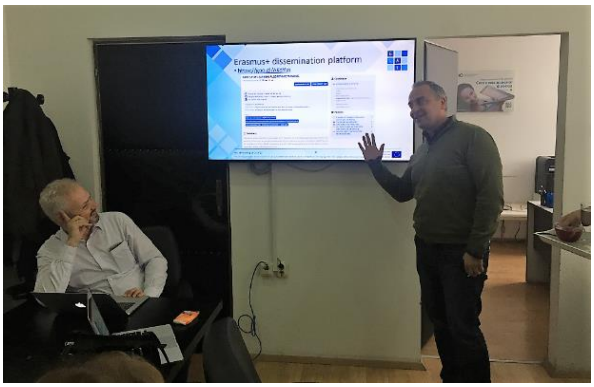
Month: M2 – 16th of November, 2017

Number of participants/type of audience: 10 members of management and different research groups at FCSE

GLAT project was presented at Faculty of Computer Science and Engineering, Sts Cyril and Methodius University (UKIM) in Skopje.

Prof. Ana Madevska Bogdanova, the coordinator for the partner UKIM, and prof. Vladimir Trajkovik, member, have presented the GLAT project in front of the management of FCSE and representatives of different research groups at FCSE – UKIM. The presentation was held on 16th of November 2017 and raised interest among the listeners. The audience was introduced to the main objectives of the project, partners, planned activities and expected results.





Presentation at Ministry of Science and Education, Croatia

Level: National

Partner: UNIRI

Month: M5 – 12th of February, 2019

Number of participants/type of audience: 12 teachers and leader of the group - Lidija Kralj, Assistant Minister at Ministry of Science and Education, Croatia

Project coordinator Nataša Hoić-Božić was a member of the Working group for preparing the introduction of the Informatics curriculum in primary and secondary schools and introduced the project to the other members on 12th of February.

Panel discussion
"Education of Informatics teachers for contemporary Informatics teaching" at UNIRI

Level: National

Partner: UNIRI

Month: M7 – 13th of April, 2019

Number of participants/type of audience: 25 students, teachers, headmasters of primary schools, representatives of Education and Teacher Training Agency, representatives of local bodies, representatives of CARNet - Croatian Academic and Research Network, and Lidija Kralj - Assistant Minister at Ministry of Science and Education, Croatia

Project leader prof. Nataša Hoić-Božić participated in the panel discussion „Education of Informatics teachers for contemporary Informatics teaching" that was held on April 13th at the Department of Informatics University of Rijeka. The panel discussion was organized on the occasion of the 10th anniversary of the Department of Informatics, with the aim of emphasizing the importance of continuous education of Informatics teachers, indicating the need to introduce Informatics as a compulsory subject in primary schools and encouraging debate on the benefits of inclusion of programming and algorithmic way of thinking in teaching younger students. The panelists were:

- Mrs. Lidija Kralj, Assistant Minister, Ministry of Science and Education of the Republic of Croatia,
- Prof. Nataša Hoić-Božić, GLAT project leader and vice head of Department of Informatics, University of Rijeka,
- Dr. Jasna Tingle, head of the E-Learning Research and Development Service, Education Support Department, Croatian Academic and Research Network – CARNet,
- Prof. Neven Vrček, dean of Faculty of Organization and Informatics, University of Zagreb.

Prof. Hoić-Božić presented the main goals and the purpose of the GLAT project and emphasized importance of teachers training for acquiring contemporary knowledge and skills aimed at innovative teaching in the field of ICT. Besides other panelists, students, teachers, principals of primary schools and representatives of Teacher Training Agency from the audience also participated in the discussion and shared their thoughts and experiences.

Open Doors Days of EU Projects at UNIRI

Level: Regional

Partner: UNIRI

Month: M8 –11th of May, 2018

Number of participants/type of audience: 30 UNIRI teachers, representatives from UNIRI, representatives of regional bodies, leaders and members of presented EU projects

The University of Rijeka joined the initiative of the Open Doors Days of EU Projects as a part of the traditional European Week celebration. The goal of the Open Doors Day of EU projects is to present projects that have contributed to the development of local communities through their successful implementation.

The central event of the Open Doors Day of the EU projects in Rijeka was organized by the University of Rijeka in cooperation with the Primorsko-goranska County and held on 11th of May, 2018 at the University Student center's Cafe "Akvarij". All interested had the opportunity to attend presentations of successful projects of Primorsko-goranska County, UNIRI Department of Informatics, UNIRI Faculty of Law and projects of STEPRI Scientific-Technological Park.

One of the presented projects was Games for Learning Algorithmic Thinking – GLAT. Prof. Nataša Hoić-Božić, the leader of the project, presented the main objectives of the project, partners, expected results and experiences with project implementation gained so far.

International Conference on Education and Distance Learning (ICEDL 2018)

Level: EU and international

Partner: UNIRI, UL

Month: M8 – 18th of May, 2018

Number of participants/type of audience: 25 teachers and researchers

Members of the GLAT project team participated at the 4th International Conference on Education and Distance Learning that was held in Colombo, Sri Lanka on May 18th.

Prof. Nataša Hoić-Božić presented the paper "Games for Learning Algorithmic Thinking – GLAT Project" at the conference (co-authors are Martina Holenko Dlab, Lucia Načinović Prskalo, Jože Rugelj, and Irena Nančovska Šerbec). The paper describes context and reasons for starting the GLAT project, gives an overview of initiatives to encourage coding at a young age and highlights the need for education of teachers, presents planned activities and intellectual outputs of the GLAT project as well as expected impact.

41st International Convention on Information and Communication Technology, Electronics and Microelectronics – MIPRO 2018

Level: National, International

Partner: UNIRI, UL, UF, SWU

Month: M8 – 22nd and 23rd of May, 2018

Number of participants/type of audience: 70 researchers and teachers

Members of the GLAT project team participated at the 41st International Convention on Information and Communication Technology, Electronics and Microelectronics – MIPRO 2018 that was held in Opatija, Croatia from 21st to 25th May.

Lucia Načinović Prskalo (UNIRI) presented the paper "Projekt GLAT – poticanje algoritamskog razmišljanja korištenjem didaktičkih igara" that gives information about the GLAT project, planned activities, and expected results and impact. Co-authors of this paper are Nataša Hoić-Božić (UNIRI), Martina Holenko Dlab (UNIRI), Jože Rugelj (UL), and Irena Nančovska Šerbec (UL).

Jasminka Mezak (UF) presented the paper "Learning Scenarios and Encouraging Algorithmic Thinking" written in co-authorship with Petra Pejić-Papak (UF). The paper discusses how learning scenarios can contribute to the development of innovative ideas for the implementation of educational activities and presents how appropriate learning scenarios can stimulate the algorithmic thinking of young students in everyday situations.

Daniela Tuparova (SWU) presented the paper "Educational Computer Games and Gamification in Informatics and Information Technology Education – Teachers' Points of View" (co-authors are G. Tuparov, V. Veleva, and E. Nikolova) which brings results of a study conducted among Bulgarian teachers regarding the use of educational computer games in pedagogical activities. She also co-authored the paper "Approaches for integration of educational computer games in e-learning environments" presented by G. Tuparov. This paper proposes a framework for analyzing the possibilities for game and gamification integration in e-learning environments and presents examples of integration of educational computer games in Moodle.

Conference “Education and Research in Information Society” 2018

Level: EU and International

Partner: SWU, UL

Month: M9 – 2nd of June, 2018

Number of participants/type of audience: 54 researchers and teachers

Members of the GLAT project team from South-West University “Neofit Rilski” and University of Ljubljana participated at the 11th National Conference Education and Research in Information Society that was held in Plovdiv, Bulgaria on 1st and 2nd of June. In her presentation, Assoc. prof. Daniela Tuparova outlined the main goals, approaches, objectives, and activities of the GLAT project. Participants of the conference who attended the presentation were both, researchers and teachers.

The publications “Project GLAT – Games for Learning Algorithmic Thinking” (in Bulgarian) is published in the Proceedings of the National Conference on “Education and Research in the Information Society”. Co-authors are Ivanichka Nestorova and Kostadin Samardzhiev.

International Conference "The Future of Education" 2018

Level: EU and international

Partner: UNIRI

Month: M9 – 28th of June, 2018

Number of participants/type of audience: 25 researchers and teachers

Ivona Franković, a member of the GLAT project team, participated at the 8th International Conference The Future of Education that was held in Florence, Italy on June 28 – 29. She presented the paper "Serious Games for Learning Programming Concepts" (co-authors are prof. Nataša Hoić-Božić and Lucia Načinović Prskalo).

The paper presents an overview of the game genres and tasks suitable for a better understanding of certain programming concepts, gives the examples of serious games and classified them according to the main programming concepts.

DAAD Workshop 2018
"Cooperation at Academic Informatics Education across Balkan Countries and Beyond"

Level: EU and international

Partner: UNIRI, UKIM

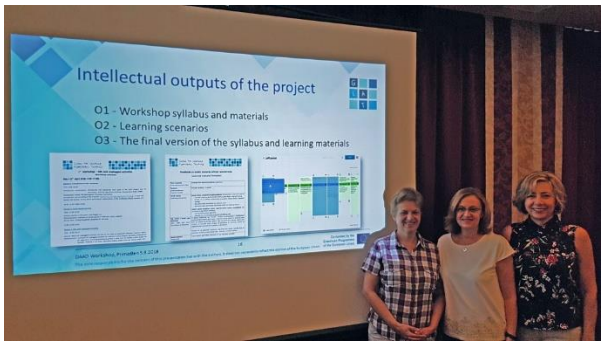
Month: M12 – 5th of September, 2018

Number of participants/type of audience: 40 researchers and teachers from Universities from Balkan and other EU Countries

GLAT project members participated at the DAAD Workshop Cooperation at Academic Informatics Education across Balkan Countries and Beyond that was held in Primošten, Croatia from the 5 th to the 8th of August 2018.

During the Workshop, prof. Nataša Hoić-Božić held the presentation entitled „E-Learning Projects: New Potentials to Enhance Multilateral Cooperation in Informatics". The aim of presentation was to stress out the importance of international cooperation in science and technology that is recognised in the EU funding programmes for research and innovation such as Horizon 2020, COST, Erasmus+ and similar.

Prof. Hoić-Božić presented the GLAT as an example of good practice in submitting and managing Erasmus+ projects in the area of e-learning. She introduced the Workshop participants with the main information about the project, project activities and results, especially those achieved so far. In addition, she presented possibilities for sharing project results and cooperation with the universities participating in the DAAD Workshop as well as with other institutions across Europe.



International Council of Educational Media – ICEM 2018

Level: International

Partner: TU, UL

Month: M12 – 7th of September, 2019

Number of participants/type of audience: 50 researchers and teachers

Members of the GLAT team from the Tallinn University participated at the International Conference of Educational Media – ICEM 2018, which was held from 5th to 7th September 2018, at Tallinn University, Tallinn, Estonia.

James Sunney Quaicoe presented the paper "Games for Learning Algorithmic Thinking (GLAT) Project: The influence of personal and environmental factors on perceived usefulness and usage of the LePlanner – learning scenario design tool" (co-authors are Mart Laanpere, Kai Pata and Nataša Hoić-Božić).

The paper presents GLAT project, the tool LePlanner – introduced to the teachers participating in the project, and descriptive overview about the perceptions of the teachers on digital self-efficacy, digital ICT usage, the digital supports in their schools, and the perceived usefulness and the actual use of LePlanner.

European Researchers' Night in Rijeka

Level: Regional

Partner: UNIRI

Month: M12 – 28th of September, 2019

Number of participants/type of audience: 150 researchers, teachers, and students

GLAT project was presented among EU projects from UNIRI at EU Corner at the European Researchers' Night that was held on Friday, September 28th, 2018, from 5 pm to 10 pm at the Tower Center Rijeka.

The Rijeka Researchers' Night was a part of the Techno-Past Techno-Future: European Researchers' Night project, co-funded by the Horizon 2020 – the European Union Research and Innovation Program. The event was coordinated by the Ministry of Science and Education of the Republic of Croatia at the national level, and by the University of Rijeka at a local level.

For the purpose of promoting the project at the European Researchers' Night and on similar events in the future, a leaflet was designed and printed.

Lifelong Learning Week in Rijeka

Level: Regional

Partner: UNIRI, UF

Month: M12 – 3rd of September, 2019

Number of participants/type of audience: 50 researchers, teachers, students, representatives from UNIRI, representatives of local bodies, leaders and members of presented lifelong learning programmes

Project members from Faculty of Teacher Education and Department of Informatics took part in the program of Lifelong Learning Week in Rijeka and presented the GLAT project.

The Lifelong Learning Week, marked from 1st to 7th October, seeks to support the quality of life of the widest population by adapting to real-time, raising the level of general motivation and mental health and improving the social inclusion of citizens.

The presentation of the Lifelong Learning Week organized on Wednesday, October 3rd 2018, at the Rijeka City Hall was used to announce the launch of a lifelong learning programme for teachers that will be based on the materials developed during the GLAT project as well as on experiences and feedback from the GLAT workshops participants.

Leaflets with information about the project were also available at the University of Rijeka booth for all interested visitors.

Kick-off meeting of the Erasmus+ project Coding4Girls

Level: EU and international

Partner: UNIRI, SWU, UL

Month: M1 – 18th of September, 2019

Number of participants/type of audience: 8 researchers from partners' institutions

Members of the GLAT project team from University of Ljubljana, South-West University and University of Rijeka collaborate in Erasmus+ project Coding4Girls (C4G) with partners from University of Thessaly, EU Track – European Training and Research Association for a Cooperation Key to Business, Istanbul Governorship and Virtual Campus Lda. The project is coordinated by University of Ljubljana.

The project Coding4Girls has similar aims as the GLAT project. Therefore, GLAT project and the experiences with its execution were presented to the partners included in the C4G project at the kick-off meeting that was held at Polytechnic of Porto – School of Engineering (ISEP) in Porto, Portugal on 18th and 19th of October 2018.

The project Coding4Girls aims at addressing the gap between male and female participation in computer science education and careers by introducing early methodological learning interventions that make computer science attractive for all. One of the aims is also building teacher capabilities in relation to the participation of girls in computer science.

The contacts with the new partners in this project will contribute to the dissemination of the GLAT project results.

International Conference on Education, Research and Innovation (ICERI 2018)

Level: EU and international

Partner: UKIM

Month: M14 – 12th -14th of November, 2018

Number of participants/type of audience: 50 researchers and teachers

The members of the UKIM team have presented two papers within the scope of the GLAT project at the 11th annual International Conference on Education, Research and Innovation (ICERI 2018), held in Seville (Spain) 12th -14th November 2018.

First paper "Using Scottie Go! as Game Based Learning Tool for Computational Thinking Course" elaborates how to use game based learning combined with flipped classroom and collaborative team work in order to utilize students' energy and enthusiasm they have when playing games, in achieving educational goals.

Second paper "Serious Games Evaluation Methodology" describes simple methodological tool for evaluation of educational games, together with the use cases and results of the survey on its usage.

Spring Conference of the Union of Bulgarian Mathematicians

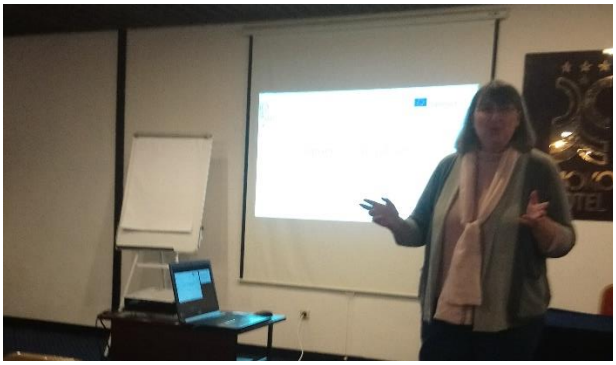
Level: National

Partner: SWU

Month: M19 – 1st - 4th of April, 2019

Number of participants/type of audience: 30 researchers and teachers

Daniela Tuparova participated at the Forty-eighth Spring Conference of the Union of Bulgarian Mathematicians that was held in Borovetz, Bulgaria from 1st to 4th of April 2019 and presented the paper "Educational computer games for learning programming and development of algorithmic thinking - comparative analysis".



International Conference on Informatics and Information Technologies - CIIT 2019

Level: EU and international

Partner: UKIM

Month: M20 – 10th of May, 2019

Number of participants/type of audience: 30 teachers and researchers

GLAT team members from UKIM, Ana Madevska Bogdanova and Vladimir Trajkovik, published a paper "Practical evaluation on serious games in education" at 16th International Conference on Informatics and Information Technologies that took place in North Macedonia.

The paper presents a tool for the teachers in order to follow the student's interest when choosing appropriate educational games in the teaching process.

International Convention on Information and Communication Technology, Electronics and Microelectronics – MIPRO 2019

Level: EU and international

Partner: UF, SWU

Month: M20 – 21st of May, 2019

Number of participants/type of audience: 100 researchers and teachers

Members of the GLAT project team participated at the 42nd International Convention on Information and Communication Technology, Electronics and Microelectronics – MIPRO 2019 and presented project results. The convention that was held in Opatija, Croatia from 20th to 24th of May.

Jasminka Mezak (UF) presented the paper "Problem Based Learning for Primary School Junior Grade Students Using Digital Tools" written in co-authorship with Petra Pejić-Papak. This paper presents a part of the analysis concerning the teachers' attitudes on the preparation of problem based learning (PBL) activity using digital tools. During the second GLAT workshop, the teachers who participate in the project were introduced to the use of digital tools for developing logical tasks and for the conduction of PBL. The set task for the participants was to conceive such activities, create a learning scenario of PBL and perform it with their students. After performing the activity in the classroom, a qualitative analysis of the preparation and implementation of the conceived activity was carried out.

International Conference on Information Technologies in Pedagogical Research "Innovative approaches to the application of digital technologies in education and research" – SLET 2019

Level: EU and international

Partner: UNIRI, UF

Month: M20 –22nd May, 2019

Number of participants/type of audience: 50 teachers and researchers

Members of the GLAT project team from UNIRI and UF participated at International Conference on Information Technologies in Pedagogical Research "Innovative approaches to the application of digital technologies in education and research" (SLET-2019). The conference took place from 20th to 23rd of May 2019 in Stavropol, Russia.

Krešo Tomljenović presented the paper "Enhancing teachers' computational thinking skills through Game Based Learning" (co-authors are Nataša Hoić-Božić and Jasminka Mezak). He presented project results achieved so far and experiences with GLAT workshops for primary junior grade teachers.

Scientific Conference "Educational Systems and Societal Changes: Challenges and Opportunities" – ESSCCO 2019

Level: EU and international

Partner: UF

Month: M21 – 6th of June, 2019

Number of participants/type of audience: 20 researchers and teachers

The GLAT project was presented at the Mediterranean Scientific Conference "Educational Systems and Societal Changes: Challenges and Opportunities" (ESSCCO). The aim of this conference is to enable collaboration and networking of researchers who explore and question the topics related to education and upbringing within a variety of scientific disciplines.

The conference was held on June 6th and 7th, 2019 in Rijeka. The conference was organized by the UNIRI Faculty of Teacher Education, Croatian Educational Research Association and the Faculty of Education, University of Malta.

Jasminka Mazak, Petra Pejić-Papak and Darko Lončarić (UF) held presentation entitled "Supporting Contemporary Learning and Teaching Methods through GLAT Project". They presented the project itself as well as three workshops and examples of learning scenarios developed by the teachers who participated in the project.

Annual International Conference on Computer Science and Education in Computer Science – CSECS 2019

Level: EU and international

Partner: SWU

Month: M21 – 28th of June, 2019

Number of participants/type of audience: 50 researchers and teachers

Daniela Tuparova participated at the 15th Annual International CSECS Conference on Computer Science and Education in Computer Science that was held n Fulda, Germany from June 28th to July 1st 2019 and presented the paper "Possibilities for development of algorithmic thinking through game based learning and unplugged activities in primary school".

The paper emphasizes the importance of developing of algorithmic thinking skills from early primary school with application of appropriate methods and approaches like game based learning and unplugged activities in all school subjects. She also presented a set of unplugged activities and games, applicable in primary school that have been included in training materials developed during the GLAT project.

International Conference on Education and New Learning Technologies – EDULEARN 2019

Level: EU and international

Partner: UNIRI, TU

Month: M22 – 1st of July, 2019

Number of participants/type of audience: 50 researchers and teachers

The members of the GLAT project participated at the 11th International Conference on Education and New Learning Technologies – EDULEARN 2019 that was held from 1st to 3rd July 2019 in Palma de Mallorca, Spain and presented the paper "Games for Learning Algorithmic Thinking (GLAT) Project: The influence of personal and environmental factors on perceived usefulness and usage of the LePlanner – learning scenario design tool". Authors of the paper are J. S. Quaicoe (TU), M. Laanpere (TU), K. Pata (TU), N. Hoić-Božić (UNIRI), and R. Rõbtšenkov (TU).

The objective of this paper is to undertake a descriptive overview of the perceptions of the teachers participating in the GLAT project on digital self-efficacy, ICT usage, and the digital support in their schools.

DAAD Workshop 2019

"Cooperation at Academic Informatics Education across Balkan Countries and Beyond"

Level: EU and international

Partner: UNIRI

Month: M24 – 1st of September, 2019

Number of participants/type of audience: 40 researchers and teachers

Prof. Nataša Hoić-Božić, the leader of the GLAT project, presented the project results at DAAD Workshop "Cooperation at Academic Informatics Education across Balkan Countries and Beyond: The Impact of Informatics to Society".

The Workshop (https://www2.informatik.hu-berlin.de/~wwwcompsoft/intkoop/daad/2019/) was held in Jelsa, Croatia from 1st to 7th of September 2019.

The sole responsibility for the content of this publication lies with the authors. It does not necessarily reflect the opinion of the European Union.

Co-funded by the Erasmus+ Programme of the European Union

Conference eLearning 2019

Level: EU and international

Partner: UNIRI, UF

Month: M24 – 26th of September, 2019

Number of participants/type of audience: 30 researchers and teachers

Members of the GLAT team participated at the conference eLearning 2019. Prof. Nataša Hoić-Božić presented the project results and the paper "Development of Computational Thinking Skills in Primary School through Digital Storytelling with Scratch". Co-authors of the paper are Martina Holenko Dlab (UNIRI), Sara Ursić Budim and Jasminka Mezak (UF).

The conference took place at Metropolitan University in Belgrade, Serbia on 26th and 27th of September 2019.

Panel discussion "Games for Learning Algorithmic Thinking (GLAT): Experiences and results of the Erasmus+ project"

Level: National

Partner: UF

Month: 25th of October, 2019

Number of participants/type of audience: 70 students, teachers, researchers

The project was presented at panel discussion "Games for Learning Algorithmic Thinking (GLAT): Experiences and results of the Erasmus+ project" that was held on 25th of October at Faculty of Teacher Education on the occasion of Faculty of Teacher Education Days.

Members of the GLAT team Petra Pejić-Papak and Jasminka Mezak (UF) presented the project results, Bojana Lanča, participant of the GLAT education from Primary School San Nicolò Rijeka presented examples of good practice and Sanja Kusturin Barković, former student of Faculty of Teacher Education, presented her master's thesis based on the GLAT project.

The panel discussion was attended students of Faculty of Teacher Education by educators and teachers as well as researchers and teachers.

Conference
"STEM Area in the Educational System: Today for Tomorrow 2" – STEM 2

Level: National

Partner: UNIRI, UF

Month: 15th of November, 2019

Number of participants/type of audience: 30 researchers, teachers and students

Members of the GLAT team from UNIRI and UF participated at the conference STEM Today for Tomorrow 2 that took place at University of Rijeka on 15th of November 2019.

Martina Holenko Dlab (UNIRI) held a lecture and presented the GLAT project and project results: Syllabus and materials, Guide for teachers, Learning scenarios, and developed GLAT e-course. She also organized a workshop "Games for Learning Algorithmic Thinking" for primary school students and their teachers. During the workshop, Ivona Franković (UNIRI) demonstrated Scratch games developed during the project.

Jasminka Mezak and Petra Pejić Papak (UF) organized a workshop "Encouraging algorithmic thinking with and without computers" for university students – future junior grade teachers where she presented learning scenarios developed during the project and demonstrated the use of Web 2.0 tools for preparing content for learning activities for development of algorithmic thinking.

International Scientific and Art Conference Contemporary themes in education – CTE 2019

Level: National

Partner:

Month: 15th of November, 2019

Number of participants/type of audience: 50 researchers and teachers

Experiences from the GLAT project were presented at International Scientific and Art Conference Contemporary themes in education – CTE 2019. Krešo Tomljenović presented the paper "Computational Thinking of Future Junior Primary School Teachers" and introduced conference participants with activities and results of the GLAT project.

The conference took place from 15th to 17th of November at Faculty of Teacher Education, University of Zagreb, Croatia.

Workshops and events

At local and regional levels, project and its results have been also disseminated by organizing workshops and similar events.

Three workshops for professional development of primary school junior grade teachers were held at UNIRI, as the most important part of the GLAT education which was organized according to the developed syllabus and materials.

In the last month of the project, final conference was organized at UF and attended by teachers, students, and representatives from UNIRI.

A series of other events was organized for teachers and students to disseminate project results and promote goals of the project in Croatia, partner countries and beyond. For example, lecture about digital competences and computational thinking at UF attended by 200 primary school junior grade teachers.

GLAT workshops

Workshop 1 - Game based learning and unplugged activities

The workshop “Game based learning and unplugged activities” was successfully held at the University of Rijeka, Department of Informatics on 5th and 6th of April 2018. The workshop gathered focus group of 24 junior grade teachers from 13 primary schools.

The workshop “Game based learning and unplugged activities” was the first of three workshops or three modules for professional development of primary school junior grade teachers organized within the GLAT project and in cooperation with Croatian Education and Teacher Training Agency.

During the workshop, teachers attended lectures and demonstrations and were introduced to the concepts of Game Based Learning (GBL) and unplugged activities. They also participated in individual and group activities and analysed examples of games and unplugged activities for different school subjects. Teachers had the opportunity to get to know and try out the tools for creating learning scenarios (LePlanner) and materials for unplugged activities (Web 2.0 tools). In addition, they started to apply newly acquired knowledge through the development of their own learning scenarios. Their task is to design a learning scenario for a selected subject that will include games and unplugged activities which will encourage creativity, logical thinking, and problem-solving skills in students.

After the first workshop, education within the GLAT project was continued in the online environment – the MoD learning management system, in which teachers were trained by project team experts. Based on advice and feedback from the experts, teachers developed improved versions of the learning scenarios and implemented them in classes with their students.

Workshop 2 - PBL, online quizzes and logical tasks

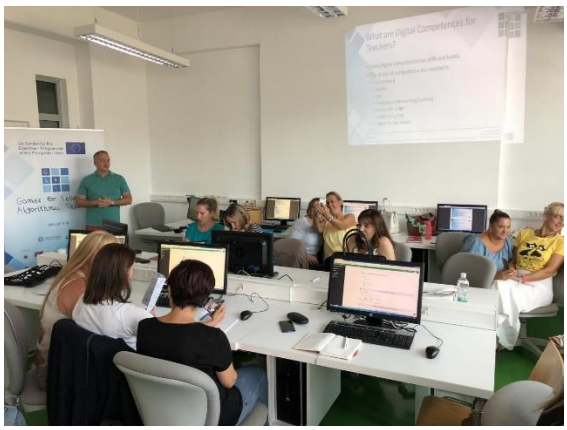
The second GLAT workshop was held at the University of Rijeka, Department of Informatics on 28th and 29th of August 2018 and was attended by the focus group of junior grade teachers from primary schools in Rijeka. The theme of the workshop was “PBL, online quizzes and logical tasks”.

The workshop “PBL, online quizzes and logical tasks” was the second of three workshops for the professional development of junior grade primary school teachers organized within the GLAT project and in cooperation with Croatian Education and Teacher Training Agency.

During lectures, demonstrations and practical work, participants were introduced to the concept of Problem Based Learning (PBL) and the possibilities for integration of problem-solving tasks and games into the lecturing process. They were also introduced to digital tools for creating online quizzes and logical tasks (Web 2.0 tools). Through individual and group work, participants had a chance to analyze and create examples of activities for various school subjects. During the workshop, teachers started to apply the newly acquired knowledge in designing their own learning scenarios with PBL activities and online quizzes and logical tasks in order to encourage the development of algorithmic thinking of students. For this purpose, teachers use the tool LePlanner.

After the end of the workshop, teachers continued to work on their scenarios. They used the Moodle MoD learning management system and consulted with experts from project team who mentor the development of scenarios. Teachers implemented their scenarios in classrooms with their students and shared their experiences with other participants.





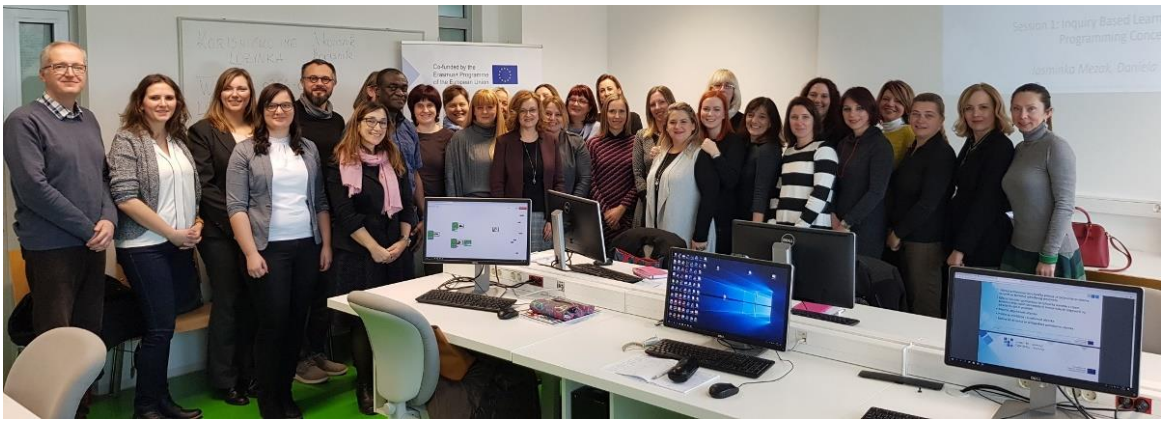
Workshop 3 – Games and tools for programming

The workshop “Games and tools for programming” was successfully held at the University of Rijeka, Department of Informatics on 9th and 10th of January 2019.

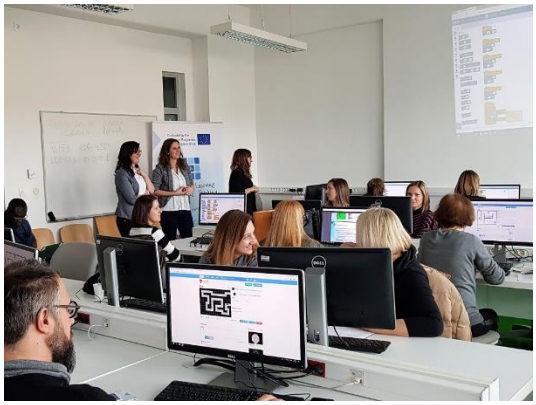
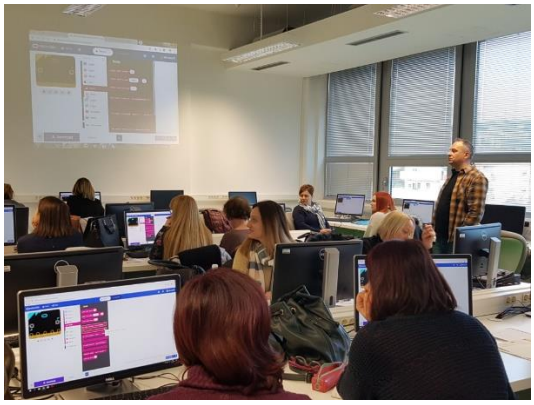
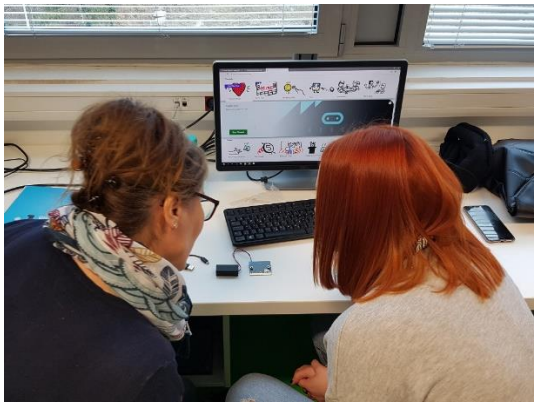
This workshop was the last of three workshops for the professional development of junior grade primary school teachers organized within the GLAT project and in cooperation with Croatian Education and Teacher Training Agency.

During the workshop, participants attended lectures, demonstrations, and practical work and were introduced to the concept of Inquiry Based Learning (IBL) and possibilities for learning basic programming concepts using games. Through individual and group activities, they analysed and designed examples of games for different school subjects. They were also introduced to games and tools for learning programming like Run Marco!, Code.org, Blockly Games, and Scratch – a block-based visual programming language by which students can program their interactive stories, games, and animations. Participants have also learned how to apply the micro:bit for encouraging algorithmic thinking.

Teachers started designing their own learning scenarios with games and tools for learning programming for selected school subjects. They continued to develop the scenarios after the completion of the workshop, with the help of experts from the project team. Mentoring of the scenario development took place in the MoD LMS. Teachers also designed a graphical form of their scenarios using the LePlanner tool and implemented them in the classroom with their students.






Final GLAT conference

Erasmus + project GLAT – Games for Learning Algorithmic Thinking was concluded with the final conference held on Friday, 20th of September, 2019 at the Faculty of Teacher Education, University of Rijeka.

The conference was attended by 70 teachers, students, and representatives from UNIRI among which there was about 40 students – future teachers and primary school junior grade teachers who were not included in the GLAT education.

In the beginning of the conference, the project leader prof. Nataša Hoić-Božić presented the GLAT project and project activities with a focus on education for primary junior grade teachers, which was organized in cooperation with the Croatian Education and Teacher Training Agency (AZOO) from Rijeka. The education was held for a focus group of about 20 teachers from Rijeka region and included three face-to-face workshops and online teaching using the learning management system Moodle MoD. During the workshops, teachers had the opportunity to learn about various innovative teaching methods using ICT: Game Based Learning (GBL), Problem Based Learning (PBL) and Inquiry Based Learning (IBL). After each workshop, their task was to apply the lessons learned in designing learning scenarios for the chosen subject and apply it with their students.

Project team coordinator from the Faculty of Teacher Education dr. Jasminka Mezak expressed her satisfaction with the project activities and thanked all the participants for the successful collaboration.

Dr. Martina Holenko Dlab presented the project results that are available on the GLAT web site. The results include a syllabus with lessons plans and materials, and a set of learning scenarios created by the teachers – participant of GLAT education. With the support of mentors from the project team, participant developed 62 learning scenarios on the following topics:

1. Game Based Learning (GBL) and unplugged activities
2. Problem Based Learning (PBL), online quizzes and logical tasks
3. Games and tools for programming

Outstanding learning scenarios were translated into English. One particularly noteworthy result is the set of scenarios involving digital games designed by teachers and their students and created by university students using Scratch. Games that can be used to practice math or learn about nutrition, the seasons, cultural and historical monuments and many other topics are available in the Scratch studio GLAT.

After presentation of results, the participants Mate Verović from Primary School “Pehlin” Rijeka and Bojana Lanča and Tašana Bobanović from Primary School San Nicolò Rijeka described their experiences during the project and presented examples of good practice. On behalf of all the participants, teacher Tašana Bobanović thanked the members of the project team for their knowledge and advice and patience during the mentoring. She expressed hope that there will be opportunities for further education in the future and that successful collaboration will continue.

In the final part of the conference, all participants of GLAT education were awarded diplomas for participation.

Participants were addressed via video messages by project team members from partner institutions from Slovenia, Estonia, Bulgaria and Northern Macedonia. They thanked them for their hard work in developing the learning and teaching scenarios and congratulated them on their diplomas. The

partners noted that they shared the results of the project with teachers in their countries and that they would continue to do so.

The conference was concluded by Senior Advisor Ivana Jurjević Jovanović from Education and Teacher Training Agency who emphasized the great importance of GLAT education topics for teachers in the context of implementing the curricular reform programme School for Life.

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Other events

Programming contest Scratch Match 2018

GLAT project members from UNIRI team participated in the organization of the programming contest „Scratch Match“. The contents was held on 17th of April on the occasion of the Open-Door Days of UNIRI Departments, in the week of Science Festival.

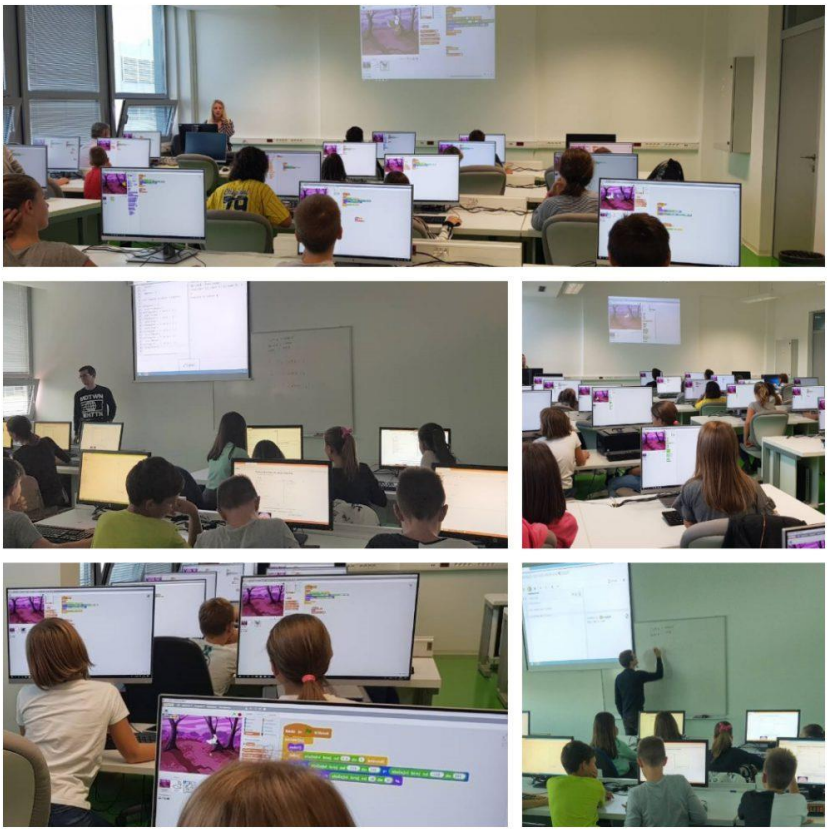
Task for students was related to the highlighted theme of this year’s Science Festival – “Discoveries”. Students were expected to create a game using Scratch in which a player should recognize discoveries in the field of ICT.

A total of 22 students involved in Code Clubs organized by UNIRI participated in the contest. Students demonstrated good knowledge of a programming language Scratch and created interesting games.

EU Code Week event at UNIRI

GLAT project members organized coding workshops on the occasion of the EU Code Week. The workshops were held at the University of Rijeka, Department of Informatics on 17th of October 2018.

During the workshops, students from primary schools created Code club projects in Scratch and Python. By creating animations and computer games, the students gained their first programming experience in a fun way that, at the same time, stimulate creativity and logical thinking.



Activities for encouraging algorithmic thinking during Open-Door Days at UNIRI

During the Open-Door Days of UNIRI Departments, traditionally held in the week of Science Festival, GLAT project members from UNIRI team organized several activities in order to encourage algorithmic thinking and promote learning programming:

Programming contest „Scratch Match“ – Students were expected to create a game using Scratch in which a player needed to recognize colors and write color names in English (“Colors” was the highlighted theme of this year’s Science Festival).

Programming contest „Mighty Py“ – Students were expected to create an application with Python which can be used to randomly assign students to teams and display badges (selected geometric shapes) with names of team members.

Workshop “Games for encouraging algorithmic thinking” – Students were expected to design games and interactive stories that can be used for learning (for different school subjects) and than to create them in Scratch.

A total of 39 primary school students participated in these activities on 9th of April 2019. Students designed interesting games and demonstrated good programming knowledge in Scratch or Python.

In addition, GLAT project promotional materials were distributed to all interested visitors including teachers who attended popular-scientific lectures at the Open-Door Days of UNIRI.

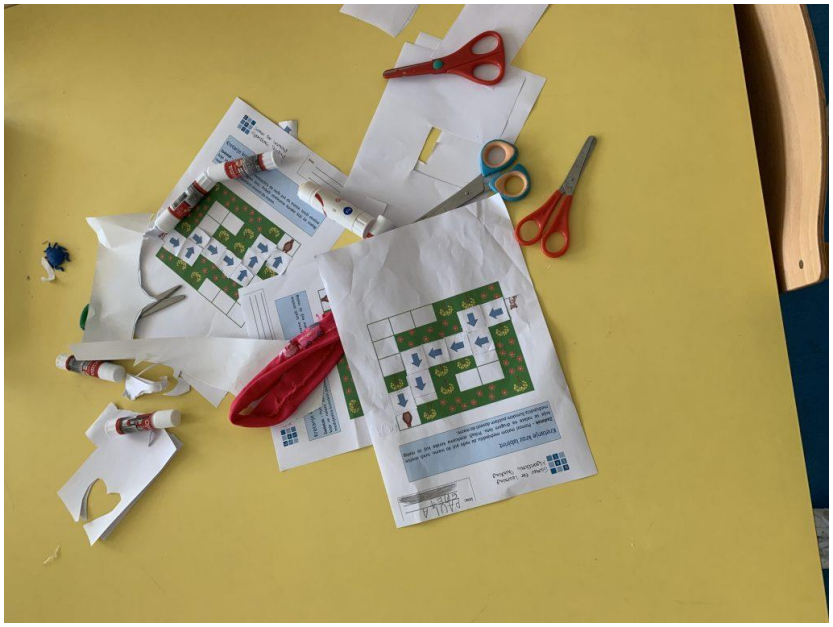
Promoting algorithmic thinking during “Magical Day” in kindergarten “Đurđice”

Jasminka Mezak (UFRI) held workshop for promoting algorithmic thinking development on May 10th 2019 in the kindergarten “Đurđice”, Rijeka. The workshop was held within “Magical Day” project.

“Magical Day” project is organized as part of the program 27 neighbourhoods within the framework of the project Rijeka European Capital of Culture (EPK) 2020. A series of short, creative and innovative workshops are adapted to preschool children and held for children from kindergarten “Đurđice”.

During her workshop, Jasminka Mezak encouraged algorithmic thinking among children in a fun way, through games. Children participated in unplugged activities where they used worksheets (to solve the maze) and led each other through the space (to practice terms left, right, up, down, back and forth).

These activities served to educators from the kindergarten as examples for encouraging the algorithmic thinking among pre-school age children.



Development of computer thinking through project work in Scratch

Irena Nančovska Šerbec (UL) organized a workshop “Development of computer thinking through project work in Scratch” for Slovenian teachers during the Conference of Science Teachers: Education for the Present and the Future (NAK 2019).

She presented how students develop computational thinking through concepts, practice and perspective and that concepts of computer thinking are present in Scratch projects. P

Participants were introduced with experiences from the GLAT project where digital storytelling approach was used in combination with Scratch to develop computational thinking skills among young students.

Various projects such as Maze, Escape Room and Driving Simulation were analysed and discussed in order to highlight the possibility of their application for development of computer thinking among students. Participants also had chance to quantitatively evaluate Scratch projects with dr. Scratch tool, which checks for the presence of the computational thinking concepts and provides feedback to students and teachers with ideas and tips on how to improve the code.

Workshop "Games for Learning Algorithmic Thinking" during STEM 2 conference

Members of the GLAT team from UNIRI organized a workshop "Games for Learning Algorithmic Thinking" during the conference "STEM Area in the Educational System: Today for Tomorrow 2" – STEM 2 that took place at University of Rijeka on 15th of November 2019.

The aim of the workshop is to outline the possibilities of using educational games to develop algorithmic thinking and to prepare students for learning programming. By designing and playing educational games, students can learn basic programming concepts (sequence, variable, loop, condition) and concepts of computational, algorithmic thinking (decomposition, pattern recognition, abstraction, and algorithms). Also, students can achieve specific learning outcomes from different school subjects.

During the workshop, Ivona Franković demonstrated Scratch games developed during the project. Students had the opportunity to play games developed in the visual programming language Scratch and practice math, test their knowledge about nutrition, seasons, cultural and historical monuments, etc.

Students also had the opportunity to create a simple game in Scratch.

The workshop was attended by 38 primary school students and 3 teachers.

Workshop "Games for Learning Algorithmic Thinking" during STEM 2 conference

Members of the GLAT team from UF organized a workshop "Encouraging algorithmic thinking with and without computers" during the conference "STEM Area in the Educational System: Today for Tomorrow 2" – STEM 2 that took place at University of Rijeka on 15th of November 2019.

The workshop was attended by 15 university students – future junior grade teachers.

Jasminka Mezak and Petra Pejić Papak presented different innovative teaching methods that stimulate creativity, logical thinking, and problem solving skills among students, and can be used for development of algorithmic thinking.

They also presented learning scenarios developed during the GLAT project and demonstrated the use of Web 2.0 tools for preparing content for learning activities for development of algorithmic thinking.

Students were introduced to tools for designing activities with and without use of computer and GLAT template for creating learning scenarios.

Students also had the opportunity to create an example scenario that involve simple logic assignments and online quizzes.

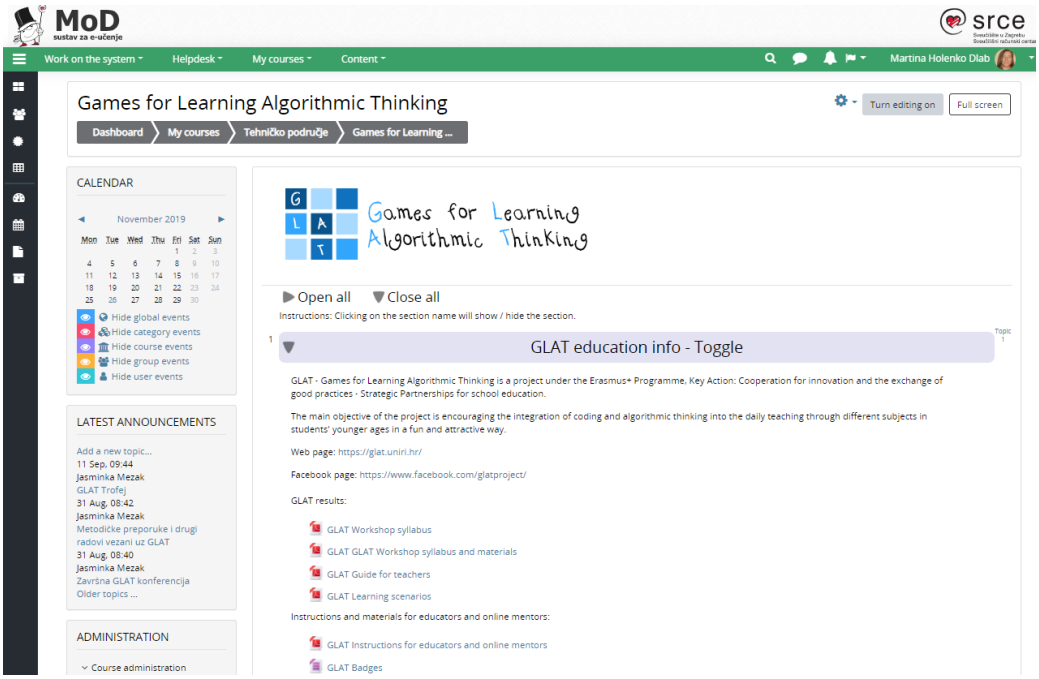
E-course

E-course GLAT – Games for Learning Algorithmic Thinking includes materials for education designed during the project GLAT. The emphasis is placed on the three two-days f2f (classroom-based) workshops, which are combined with online learning during which the teachers are mentored by the experts who conduct the education.

All learning materials for GLAT education are available within Moodle e-course "Games for Learning Algorithmic Thinking" in the MoD learning system (https://mod.srce.hr/course/view.php?id=284). After enrolling in the e-course, it is possible to access the materials in Croatian and English. Users need to log into the system MoD with an AAI@EduHr account. To access the e-course without AAI@EduHr account, please contact us at glat@inf.uniri.hr.

Mirror courses are also freely available in English at SWU EDUGAMES platform (https://edugames.swu.bg/moodle/course/view.php?id=8).

Backup of the e-course (English or Croatian version) is also available on request to be restored on your own Moodle server. Please, contact us at glat@inf.uniri.hr.



The **introductory section** of the e-course contains Workshop syllabus, Guide for Teachers, and a document with learning scenarios prepared by teachers that serve as examples of good practice. It also includes instructions for educators and online mentors that are accompanied with **e-course backup** and archive with pictures for creating badges for participants. The **badges** are awarded for the created learning scenarios and written reflections after implementing the scenarios in classrooms. Participants who win all the badges are assigned a special badge - the **GLAT trophy**.

Workshop materials are organized in the e-course in three sections, one for each workshop. All documents are available under a license that allows them to be freely shared, modified and transform, so lecturers of future educations can **adapt them to their participants**. Sections include Word documents with lesson plans and PowerPoint presentations that educators can easily modify. Word templates, examples, links and tasks for the participants are also prepared.

The section "Learning scenarios development" contains block for important dates (deadlines for completing the tasks) and the forums for submitting the results of the tasks.

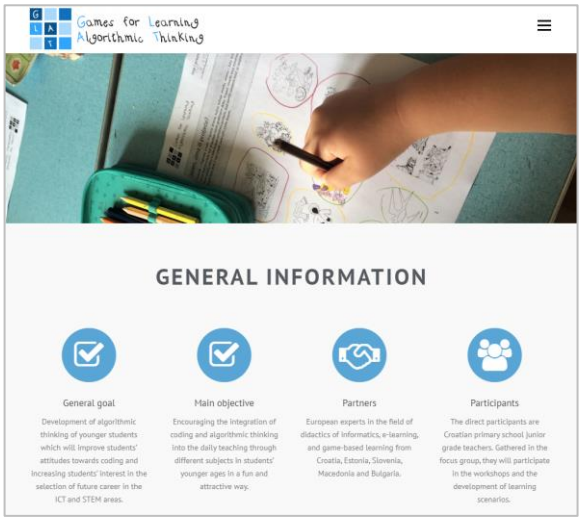
Online dissemination

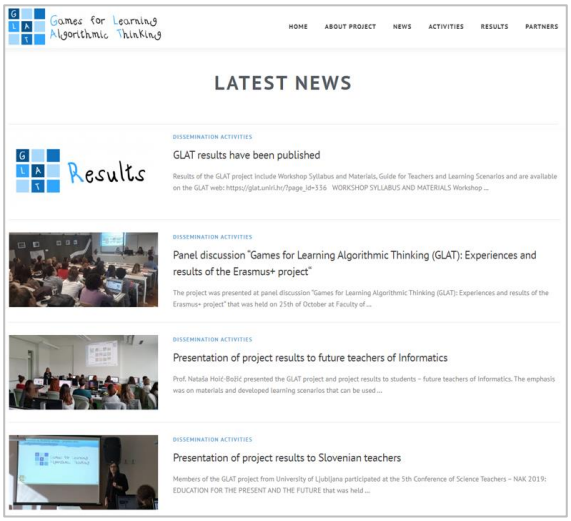
Online dissemination activities included publishing project main events and news on project web site and project Facebook page, publication of newsletters, sharing resources online, and posting news and articles.

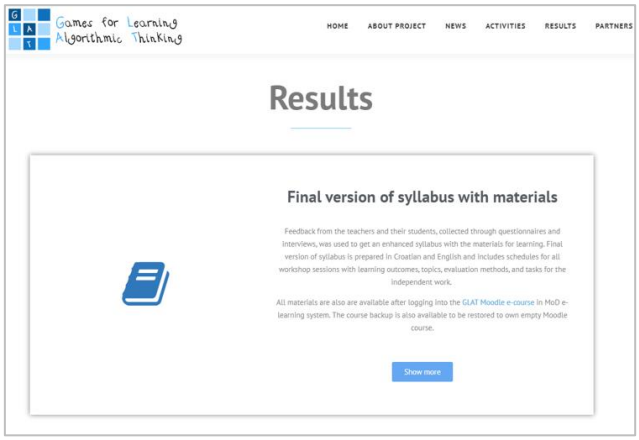
Website

Project website https://glat.uniri.hr on WordPress platform offers all information about the project including background, objectives, contact information and details about the partners, activities, and results. During the project, the web site has been continuously updated with news and other relevant information about the project.

All project results are also available for download at the web site in section Results.







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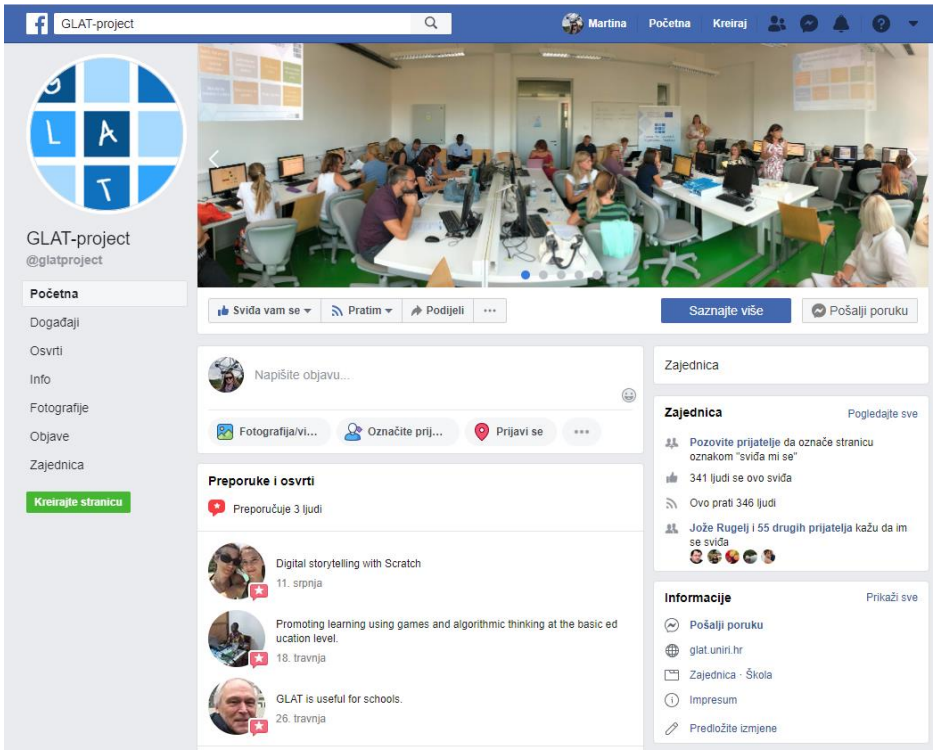
Facebook page

Project Facebook page https://www.facebook.com/glatproject/ has been used for publishing project main events, news and dissemination activities of all participating organisations in order to keep stakeholders and target groups informed.



Newsletters

GLAT newsletters have been published periodically to disseminate news regarding project activities and results.

Four issues of newsletter were published about the following topics:

1. **Newsletter 1, (May, 2018)**: Workshop 1 – GBL and unplugged activities
2. **Newsletter 2, (October, 2018)**: Workshop 2 – PBL, online quizzes and logical tasks
3. **Newsletter 2, (February, 2019)**: Workshop 3 – Games and tools for programming
4. **Newsletter 4, (July, 2019)**: Development of algorithmic thinking using digital storytelling

1st workshop – Game Based Learning and unplugged activities

The first workshop entitled “Game based learning and unplugged activities” was held at the University of Rijeka, Department of Informatics on 5th and 6th of April 2018. The Faculty of Teacher Education gathered focus group of 24 junior grade teachers from 13 primary schools with the help of Education and Teacher Training Agency (AZOO). Participation in the workshops will represent a form of professional development for the teachers.

The goal of the first workshop was to introduce the participants to the concepts and examples of Game Based Learning and unplugged activities as well as tools for creating content for unplugged activities and designing learning scenarios.

The main learning outcomes of the workshop were:

- describe principles of Game Based Learning,
- use Web 2.0 tools for creating content for unplugged activities,
- create learning scenarios in order to develop innovative ideas for carrying out unplugged activities.

The workshop was conducted by Nataša Hoić-Božić, Martina Holenko Dlab and Ivona Franković from the University of Rijeka, Department of Informatics, Jasminka Mezak, Petra Pejić Papak and Darko Lončarić from the Faculty of Teacher Education, University of Rijeka, Viktoria Humal from Tallinn University, Jože Rugelj, Mateja Bevčič and Anja Luštek from the University of Ljubljana, Daniela Tuparova and Ivanichka Nestorova from South-West University Neofit Rilski.

In the introductory session the leader of the GLAT project from UNIRI welcomed workshop participants, presented the main information about the project and introduced project members. She also explained the concepts of algorithmic thinking, computational thinking and problem solving as well as presented planned activities for participants. Afterwards, all the participants briefly presented the school they come from and their motivation for participating in the workshop. They all share the desire to acquire new knowledge that will enable them to keep up with their students and with the new trends in education.

During the first session, teachers were introduced to the learning management system MoD and provided with access to the e-course "Games for Learning Algorithmic Thinking". Within this e-course, teachers will be able to access all learning materials, communicate with other project members, submit created learning scenarios, and share their impressions regarding implementation of learning scenarios in classroom with other participants.

Teachers also participated in the survey that was conducted in order to determine to which extent the teachers are familiar with certain concepts, teaching and learning methods and tools.

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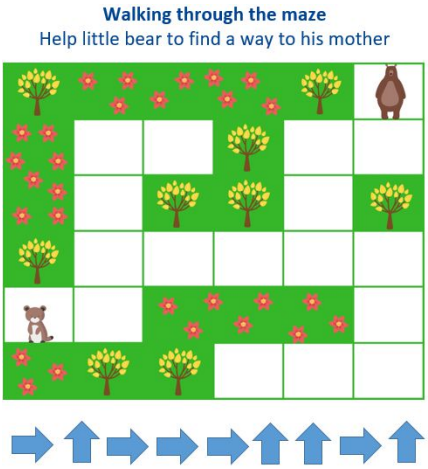
In the second workshop session, teachers attended lectures conducted by the experts from UL during which they were introduced to the concepts of Game Based Learning. Learners explored and analysed the examples of simple serious games with the topics from different school subjects in order to be able to point out typical characteristics of games and select suitable games for integration into learning process.

Next workshop sessions held by SWU and UF experts were about unplugged activities for algorithmic thinking. Teachers learned what unplugged activities were and how to use them in classroom. They also participated in individual and group activities and analysed examples of games and unplugged activities for different school subjects (e.g. “Walking through the maze”, “Song algorithm”, “Find the words in the grid”) as well as real – life algorithms (e.g. “Make a sandwich”, “Seed the plants”, “Clean teeth”). Through practical part of the sessions teachers learned how to use Web 2.0 tools Canva and Sketchpad for creating materials for unplugged activities.



The first day of the workshop was concluded with the group work during which teachers working in teams designed their own examples of unplugged activities for different school subjects by using presented Web 2.0 tools and previously prepared templates. On the second day of the workshop, teachers were introduced to the concept of *learning scenario*. Experts from UF explained how to design learning scenarios and presented the examples of scenarios with games and unplugged activities. Teachers started to use written forms for preparing the learning scenarios, but they also had the opportunity to try out the authoring tool LePlanner (introduced by TU) for visualising learning scenarios in graphical forms.

In the last part of the workshop, participants started to apply newly acquired knowledge through the development of their own learning scenarios. Their task was to design a learning scenario that include unplugged activities which encourage creativity, logical thinking, and problem-solving skills. Teachers could choose any school subject (e.g. mathematics, nature and society, Croatian) and lesson within the subject as well as unplugged activity that promotes algorithmic way of thinking.

In the following weeks, teachers will continue to design learning scenarios with the help of online mentoring by the GLAT project experts. Completed versions of the scenarios will be reviewed by the experts and the final refined versions will be implemented in the classrooms by the teachers.

The second workshop on the use of online quizzes and logical tasks to encourage computational thinking will be held on 28 and 29 August 2018.

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Games for Learning Algorithmic Thinking

Newsletter 2
October 2018

2nd workshop – PBL, online quizzes and logical tasks

The second of three GLAT workshops entitled "PBL, online quizzes and logical tasks" was held at the University of Rijeka, Department of Informatics on 28th and 29th of August 2018. The workshop was attended by the focus group of junior grade teachers from primary schools in Rijeka.

The goal of the second workshop was to introduce the participants to the concepts and examples of Problem Based Learning (PBL), logical tasks and online quizzes as well as with tools for creating logical tasks and online quizzes.

The main learning outcomes of the workshop were:

- describe principles of Problem Based Learning,
- use Web 2.0 tools for creating logical tasks and online quizzes,
- apply digital didactic games in different school subjects,
- create learning scenarios in order to develop innovative ideas for carrying out logical tasks and online quizzes.

1st workshop follow-up activities

After the first GLAT workshop, the teachers from focus group created learning scenarios with innovative ideas to carry out game-based learning and unplugged activities. They were able to decide independently which subject and lesson to choose.

During the learning scenario development, online mentoring of experts from partner organizations was provided within the e-course in the LMS. The teachers also implemented the designed scenarios in classes with their students and shared their experiences in the LMS.

The following three scenarios were chosen, translated into English, and published on GLAT website:

1. *Rhythmic and dance structures,* Physical Education (4th grade).
2. *Playing and revising about the traffic,* Nature and Society/Homeroom class (2nd grade).
3. *Addition and subtraction to 20,* Mathematics (1st grade).

In the introductory session the leader of the GLAT project Nataša Hoić-Božić (University of Rijeka, Department of Informatics) and Jasminka Mezak (Faculty of Teacher Education) welcomed the workshop participants, gave overview of the 1st workshop and presented the main information about the 2nd workshop. After that the teachers from the focus group attended lectures, demonstrations and participated in practical work sessions.

In the first session, Mart Laanpere and James Sunney Quaicoe (Tallinn University) introduced the concept of PBL and presented examples of learning scenarios illustrating scaffolding and fading in coding lessons. Teachers also had a group task to design a PBL scenario with coding problems.

Daniela Tuparova (South-West University Neofit Rilski) held a presentation about logical tasks and quizzes in classroom in the second session. She pointed out examples of logical tasks and quizzes providing propaedeutic for algorithms and programming. During the group work, participants were exploring examples and resources for different school subjects.

In the third session, Jasminka Mezak (Faculty of Teacher Education) introduced participants to advantages of using Web 2.0 tools for creating quizzes and logical tasks. They had a chance to explore examples and resources and create examples of quizzes and logical tasks for different school subjects using the following tools: Kahoot, Wizer, Match the memory.

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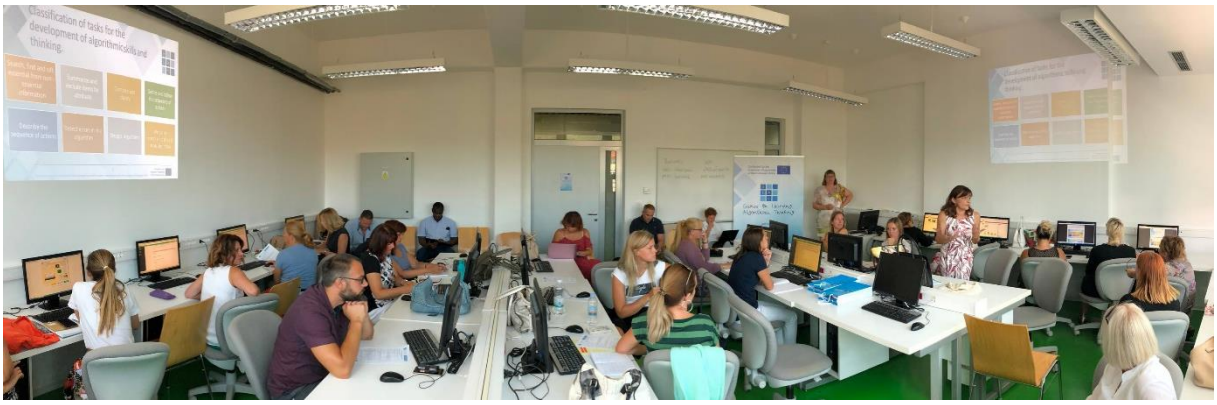
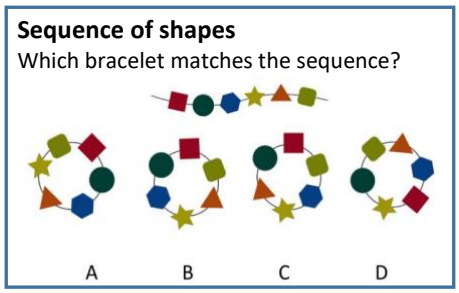
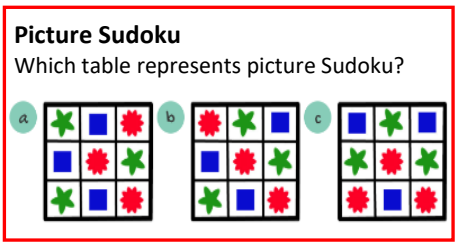
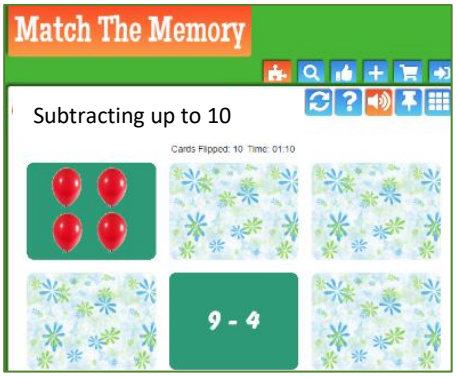
Games for Learning Algorithmic Thinking



The second day of the workshop started with the session entitled “Games in lessons”. Ana Madevska Bogdanova, Katerina Zdravkova and Vladimir Trajkovik (Ss. Cyril and Methodius University in Skopje) held presentations about digital tools within the process of problem solving, role-playing and knowledge gathering, and integration of games into lecturing process. The lecturers demonstrated how to use problem solving, role-playing and knowledge gathering in logical games and how to find an appropriate place for games in the lessons. During the group work, the teachers were exploring and analysing existing games.







During the last workshop session, the participants started with the development of their own learning scenarios with the help of all lecturers. Their task was to apply newly acquired knowledge and design a learning scenario containing quizzes and logical tasks in order to encourage creativity, logical thinking, and problem-solving skills. Teachers could choose any school subject and lesson within the subject. They used the prepared template for learning scenario development and the tool LePlanner for visualising learning scenarios.

At the end of the workshop, teachers participated in the survey that was conducted in order to determine their level satisfaction with the presented topics and applied teaching and learning methods.

After the end of the workshop, teachers will continue to work on their scenarios. They will use the Moodle MoD LMS and consult with experts from project team who will mentor the development of scenarios. Teachers will implement their scenarios in classrooms with their students and share their experiences with other participants. Developed learning scenarios will be one of the results of the GLAT project. Outstanding scenarios will be translated into English and, together with workshop syllabus and learning materials, available for use to all interested parties in Croatia and beyond.

The third GLAT workshop “Games and Tools for Programming” will be held on 9th and 10th of January 2019.

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Games for Learning Algorithmic Thinking

Newsletter 3
February 2019

3rd workshop – Games and tools for programming

On 9th and 10th of January 2019, the third GLAT workshop "Games and tools for programming" was held at the University of Rijeka, Department of Informatics. The workshop gathered focus group of junior grade teachers from primary schools in Rijeka who were introduced to the basic programming concepts and various games and tools that can be used for learning programming.

The main learning outcomes of this workshop were:

- describe principles of Inquiry Based Learning
- describe the elements and process of computational thinking
- recognise the basic programming concepts in examples of different didactic games
- find, analyse, and remix existing examples of didactic games
- create learning scenarios in order to develop innovative ideas for using games with elements of coding.

After the introductory greetings and the overview of the 2nd workshop follow-up activities, the main activities of the 3rd workshop were announced. The introductory part was followed by the lectures, demonstrations and practical work sessions attended by the teachers from the focus group.

In the first session, Daniela Tuparova (South-West University Neofit Rilski) and Jasminka Mezak (Faculty of Teacher Education) introduced participants to the concept of Inquiry Based Learning (IBL) and possibilities of using games for learning basic programming concepts (algorithm, sequence of instructions, conditional sentence, loop, and variable).

Through individual and group activities, teachers analysed examples of games and tools for learning programming like Run Marco!, Code.org, Blockly Games, and Scratch.

Irena Nančovska Šerbec (University of Ljubljana) held a presentation about learning programming with games and stories in the second session. She explained the concept of computational thinking and possibilities for its development with visual programming language Scratch. By using Scratch, students can program their own interactive stories, games, and animations.

Participants were given the task to find, analyse and compare different examples of games and digital stories in Scratch.

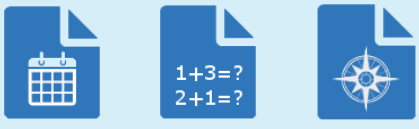
2nd workshop follow-up activities

Teachers from the focus group applied the acquired knowledge from the second GLAT workshop "PBL, online quizzes and logical tasks" to design their learning scenarios. The designed scenarios contain quizzes and logical tasks in order to encourage creativity, logical thinking, and problem-solving skills. Experts from partner organizations provided online mentoring within the e-course in the LMS MoD.

The teachers implemented the designed scenarios in classes with their students and shared their experiences in the LMS.

The outstanding three scenarios, translated into English are:

1. *Addition to 5,* Mathematics (1st grade).
2. *Months of the year,* Nature and Society (2nd grade).
3. *Spatial orientation,* Nature and Society (3rd grade).



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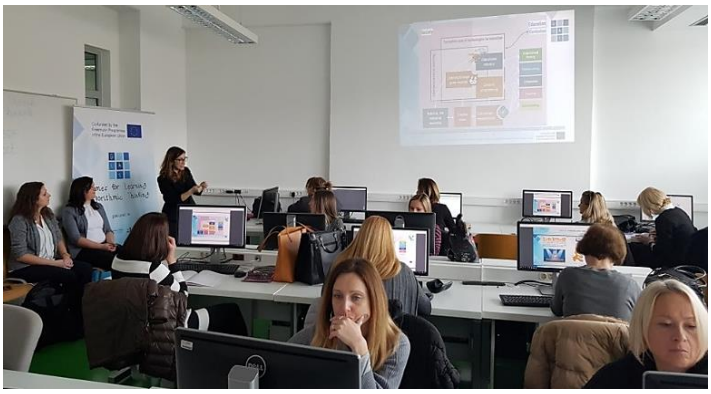
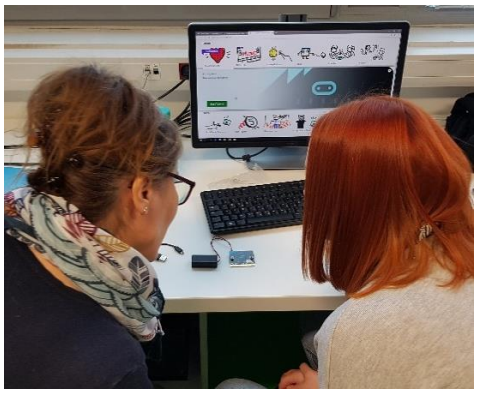
Games for Learning Algorithmic Thinking

Newsletter 3
February 2019





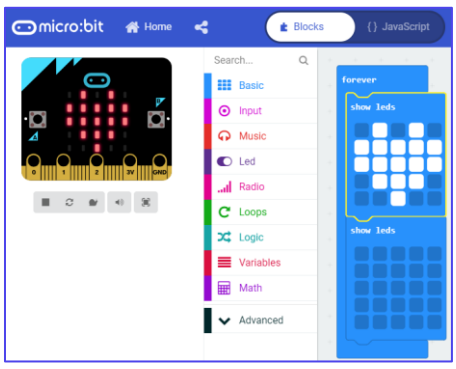
In the third session, Anja Luštek and Mateja Bevčič (University of Ljubljana) presented possibilities of the Scratch in more detail. Participants were first asked to test few previously prepared examples, then they were introduced to the basic principles of the way Scratch works (how to start, where and what are blocks, how to move them), and at the end of the session they were encouraged to change and remix existing Scratch projects to create their own stories.

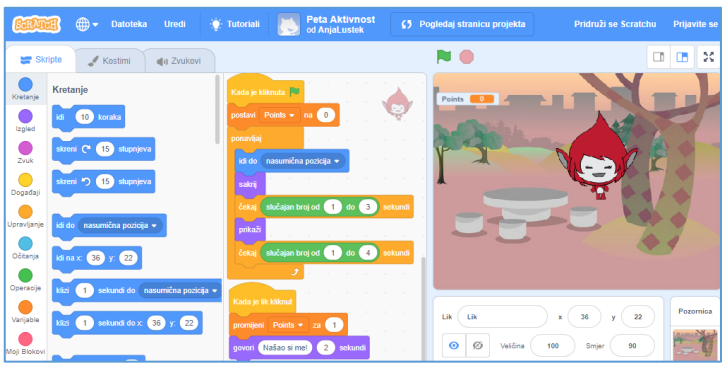
During the second day of the workshop participants had a chance to learn how to apply micro:bit for encouraging algorithmic thinking. In the session led by Vladimir Trajkovik (Ss. Cyril and Methodius University in Skopje), the role of games in development of computational thinking was further explained and participants were introduced to the ways to incorporate technology and digital tools to engage their students. Afterwards, they explored the functionalities and features of micro:bit and its development environment as well as possibilities to apply this technology in different school subjects.

With the help of experts from project team, teachers started with creation of their game-based learning scenarios. They could use some of the existing games for encouraging algorithmic thinking or design a game or a story in Scratch with their students who will help to define the main elements of the game: the story, the goal of the game, the characters, the scenes, and logical tasks for directing the flow of the game.

At the end of the workshop, an evaluation was carried out. This was the last of the three workshops so, beside survey regarding the activities of the 3rd workshop, teachers participated in a survey about their expectations regarding the development of algorithmic thinking during GLAT workshops. The results will be compared with the matched survey conducted at the beginning of the 1st workshop.

The future project activities will include preparation and evaluation of the final enhanced version of syllabus with the learning materials and the best examples of learning scenarios as well as organization of a final video conference for dissemination of project's results.





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Games for Learning Algorithmic Thinking

Newsletter 4
July 2019

Development of algorithmic thinking using digital storytelling

Since the 3rd GLAT workshop "Games and tools for programming", teachers from the focus group have developed learning scenarios that include digital storytelling.

Digital storytelling is a process of telling stories by integrating multimedia elements (images, sound, text, animation) using digital tools. By engaging in the process of designing and creating digital stories, students can develop algorithmic thinking skills as well as many other skills such as research, organization, digital literacy, and problem solving skills.

The teachers have developed initial ideas for interactive digital stories related to topics from various school subjects. With the help of their students, they described the setting of the story and decided on names and appearances of characters (playing characters and characters who guide the player through the game and give instructions and feedback). After exploring the topic and gathering necessary information, they designed game elements that enable the player to develop algorithmic thinking skills (e.g., challenges like labyrinths, brainteasers, sorting games, and puzzles). The students were also included in defining scenes, the sequence of events, and logical conditions for directing the flow of the game.

In the process of designing interactive stories with game elements, students had the chance to develop their algorithmic thinking skills and learn basic programming concepts:

- **sequence** – students arrange the elements in the chronological order in which they will appear in the story
- **data** – students define which data need to be stored (e.g. player's name, collected points, remaining time, etc.)
- **condition** – students direct the story flow, define how the player will collect points, define the end of the game, etc.
- **loop** – students define challenges for the player, decide how many attempts the player will have to finish the game, etc.

Visual programming language Scratch has been chosen for creating designed digital stories because it offers a library with numerous sprites (characters), backgrounds, and sounds. The participants of the GLAT workshops were junior grade teachers and non-informatics teachers who did not have enough knowledge and skills to independently code in Scratch. Therefore, in the preparation of the stories with game elements university students - future teachers of informatics, helped the teachers. They programmed the stories according to the instructions provided by the teachers and their students.

The following table shows outstanding stories that were created during this very successful collaboration.

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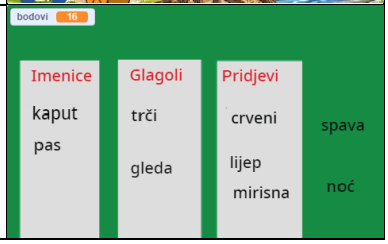
Games for Learning Algorithmic Thinking

Name with link	Subject and grade	Story	Game elements	Preview
Seasons	Science 1st grade	A girl named Mia moved from Africa to Croatia and wants to learn about the seasons.	Choose appropriate clothes, seasonal food, and write the names of the seasons.	
Choose healthy!	Science 2nd grade	A girl named Tašana goes to the market to buy healthy food for a meal.	Collect healthy food, write the names of the main meals, and put the cutlery next to the plate.	
Cultural heritage	Science 4th grade	A boy named Joseph was abducted by aliens who want to learn about the Croatian cultural heritage.	Mark the Croatian counties where UNESCO sights are located, collect pictures of the intangible cultural heritage.	
Calculation castle	Mathematics 1st grade	To win the princess' hand, young prince must find the golden key and free the princess from the castle.	Collect a number of items (according to given numerical expression), solve word problems.	
Hlapić plays with words	Croatian language 3rd grade	To find his lost friends in a castle, a boy named Hlapić needs to recognize different word classes (nouns, verbs, adjectives).	Sort words, to find a certain word class in a sentence, collect words of a given class.	

Teachers combined the activity of designing the digital story with other activities in line with Inquiry Based Learning, which was one of the topics of the 3rd workshop, and developed learning scenarios for various school subjects. Most of the learning scenarios were for the *Science* course and the other scenarios were for *Mathematics* and *Croatian language*. The teachers implemented the designed scenarios in the classroom with their students who really enjoyed playing the game they had designed together.

All the stories can be found in the GLAT Scratch studio: https://scratch.mit.edu/studios/7387159/.

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Online resources, posts and articles

Posts on social media, articles on various web sites and educational portals, published to reach all target groups, are listed in the table below.

Month	Partner	Website	Title/Topic
M1 October, 2017	UNIRI	University of Rijeka web site http://uniri.hr/	The start of the GLAT project
M1 October, 2017	UNIRI	University of Rijeka, Department of Informatics web site www.inf.uniri.hr	General information about the project
M1 October, 2017	UNIRI	University of Rijeka, Department of Informatics web site www.inf.uniri.hr	Info about the presentation of the GLAT project to the Council of the Department of Informatics
M1 October, 2017	UNIRI	Project ELARS web site https://goo.gl/vMoi6U	Info about the start of the GLAT project
M1 October, 2017	UNIRI	Facebook page www.facebook.com/glatproject/	General information about the project
M1 October, 2017	UNIRI	Alumni group of Department of Informatics at LinkedIn https://www.linkedin.com/groups/2140273	The start of the GLAT project
M1 October, 2017	UL	Faculty of Education, University of Ljubljana (News): https://goo.gl/JPVuzv	News about the GLAT project (partners, duration, short description of the project)
M1 October, 2017	UL	Faculty of Education, University of Ljubljana (Erasmus+ projects): https://www.pef.uni-lj.si/947.html	Information about the project
M2 November, 2017	UFRI	Faculty of Teacher Education Rijeka webpage (News): http://www.ufri.uniri.hr	News about the presentation of the GLAT project to the Council of the Faculty of Teacher Education
M2 November, 2017	UFRI	Faculty of Teacher Education Rijeka webpage (International projects) https://bit.ly/37CK8vw	Information about the project

Month	Partner	Website	Title/Topic
M2 November, 2017	UKIM	Faculty of Computer Sciences and Engineering, Ss. Cyril and Methodius University in Skopje web page https://www.finki.ukim.mk/mk/content/start-glat-project	News about the GLAT project (partners, duration, short description of the project)
M2 November, 2017	UKIM	Faculty of Computer Sciences and Engineering, Ss. Cyril and Methodius University in Skopje	Information about the project to the management and research groups at FCSE
M3 December, 2017	TLU	University Website http://htk.tlu.ee/htk/2017/11/24/glat.html	Start of a New Project – GLAT announced
M3 December, 2017	UF	AZOO website https://www.azoo.hr/	First workshop announced
M4 January, 2018	UNIRI	GLAT project webpage	Workshop syllabus was published
M6 March, 2018	SWU	South-West University "Neofit Rilski" website http://www.swu.bg/	Logo of GLAT project published with a link to project website
M7 April, 2018	UNIRI	GLAT project webpage https://glat.uniri.hr/?page_id=2121	Information about the first workshop
M7 April, 2018	UNIRI	University of Rijeka, Department of Informatics web site www.inf.uniri.hr	Information about the first workshop
M7 April, 2018	UNIRI	University of Rijeka web site http://uniri.hr/	Information about the first workshop
M7 April, 2018	SWU	South-West University "Neofit Rilski" website http://www.swu.bg/news/12-04-2018-glat.aspx	Information about the first workshop
M8 May, 2018	UNIRI	Virtual Classroom in Loomen "Informatics"- preparations for introducing a new curriculum" https://loomen.carnet.hr	GLAT learning scenario template and tool for designing learning scenarios LePlanner are presented among the examples for the planning and preparing for teaching and creating learning scenarios.

Month	Partner	Website	Title/Topic
M8 May, 2018	UF	AZOO website https://www.azoo.hr/	Second workshop announced
M10 July, 2018	UNIRI	GLAT project webpage https://glat.uniri.hr/?page_id=2371	Translated learning scenarios developed after the first workshop
M11 August, 2018	UNIRI	GLAT project webpage https://glat.uniri.hr/?page_id=2523	Information about the second workshop
M11 August, 2018	UNIRI	University of Rijeka, Department of Informatics website www.inf.uniri.hr	Information about the second workshop
M11 August, 2018	UNIRI	University of Rijeka web site http://uniri.hr/	Information about the second workshop
M14 November, 2018	UF	AZOO website https://www.azoo.hr/	Second workshop announced
M16 January, 2019	UNIRI	GLAT project webpage https://glat.uniri.hr/?p=2753	Translated learning scenarios developed after the second workshop
M16 January, 2019	UNIRI	GLAT project webpage https://glat.uniri.hr/?p=2740	Information about the third workshop
M16 January, 2019	UNIRI	University of Rijeka, Department of Informatics website www.inf.uniri.hr	Information about the third workshop
M16 January, 2019	UNIRI	University of Rijeka web site http://uniri.hr/	Information about the third workshop
M16 January, 2019	UNIRI	Portal “Torpedo” https://bit.ly/2QHhwuN	Information about the project and the third workshop
M17 February, 2019	UKIM	Newsletter SCIENTIX for Macedonian teachers, members of the organization “Friends of education” https://sway.office.com/65O0uhg81kk3WsJa?ref=email	Information about the project and the third workshop
M20 May, 2019	UFRI	Website of Student Cultural Centre – UniRi https://bit.ly/2QGkRu9	Information about the workshop and link to the project website.

Month	Partner	Website	Title/Topic
M21 June, 2019	TU	Website of Euneos Erasmus+ courses https://bit.ly/34aRxjt	Announcement of the course "Teaching Computational Thinking in Primary School" that is based on the results of the GLAT project
M21 June, 2019	TU	School Education Gateway - Europe's online platform for school education https://bit.ly/2qALC8E	Announcement of the course "Teaching Computational Thinking in Primary School" that is based on the results of the GLAT project
M21 June, 2019		Website of primary school Sv. Matej, Viškovo https://bit.ly/2Ob79hq	Information about the project activities
M22 July, 2019	UF	AZOO website https://www.azoo.hr/	Final conference announced
M24 September, 2019	UNIRI	GLAT project webpage https://glat.uniri.hr/?p=3143	Information about the final conference
M24 September, 2019	UNIRI	University of Rijeka, Department of Informatics website www.inf.uniri.hr	Information about the final conference
M24 September, 2019	UNIRI	University of Rijeka web site http://uniri.hr/	Information about the final conference
M24 September, 2019	UNIRI	GLAT project webpage https://glat.uniri.hr/?p=2753	Translated learning scenarios developed after the third workshop
M24 September, 2019	UNIRI	GLAT project webpage https://glat.uniri.hr/?p=2753	Learning scenarios in English and Croatian (Output 2)
October, 2019	UL	Slovenian portal "MIPI - Medijska i informacijska pismenost" https://www.mipi.si/iskalnik/projekt-glat	Information about the project and project results
October, 2019	UL	Slovenian portal "SIO - Slovensko izobraževalno omrežje" https://novice.sio.si/2019/10/08/projekt-glat/	Information about the project

Month	Partner	Website	Title/Topic
October, 2019	UL	Faculty of Education, University of Ljubljana website: https://bit.ly/2KJbWVa	Information about the project and project results
October, 2019	UL	University of Ljubljana website https://bit.ly/336crPv	Information about the project and project results
October 2019		Website of Regional Development Agency of Primorje-Gorski Kotar County https://prigoda.hr/pametni-gradovi/	Information project results (digital game)
October, 2019	UL	Faculty of Education, University of Ljubljana website: https://bit.ly/34cL8nP	Information about the project activities (Workshops)
October, 2019	UL	Slovenian portal "SIO - Slovensko izobraževalno omrežje" https://bit.ly/2qAiQVO	Information about the project activities (Workshops)
October, 2019	UL	Slovenian portal "SIO - Slovensko izobraževalno omrežje" https://bit.ly/2D8Og8t	Information about the project results
November, 2019	UNIRI	GLAT project web site https://glat.uniri.hr/?p=3305	Final version of output O1 published (Syllabus, Syllabus and Materials, Guide for Teachers)
November, 2019	UNIRI	University of Rijeka, Department of Informatics web site www.inf.uniri.hr	Information about the project results
November, 2019	UNIRI	Facebook page www.facebook.com/glatproject/	Information about the project results
November, 2019	UNIRI	Alumni group of Department of Informatics at LinkedIn https://www.linkedin.com/groups/2140273	Information about the project results
November, 2019	UNIRI	Erasmus+ dissemination platform https://bit.ly/2qx9z0U	Publication of project results
November, 2019	SWU	EDUGAMES Moodle platform	English version of GLAT e-course (public)

Month	Partner	Website	Title/Topic
		https://edugames.swu.bg/moodle/course/view.php?id=8	
November, 2019	UNIRI	Edutorij – Repozitorij digitalnih obrazovnih sadržaja https://bit.ly/2QXmjZx	Publication of project results (in open access)
November, 2019	UL	Slovensko izobraževalno omrežje - Slovenian Educational Network: https://podpora.sio.si/glat-ucna-gradiva-za-ucenje-algoritmicnega-razmisljanja/	Publication of project results (Learning scenarios)
November, 2019	UL	Slovensko izobraževalno omrežje - Slovenian Educational Network:https://podpora.sio.si/projekt-glat-gradiva-iz-delavnic/	Publication of project results (Workshop syllabus and materials)
November, 2019	UL	Slovensko izobraževalno omrežje - Slovenian Educational Network: https://podpora.sio.si/projekt-glat-vodnik-za-ucitelje/	Publication of project results (Guide for teachers)
November, 2019	UNIRI	Dabar – digitalni akademski arhivi i repozitoriji: https://bit.ly/33mDN3J	Publication of project results

Leaflets

Leaflet 1 - Basic project information and expected learning outcomes for the purpose of gathering potential participants.

Projekt GLAT

Games for Learning Algorithmics Thinking

Erasmus+ program

Glavni cilj

Poticanje uključivanja elemenata programiranja i **algoritamskog razmišljanja** u poučavanje različitih predmeta u nižim razredima osnovne škole na **zabavan i atraktivan način**.

Koordinator projekta

ODJEL ZA INFORMATIKU
SVEUČILIŠTE U RIJECI

Naglasak je na korištenju obrazovnih strategija **učenja uz pomoć igara** koje će kod učenika potaknuti kreativnost, logičko razmišljanje i vještine rješavanja problema.

Jedna od glavnih aktivnosti projekta bit će organiziranje **stručnog usavršavanja nastavnika razredne nastave** kroz tri modula. Edukacija u okviru svakog modula će se organizirati kao **dvodnevni stručni skup** Agencije za odgoj i obrazovanje (AZOO).

Priključite se!

- postanite dio **fokus grupe** u kojoj ćemo okupiti zainteresirane nastavnike razredne nastave
- sudjelujte u **stručnom usavršavanju** putem radionica u živo i sustava za e-učenje
- usvojite nova znanja o **inovativnim pristupima poučavanju** kojima se potiče kreativnost, logičko razmišljanje i vještine rješavanja problema
- primijenite stečeno znanje i uz pomoć hrvatskih i europskih stručnjaka u području didaktike i metodike izradite **inovativne scenarije učenja**
- unaprijedite kvalitetu poučavanja primjenom izrađenih scenarija učenja **u radu sa svojim učenicima**

Modul 1 Učenje uz pomoć igara u razrednoj nastavi

Ishodi

- protumačiti principe poučavanja uz pomoć didaktičkih igara (eng. Game Based Learning – GBL)
- koristiti alate Weba 2.0 za kreiranje sadržaja potrebnih za nastavne aktivnosti uz pomoć didaktičkih igara
- izraditi scenarije učenja koji će uključiti nastavne aktivnosti za učenje uz pomoć didaktičkih igara
- primijeniti izrađene scenarije učenja u različitim predmetima razredne nastave

Više informacija

glat.uniri.hr
www.facebook.com/glatproject
glat@inf.uniri.hr

Agencija za odgoj i obrazovanje
www.azoo.hr

Games for Learning Algorithmic Thinking

glat.uniri.hr

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Sufinancirano sredstvima programa Europske unije Erasmus+

Leaflet 2 - Basic information about the project and expected results for the purpose of project promotion.

Projekt GLAT

Games for Learning Algorithmics Thinking

Erasmus+ program

Glavni cilj

Poticanje uključivanja elemenata programiranja i **algoritamskog razmišljanja** u poučavanje različitih predmeta u nižim razredima osnovne škole na **zabavan i atraktivan način**.

Koordinator projekta

ODJEL ZA INFORMATIKU
SVEUČILIŠTE U RIJECI

Naglasak je na korištenju obrazovnih strategija **učenja uz pomoć igara** koje će kod učenika potaknuti kreativnost, logičko razmišljanje i vještine rješavanja problema.

Jedna od glavnih aktivnosti projekta je organiziranje **edukacije** za nastavnike razredne nastave kroz tri **dvodnevne radionice**.

Teme radionica su:

1. Učenje uz pomoć igara i aktivnosti bez uporabe računala
2. Online kvizovi i logički zadaci
3. Igre i alati za učenje programiranja

Očekivani rezultati

- **Silabus i materijali** za edukaciju nastavnika s ciljem unaprjeđenja njihovih kompetencija znanjima o **inovativnim pristupima poučavanju**.
- **Scenariji poučavanja** kojima će nastavnici prezentirati ideje za izvođenje nastavnih aktivnosti **suvremenim metodama** poučavanja uz korištenje odgovarajućih digitalnih sadržaja i alata.
- **Materijali za učenje s najboljim primjerima scenarija učenja** izrađeni na temelju povratnih informacija nastavnika i učenika.
- **Kolegij u sustavu za e-učenje** sa silabusom i materijalima kojemu će moći pristupiti zainteresirani nastavnici iz Hrvatske, partnerskih zemalja, ali i šire.

Algoritamsko razmišljanje je jedan od koncepata **računalnog razmišljanja**.

Predstavlja način dolaženja do **rješenja problema** jasno definiranim koracima koje je potrebno napraviti određenim redoslijedom. Prethodno se problem analizira pri čemu se koriste koncepti računalnog razmišljanja kao što su evaluacija, dekompozicija, apstrakcija, generalizacija.

Razvija i potiče **preciznost, sustavnost, kreativnost i inovativnost** te je prikladno ne samo za probleme koji se rješavaju pomoću računala nego i za primjenu u drugim područjima i svakodnevnome životu.

Više informacija

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Sufinancirano sredstvima programa Europske unije Erasmus+

Press releases

Newspaper "Novi list", 9.11.2017.

Information about the GLAT project.

16 NOVI LIST Četvrtak, 9. studenoga 2017.

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INOVATIVNE METODE Odjel za informatiku Sveučilišta sudjeluje u europskom projektu

Prva znanja stjecat će se na atraktivniji način

Naglasak će biti na korištenju obrazovnih strategija učenja uz pomoć igara te poticanju kreativnosti, logičkog razmišljanja i vještine rješavanja problema

Ingrid ŠESTAN KUČIĆ

RIJEKA » » Odjel za informatiku Sveučilišta u Rijeci koordinator je projekta GLAT – Games for Learning Algorithmic Thinking koji se sufinancira kroz Erasmus+ program, a glavni cilj projekta je poticanje uključivanja kodiranja i algoritamskog razmišljanja u poučavanje različitih predmeta u nižim razredima osnovne škole na zabavan i atraktivan način. Očekuje se da će se na taj način dugoročno postići veći interes učenika za programiranje te odabir budućih studija i zanimanja u području ICT-a i STEM-a. Projekt će trajati dvije godine, a najvažnije aktivnosti projekta uključuju stručno usavršavanje nastavnika koji će biti upoznati s različitim inovativnim metodama izvođenja nastave uz uporabu informacijsko-komunikacijske tehnologije. Naglasak će biti na korištenju obrazovnih strategija učenja uz pomoć igara te poticanju kreativnosti, logičkog razmišljanja i vještine rješavanja problema.

Projektni tim okuplja europske stručnjake koji će raditi na razvoju materijala za edukaciju nastavnika razredne nastave. Tijekom projekta će nastavnici okupljeni u fokus grupu sudjelovati na edukaciji oblikovanoj prema mješovitom modelu e-učenja. Ključni dio će predstavljati tri radionice koje će se održati u Hrvatskoj, dok će se online dio edukacije odvijati putem sustava za e-učenje. Nastavnici iz fokus grupe će uz pomoć stručnjaka iz projektnog tima primijeniti novo stečeno znanje za razvoj scenarija učenja, a zatim osmišljene scenarije učenja provoditi u nastavi sa svojim učenicima. Povratne informacije nastavnika i učenika će se koristiti za unaprjeđenje osmišljenog e-kolegija te će poboljšana verzija silabusa s materijalima za učenje i najboljim primjerima scenarija učenja biti javno dostupna kao jedan od rezultata projekta. Materijali će biti objavljeni na hrvatskom i engleskom jeziku pa će ga uz hrvatske nastavnike moći koristiti i nastavnici diljem Europe. Partneri na projektu su: Učiteljski fakultet u Rijeci, Sveučilište u Talinu (Estonija), Pedagoški fakultet Sveučilišta u Ljubljani (Slovenija), Sveučilište »Sv. Ćiril i Metod« u Skopju (Makedonija) i Jugozapadno sveučilište »Neofit Rilski« u Blagoevgradu (Bugarska).

Poticat će se kreativnost,logičko razmišljanje i vještine

Newspaper "Novi list", 11.4.2018.

Information about the first GLAT workshop.

Odjel za informatiku Sveučilišta

RADIONICA ZA EDUKACIJU UČITELJA RAZREDNE NASTAVE

RIJEKA ▸▸ U okviru Erasmus+ projekta »Games for Learning Algorithnic Thinking – GLAT« kojeg koordinira Odjel za informatiku Sveučilišta u Rijeci održana je radionica za učitelje razredne nastave s temom »Učenje uz pomoć igara i aktivnosti bez uporabe računala«. Radionica je okupila 24 učitelja iz 13 osnovnih škola s riječkog područja, a riječ je o prvoj od tri radionice za stručno usavršavanje učitelja razredne nastave u okviru GLAT projekta. Cilj projekta je poticanje uključivanja kodiranja i algoritamskog razmišljanja u poučavanje različitih predmeta u nižim razredima osnovne škole na zabavan i atraktivan način. Naglasak je na korištenju obrazovnih strategija učenja uz pomoć igara koje će kod učenika potaknuti kreativnosti, logičko razmišljanja i vještine rješavanja problema. Nakon održane prve radionice, edukacija u okviru projekta GLAT će se nastaviti u online okruženju – sustavu za e-učenje MoD u kojem će rad učitelja pratiti stručnjaci iz projektnog tima. Na temelju savjeta i povratnih informacija, učitelji će izraditi poboljšane verzije scenarija poučavanja koje će realizirati u nastavi sa svojim učenicima. Najbolji scenariji će zajedno sa silabusom radionica i materijalima za učenje predstavljati jedan od rezultata projekta GLAT te biti prevedeni na engleski jezik kako bi ih mogli koristiti učitelji i u drugim europskim zemljama. ▸▸ (I. Š. K.)

Newspaper "Novi list", 10.1.2019.

Information about the third GLAT workshop.

Četvrtak, 10. siječnja 2019. NOVI LIST 17

Edukacija za učitelje na Odjelu za informatiku

Učenje na zabavan i atraktivan način

Cilj je poticanje uključivanja kodiranja i algoritamskog razmišljanja u poučavanje različitih predmeta u nižim razredima osnovne škole, kaže prof. dr. Nataša Hoić Božić

RIJEKA U okviru Erasmus+ projekta »Games for Learning Algorithnic Thinking – GLAT« koji koordinira Odjel za informatiku Sveučilišta u Rijeci održavaju se radionice »Računalne igre i alati za programiranje«. Navodeći kako se radi o posljednjoj od tri radionice za stručno usavršavanje učitelja razredne nastave, voditeljica prof. dr. Nataša Hoić Božić pojašnjava da je cilj projekta GLAT poticanje uključivanja kodiranja i algoritamskog razmišljanja u poučavanje različitih predmeta u nižim razredima osnovne škole na zabavan i atraktivan način.

Naglasak je na korištenju obrazovnih strategija učenja uz pomoć igara koje će kod učenika potaknuti kreativnosti, logičko razmišljanja i vještine rješavanja problema. Projektni tim okuplja europske stručnjake na području metodike nastave informatike, e-učenja i GBL-a koji rade na razvoju silabusa i materijala za edukaciju učitelja razredne nastave. U sklopu treće radionice učitelji će se upoznati s mogućnostima primjene istraživačke i projektne nastave u nastavnom procesu te učenja koncepata programiranja kroz igru.

Polaznici će kroz individualne i grupne aktivnosti analizirati i dizajnirati primjere igara za različite školske predmete te će se upoznati s alatima za učenje programiranja poput Scratcha kojim učenici mogu programirati svoje interaktivne priče, igre i animacije.

Učitelji će novo stečeno znanje primijeniti u osmišljavanju vlastitih scenarija poučavanja za odabrane nastavne predmete koji će uključivati igre kako bi se kod učenika potaknuo razvoj algoritamskog razmišljanja, a ti će scenariji predstavljati jedan od rezultata projekta GLAT te će biti dostupni za korištenje svima zainteresiranima u Hrvatskoj, ali i šire, s obzirom da će biti prevedeni na engleski jezik.

I. ŠESTAN KUČIĆ

VLASTITI SCENARIJ

Učitelji će novo stečeno znanje primijeniti u osmišljavanju vlastitih scenarija poučavanja za odabrane nastavne predmete

Portal "Torpedo", 15.1.2019.

Information about the third GLAT workshop.

U okviru projekta GLAT na Kampusu je održana radionica "Računalne igre i alati za programiranje"

Marin Ružić 2 days ago Novosti , Rijeka

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Co-funded by the Erasmus+ Programme of the European Union

Newspaper "Novi list", 18.6.2019.

Information about the GLAT project activities.

bakar - kostrena - kraljevica

PROJEKT GLAT Kreativni i vrijedni učenici 3.b razreda

Kraljevica u dječjoj računalnoj igri

Na temelju scenarija kraljevičkih učenika, studentice 5. godine politehnike i informatike Tajana Pavić i Nikolina Turkalj izradile su igricu na integriranu temu Kraljevica

Biljana SAVIĆ

Kroz igricu može se upoznati brojna vrijedna kraljevička baština

KRALJEVICA » Učenici 3.b razreda Osnovne škole Kraljevica osmislili su scenarij za edukativnu računalnu igru na integriranu temu Kraljevica. Riječ je o projektu GLAT - Games for Learning Algorithmic Thinking, koji je sufinanciran Erasmus+ programom. Započeo je 2. listopada 2017., a trajat će do 1. rujna ove godine. U projektu sudjeluju Odjel za informatiku Sveučilišta u Rijeci, Učiteljski fakultet u Rijeci, Sveučilište u Talinu (Estonija), Pedagoški fakultet Sveučilišta u Ljubljani, Sveučilište Sv. Ćiril i Metod u Skopju i Jugozapadno sveučilište »Neofit Rilski« u Blagoevgradu u Bugarskoj. Glavni cilj projekta je poticanje uključivanja kodiranja i algoritamskog razmišljanja u poučavanje različitih predmeta u nižim razredima osnovne škole na zabavan i atraktivan način. Najvažnije aktivnosti projekta uključuju stručno usavršavanje učitelja razredne nastave koji se upoznaju s različitim inovativnim metodama izvođenja nastave uz upotrebu informacijsko-komunikacijske tehnologije, a naglasak je na korištenju obrazovnih strategija učenja uz pomoć igara (GBL - games-based learning) te poticanju kreativnosti, logičkog razmišljanja i vještine rješavanja problema.

Kao dio fokus grupe učitelja razredne nastave, u projektu sudjeluje učiteljica Sunčica Vučković iz OŠ Kraljevica. U ostvarivanje zadataka posljednje radionice uključili su se i učenici 3.b razreda koji su osmislili scenarij za edukativnu računalnu igru. Na temelju scenarija učenika, studentice 5. godine politehnike i informatike Tajana Pavić i Nikolina Turkalj izradile su igricu na integriranu temu Kraljevica koja obuhvaća ostvarenje odgojno-obrazovnih ishoda povezanih s nastavnim temama: Kulturno-povijesni spomenici moga mjesta, Iz prošlosti moga mjesta, Izgled i posebnosti zavičajne regije, Stvarni i nestvarni događaji i Opisivanje predmeta i likova. Igrica koju su uz pomoć studentica osmislili učenici nalazi se na linku https://scratch.mit.edu/projects/306275359.

Newspaper "Novi list", 30.9.2019.

Information about the final GLAT conference.

Ponedjeljak, 30. rujna 2019. NOVI LIST 13

Završna konferencija GLAT projekta Odjela za informatiku

Kodiranje i algoritamsko razmišljanje u poučavanju

Riječ je o poticanju kreativnosti, logičkog razmišljanja i vještina rješavanja problema kod učenika mlađeg uzrasta na zabavan i atraktivan način putem obrazovnih strategija učenja pomoću igara

RIJEKA» Konferencijom na Učiteljskom fakultetu Sveučilišta u Rijeci zaključen je Erasmus+ projekt GLAT – Games for Learning Algorithmic Thinking koji koordinira Odjel za informatiku Sveučilišta u Rijeci. Riječ je o projektu čiji je cilj uključivanje kodiranja i algoritamskog razmišljanja u poučavanje različitih predmeta u razrednoj nastavi te poticanje kreativnosti, logičkog razmišljanja i vještina rješavanja problema kod učenika mlađeg uzrasta na zabavan i atraktivan način putem obrazovnih strategija učenja pomoću igara.

Prema riječima voditeljice projekta prof. dr. Nataše Hoić-Božić naglasak projektnih aktivnosti bio je na edukaciji za učitelje razredne nastave koja je organizirana u suradnji s Agencijom za odgoj i obrazovanje iz Rijeke. Edukacija je održana za fokus grupu od dvadesetak učitelja iz Primorsko-goranske županije i uključivala je tri radionice u živo te nastavu uz pomoć Moodle sustava za e-učenje MoD. Na radionicama su se učitelji imali prilike upoznati s različitim inovativnim metodama izvođenja nastave uz uporabu IKT, posebice obrazovnim strategijama učenja uz pomoć igara (GBL), ali i problemskim učenjem (PBL) i istraživački usmjerenom nastavom (IBL). Nakon svake radionice njihov je zadatak bio primijeniti naučeno pri osmišljanju scenarija učenja i poučavanja za odabrani predmet i temu koje će primijeniti u radu sa svojim učenicima.

Naglasak projektnih aktivnosti bio je na edukaciji za učitelje razredne nastave

SCENARIJI

Polaznici su pripremili ukupno 62 scenarija učenja i poučavanja na teme učenja pomoću igara i aktivnosti bez računala te istraživački usmjerenu nastavu

Rezultati projekta uključuju silabus s planom i materijalima za edukaciju te skup scenarija učenja i poučavanja koje su izradili polaznici tijekom edukacije. Uz podršku mentora-eksperata iz projektnog tima, polaznici su pripremili ukupno 62 scenarija učenja i poučavanja na teme učenja pomoću igara i aktivnosti bez računala te istraživački usmjerenu nastavu.

Dio scenarija je preveden i na engleski jezik te je na taj način dostupan i inozemnim učiteljima, a kao posebno vrijedan rezultat ističu se scenariji s uključenim digitalnim igrama koje su osmislili polaznici u suradnji sa svojim učenicima. Te su scenarije izradili studenti Odjela za informatiku pomoću alata Scratch, a riječ je o igrama s kojima učenici mogu vježbati matematiku ili naučiti o zdravoj prehrani, godišnjim dobima, kulturno-povijesnim spomenicima i mnogim drugim temama.

U sklopu konferencije svim polaznicima GLAT edukacije dodijeljene su diplome o sudjelovanju. Partneri na projektu bile su institucije iz Slovenije, Estonije, Bugarske i Makedonije. Teme GLAT edukacije imaju značaj za učitelje razredne nastave u kontekstu provođenja kurikularne reforme Škola za život.

I. ŠESTAN KUČIĆ

Part III: Published Papers

Published papers

Members of the GLAT project team published 18 professional and research papers in conference proceedings and journals. These publications were, besides presentations on conferences, used to reach the experts and the practitioners in the field.

All publications were peer reviewed by EU or international experts and comments about GLAT model of education were positive since algorithmic and computational thinking are recognized as very important competencies for current society in EU and beyond.

Two papers were published in the journal *Education Psychology* and Bulgarian journal *Mathematics and Informatics:*

1. Hoić-Božić, N., Holenko Dlab, M., Načinović Prskalo, L., Rugelj, J., Nančovska Šerbec, I. Games for Learning Algorithmic Thinking – GLAT Project, Education Psychology, 2018, 4(2), pp. 73-95
2. Hoić-Božić, N., Lončarić, D., Holenko Dlab, M. *Preparing Primary Junior Grade Teachers to Teach Computational Teaching*: Experiences from the GLAT Project. Mathematics and Informatics. 62 (2019), 5; pp. 487-499

Papers published in conference proceedings are listed below (alphabetically by authors) and included in the reminder of the document as annexes:

1. Eftimova, S. M., Madevska Bogdanova, A., Trajkovik, V. *Practical evaluation on serious games in education*. In Proceedings of 16th International Conference on Informatics and Information Technologies, 2019, North Macedonia
2. Franković, I., Hoić-Božić, N., Načinović Prskalo, L., *Serious Games for Learning Programming Concepts*. Conference Proceedings – International Conference the Future of Education. 8th edition. Padova : Pixel - LiberiaUniversitaria, 2018, pp. 354-358. Available online: https://conference.pixel-online.net/FOE/files/foe/ed0008/FP/4748-LEG3137-FP-FOE8.pdf
3. Hoić-Božić, N., Holenko Dlab, M., Načinović Prskalo, L., Rugelj, J., Nančovska Šerbec, I. *Projekt GLAT - poticanje algoritamskog razmišljanja korištenjem didaktičkih igara*. In Proceedings of the 41st International Convention MIPRO 2018. Rijeka, Croatia, pp. 926-930 (in Croatian). Available online: http://docs.mipro-proceedings.com/ce/ce_65_4809.pdf
4. Hoić-Božić, N., Holenko Dlab, M., Ursić Budim, S., Mezak, J. *Development of Computational Thinking Skills in Primary School through Digital Storytelling with Scratch*. In Proceedings of the 10th International Conference on eLearning, Belgrade, Serbia, 2019. pp. 114-119
5. Hoić-Božić, N., Mezak, J., Tomljenović, K. *Enhancing teachers' computational thinking skills through Game Based Learning*, In Proceedings of the International Conference SLET-2019: Innovative approaches to the application of digital technologies in education and research, Stavropol, Russia, 2019. Available online: http://ceur-ws.org/Vol-2494/paper_13.pdf.
6. Holenko Dlab, M., Hoić-Božić, N., Anđelić, M., Botički, I., *Digital games and tools for development of computational thinking in primary school*, In Proceedings of the International Conference on Management, Economics & Social Science - ICMESS 2019, Brussels, Belgium, 2019. pp. 1-7
7. Mezak, J., Pejić Papak, P. *Learning Scenarios and Encouraging Algorithmic Thinking*. In Proceedings of the 41st International Convention MIPRO 2018, Rijeka, Croatia, pp. 836-841. Available online: http://docs.mipro-proceedings.com/ce/ce_49_4805.pdf

8. Mezak, J., Pejić-Papak, P. *Problem Based Learning for Primary School Junior Grade Students Using Digital Tools*. In Proceedings of the 42th International Convention MIPRO 2019, Rijeka, Croatia, 2019, pp. 805-810. Available online: http://docs.mipro-proceedings.com/ce/49_ce_5375.pdf

9. Sunney Quaicoe, J., Laanpere, M., Pata, K., Hoić-Božić, N. *Games for Learning Algorithmic Thinking (GLAT) Project: The influence of personal and environmental factors on perceived usefulness and usage of the LePlanner - learning scenario design tool*. Proceedings of the Conference of the International Council of Educational Media (ICEM), 2018, Tallinn, Estonia

10. Sunney Quaicoe, J., Laanpere, M., Pata, K., Hoić-Božić, N., Rõbshenkov, R. *Games for Learning Algorithmic Thinking (GLAT) Project: Perceived Factors in Accounting for Teacher Acceptance and Usage of a New Learning Scenario Design Tool - The LePlanner*. In Proceedings of the 11th Annual International Conference on Education and New Learning Technologies EDULEARN19, Palma de Mallorca, Spain, 2019, pp. 7898-7906.

11. Tuparova, D., *Teaching of computer programming in Bulgarian primary school – challenges and solutions*. In Proceedings of the 42th International Convention MIPRO 2019, Rijeka, Croatia, 2019. pp. 836-840. Available online: http://docs.mipro-proceedings.com/ce/54_ce_5406.pdf

12. Tuparova D., *Possibilities for development of algorithmic thinking through game based learning and unplugged activities in primary school*, In Proceedings of the 15th Annual International CSECS Conference on Computer Science and Education in Computer Science, Fulda, Germany, 2019.

13. Tuparova D., Georgieva, R. *Educational computer games for learning programming and development of algorithmic thinking - comparative analysis*. Proceedings of the Forty-eighth Spring Conference of the Union of Bulgarian Mathematicians, Borovetz, 2019 (in Bulgarian)

14. Tuparova, D., Nestorova, I., Samardzhiev, K., *Project GLAT – Games for Learning Algorithmic Thinking*, In Proceedings of 11th National Conference Education and Research in Information Society, Plovdiv, Bulgaria, 2018, pp. 136-139 (in Bulgarian). Available online: http://sci-gems.math.bas.bg/jspui/handle/10525/2956

15. Videnovik, M., Trajkovik, V. *Using SCOTTIE GO! as Game Based Learning Tool for Computational Thinking Course*, In Proceedings of ICERI2018 Conference, Seville, Spain, 2018, pp. 1337-1344

16. Videnovik, M., Madevska Bogdanova, A., Trajkovik, V. *Serious Games Evaluation Methodology*. Proceedings of ICERI2018 Conference, Seville, Spain, 2018, pp. 1354-1361

Educational Matters
Научно-методически статии

PREPARING PRIMARY JUNIOR GRADE TEACHERS TO TEACH COMPUTATIONAL TEACHING: EXPERIENCES FROM THE GLAT PROJECT

Natasa Hoic-Bozic, Darko Lončarić, Martina Holenko Dlab
University of Rijeka (Croatia)

Abstract. The 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. The results show 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

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; Grozdev & Terzieva, 2015). 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. There are positive examples like Bulgaria that should be followed by other countries. In Bulgaria, algorithmic thinking is recognized as a key competence in computer science (Grozdev & Terzieva, 2015) and topics for its development are included in school curricula for students in third and fourth grade of primary school (Tuparova, 2019). In addition, researches regarding the concept of algorithmic thinking in computer science teaching (Grozdev & Terzieva, 2011) and approaches to diagnose forming of algorithmic thinking as been carried out (Terzieva, 2011). 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 thinking 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:

Game Based Learning and unplugged activities

Problem Based Learning, online quizzes and logical tasks

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.

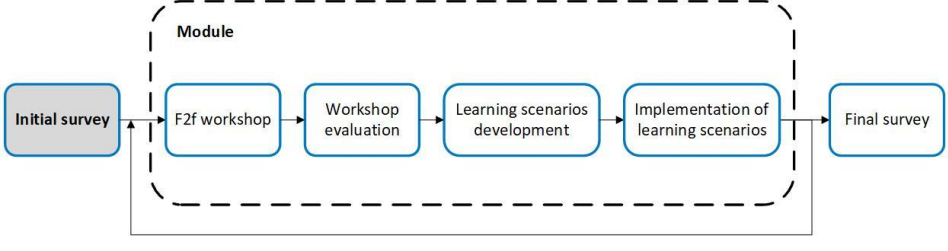

Figure 1. The model of activities for participants during GLAT training

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:

to what extent are teachers familiar with the terminology or the concepts related to using ICT in education that are relevant for the project,

to what extent are teachers familiar with the possibilities of adapting, creating and using specific content, methods, and tools important for the project outcomes,

how often teachers use teaching activities, methods and strategies that are not specifically related to the project,

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 6thquestion 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 com-

petence/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, Puzzle maker, 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".

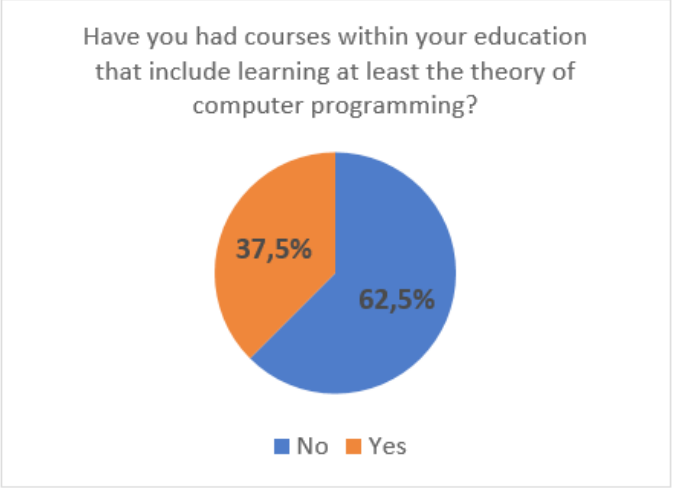

Figure 2. Previous education about computer programming

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.

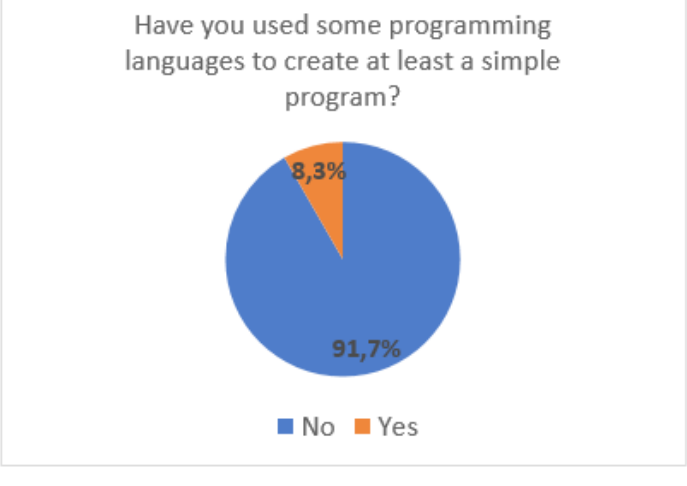

Figure 3. Experience in using programming languages

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."

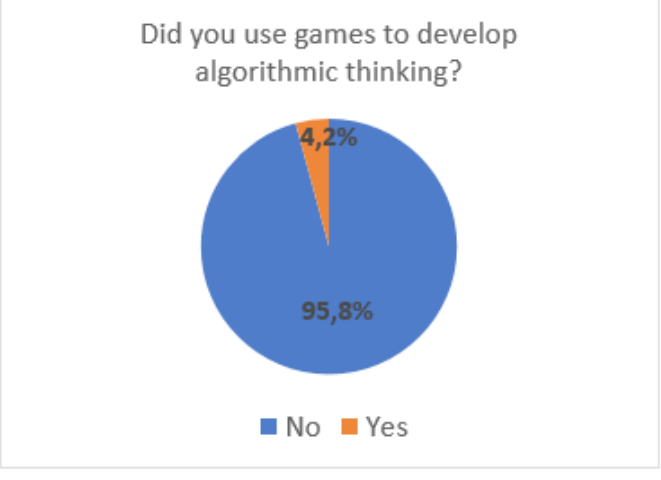

Figure 4. Experience in using games for developing algorithmic thinking

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.

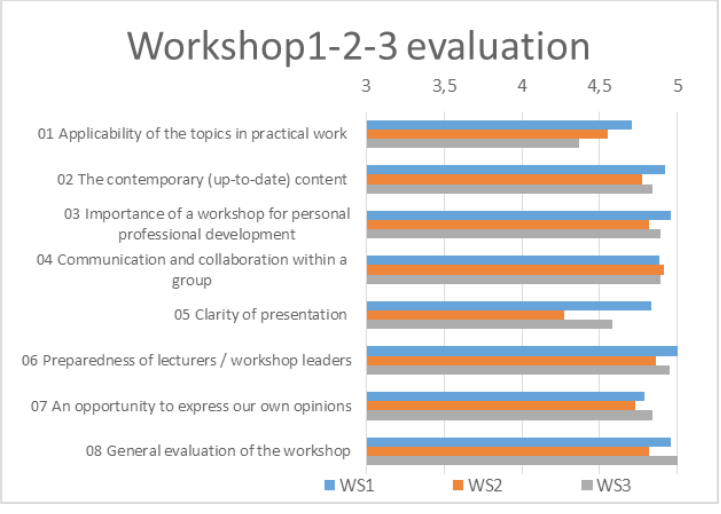

Figure 5. Evaluation items for three GLAT workshops

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 „GLAT - Games for Learning Algorithmic Thinking," and by University of Rijeka (Croatia) under the project "Digital games in the context of learning, teaching, and promoting inclusive education".

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Practical evaluation on serious games in education

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Abstract

The arrival of the new learning methodologies is in response to the reality: new generations should learn in a different way. The so-called "Millennials" are looking for another kind of stimulus. Discussions for modernizing the curriculum include various solutions to retain students' attention and, in order to ensure that teachers learn how to act with a critical attitude, they will be confident and with the developed creative skills that they will need for success in the professional world in the future. The game based learning is more than providing educational games to students, it is about changing students' access to learning and their learning approach: the goal is to enjoy the learning process itself. This paper presents a methodological tool based on an evaluation framework for integration of digital games into education (MEDGE), expanded by adding additional information from the students, MEDGE+. The evaluation framework is used on three different approaches to the educational content: robot, micro: bit and playing quiz Kahoot. MEDGE+ provides better tool for the teachers in order to follow the student's interest when choosing appropriate educational games in the teaching process.

Keywords: serious games, critical attitude, games evaluation framework

I. INTRODUCTION

Today, the teacher abandons the role of a central figure, becomes a leader who guides the students through the learning process, enabling more learning styles, so that the student can move forward with his\her learning pace [1]. Students, on their part, use technology for communication, searching and finding information, expanding social experiences, and enjoying computer games on a daily basis [2]. The digital games (on their phones or computers) are played by students with a lot of energy and enthusiasm. This commitment is a challenge for the teacher - the learning process can be done through computer games.

Students have transferable skills to share online research and access to many digital texts in a number of contexts. If digital literacy is encouraged throughout the teaching program, using positive language is necessary. By making such changes in the language teachers use, with the goal of becoming closer to their students' language, the students themselves will feel closer to the teachers and will understand the learning material more easily [3].

Technology offers a wide range of opportunities for developing learning experiences across a wide range of topics. If digital literacy is promoted through the curriculum, a positive language is required. By changing the language that teachers use, in order to be closer to the students, then the students themselves will feel closer with the teachers and will easily overcome the material.

II. BACKGROUND

With carefully selected concepts and accompanying pictures that create a pleasant and creative atmosphere, children learn more easily through various activities of games and tasks. The games often have a fantastic element that intrigue players and engage them in learning activities [4,5,6].

But in order to apply games in teaching, more conditions need to be met.

According to the UNESCO framework, teachers should use educational (serious computer games) in education, preferably in accordance with the application of the teaching experience [3]. Teachers should have the following competencies:

- Using the Internet for online research;
- Using tools for making text and spreadsheets, making presentations;
- Using communication and collaboration tools such as emails, video conferencing and social networks;
- Application of ICT sources for curriculum development;
- Interest in continuing upgrading and improving the teaching content they teach and their teaching skills;
- Knowledge of the subject they teach to be appropriate for the age of the students;
- Have managerial and organizational skills;
- Knowledge of strategies that will help the student to gain in-depth knowledge such as:

- Learning Collaboration;
- Problem-based learning;
- Project-based learning;
- Activities based on project development;
- Games and simulations;
- Research experiments;
- Case study;
- Exercises;
- Mentoring;
- Evaluation.

What conditions should the school have in order to introduce educational games in teaching? The answer to this question is divided in two parts:

- provided technical equipment in the classroom;
- teachers have to have appropriate digital competencies.

The word "competence" means knowledge or expertise in a given area [7]. Accordingly, digital competence is the ability to track, analyze, evaluate, generate and transmit information in digital format. This applies to desktops, laptops, smartphones and similar devices. Regarding the discussion of this term, there are various attempts to define definitions that are in use, as well as a few related names for it, such as information, the Internet or media competence. A person who is digitally competent will have more interlinked skills: knowledge of the basic principles of computer hardware, computer networking skills, the ability to engage in online communities and social networks. By digitizing human knowledge and developing digital technologies (mass production of devices that have access to the Internet). We can conclude that a digitally literate person will have practical knowledge of hardware and software, but also different kind of knowledge that they did not have in the last century. Computer literacy is often considered today as the ability to use the computer programs for some less complex practical tasks or the ability of individuals to effectively use the computer. Digital competence, or in other words, digital literacy, is considered to be as important today as reading and writing. Digital devices are starting to be used from an increasingly young age, but this does not help much young people to develop the skills they need for further personal and professional upgrading. Digital competence is far more than just accepting new technologies and using social media in order to create some content.

Today, digital literacy is almost equally necessary to attain personal and professional ambitions. It allows seemingly complex tasks to be performed in a much simpler and more efficient way and with better results. It is necessary to focus attention on the way the students use devices in extracting knowledge.

Digitalization and inroads have already led to major changes in our daily lives and our world in terms of information and work. However, these numerous changes have not yet become clearly visible and understandable to us. For this reason, it is particularly important to pay attention to large volumes of new information and to all innovations. To do this, it is necessary to have a sufficiently high level of digital competence.

As far as the technical equipment of the schools is concerned, as a first requirement is that there is an Internet connection and at least one laboratory with a certain number of computers, preferably connected in a local network. Possession of additional tools and equipment can greatly enrich hours with certain activities. The LEGO Mindstorm EV3 Robot [8] and micro:bit tools [9] are used in practical case studies.

III. THE CASE STUDY

In order to conduct this evaluation, the evaluation framework for integration of digital games into education (MEDGE) was used [10], expanded with two new questions, thus MEDGE+.

The following questions were answered by several professors at the “Jane Sandanski” High School:

- Is the game easy to use? (EASY)
- What is the educational goal of the game? (VAL)
- Does the game adapt to educational goals? (ADT)
- Pleasure / acceptance of the game by students? (QoE)
- What is the teacher's subjective opinion about the game? (SUB)
- What is the motivation of students to adopt the material? (MOT)

In order to achieve better motivation for the students when applying serious games, two questions were added, where the students were asked the following questions (MEDGE+):

- Through the game, I will easily overcome the material (EL);
- Through the game, my motivation for material adoption (MS) will increase.

The following scale of responses was offered:
I totally agree (5); I agree (4); I am neutral (3); I disagree (2); I completely disagree (1).

A. *CASE STUDY 1 - LEGO*

A class in high school using a memory game (with the help of the LEGO Mindstorm EV3 Robot) [8].
Teaching unit: One-dimensional arrays
Type of lesson: lecturing
In order to get the students interested as much as possible on this thematic unit, a memory game in Python was used through simulation of robotic games. Preparing for this guide: LEGO Mindstorm EV3 Robot is the tool used for this game. A robot with specific parts is built in the instructions for building the LEGO Mindstorm Education Core Set.

The goal and the game is to build the main body for the robot (base unit) and the color sensor.

Effects

Computer Science (Python) - This lesson will help students understand the use of an array, from an abstract concept to a point where they actually understand how the color storage works in random order. Students will be introduced to the random functions used to generate colors.

Exercise

Create a program that will put random colors in sequence, and then the robot will repeat (express) the order of colors. The student must remember the colors and show colors on the card to the robot sensor in the same order as given. In the end, the robot announces whether the study of time wins or not.

Reflection

Students learned how to store colors in arrays and to check if the generated colors are the same as shown in front of the sensor. They can also make different versions of this program by counting a score and saving other type of data.

Based on a poll conducted after playing this game, the following results were obtained, given in the Fig1:

	EASY	**VAL**	**ADT**	**QoE**	**SUB**	**MOT**	**EL**	**MS**
robot	2,5	3,4	5	3,8	4,4	4,6	**4,4**	**4,1**

Fig. 1. Review of robot responses, MEDGE+

B. *Case study 2 - Kahoot*

Teaching unit: Basics in programming with C++;
Type of lesson: Kahoot quiz to check the acquired knowledge on the topic Introduction to programming in C ++.

Kahoot [11] is a formative learning tool that uses quizzing technology, discussions and surveys. The principle of work is basically a game in which the whole class participates in real time. For the preparation of this class, a quiz with 10 questions was developed, which examines the gained initial knowledge in programming in C ++, which is necessary to start programming the simplest tasks in C ++.

Exercise Students get the link and join the game.

Reflection

The class with Kahoot was filled with excitement and euphoria like no previous one. The competitive spirit was at the highest level. After the quiz was conducted, questions that were incorrectly answered were discussed. The students asked after each teaching unit (or at least after completing a theme) to have a time dedicated to competing with the Kahoot Quiz**.** Based on the conducted survey after playing this game, the following results were obtained, given in the Fig2:

	EASY	**VAL**	**ADT**	**QoE**	**SUB**	**MOT**	**EL**	**MS**
Kahoot	4,6	5	5	5	4,7	5	**4,8**	**4,7**

Fig 2. Review of Kahoot responces, MEDGE+

C. *Case study 3 – micro:bit*

A class in high school using a micro:bit [9] to verify acquired knowledge of algorithms with a branched structure.

Teaching unit: Algorithms and programming;
Type of lesson: Algorithms and their representation.

In order to perform this lesson, primary school Sando Masev Strumica was visited. This school owns 30 micro:bit devices [12], obtained with the help of British Council. At this class, the application of the algorithm with a branched structure was presented, realized practically with the micro:bit.

Exercise

The acquired experiences were used for introduction into the branch structure. Other approaches were introduced to explain algorithms with a branch structure. The students were able to solve other examples.

Reflection

By using the micro:bit, the programming becomes clearer, closer and more attentive to the students.

The survey by MEDGE+ has produced the table in Fig 3.

	EASY	**VAL**	**ADT**	**QoE**	**SUB**	**MOT**	**EL**	**MS**
micro:bit	4,3	5	5	4,5	4,2	5	**4,8**	**4,5**

Fig.3. Review of micro: bit responces, MEDGE+

The evaluation methodology MEDGE+ produces the net presented in Fig.4. It gives graphical representation of the game/tool acceptance in the three case studies.

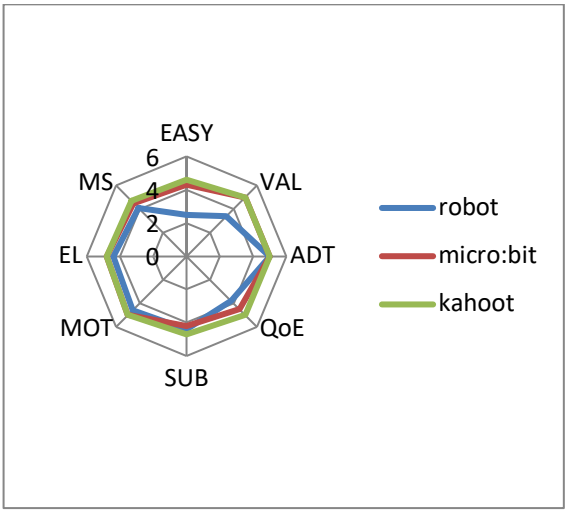

Fig4. Evaluation of the explored games with MEDGE+

IV. DISCUSION

In the following discussion, all of the case studies are elaborated by reviewing the positive and negative aspects of the serious games in the learning process. At the lesson of one-dimensional strings using the robot, the positive characteristics were: greater interest and curiosity towards the innovative approach of teaching resulting in increased interest in learning and interest in research using additional sources for the new concepts. The negative aspect is that the use of robots in teaching requires additional budget. Furthermore one robot is a not enough for a group of 24-30 students. Another point is the programming language - in order to use the robot in the teaching process, a different programming language from the one studied in the regular classes was needed. The good sides in the realization of classes using the Kahoot quiz for repeating the material for the basics of programming were: initiating a competitive spirit, raising awareness of teamwork, getting quick results for the correct answers and showing greater interest in understanding the reasons of choosing the wrong answers. Also, all students answered the same questions at the same time and there was no fear of consequences if wrong answer was submitted.

In the third case study, the algorithms for a branched structure with micro: bit was introduced. The positive side was this new approach to learning algorithms. It was more interesting to the students because of the visualization and the ease of use. One disadvantage of using micro:bit in high schools is that following the curriculum, micro:bit can be applied only at the beginning of the programming courses because the latter material is more complex.

V. CONCLUSION

The introduction of games in IT teaching is a very positive experience [13,14,15], but of course, the realization of each of these serious games and tools has positive and negative aspects.

In this paper, following the evaluation methodology [10], MEDGE+ was introduced that can give even more insight when choosing an appropriate educational game in the teaching process. We have explored three case studies, and used the MEDGE+ methodology to measure the acceptance of the given games and tools.

The performed analysis was done over three different games: robot simulation, Kahoot and micro:bit coding. It showed that all three activities positively influenced the process of adopting new knowledge and knowledge testing, while the greatest satisfaction and motivation according MEDGE+ achieved the quiz Kahoot. The extension of the methodology [10] considered the inclusion of the student's opinion, contributing to the teacher's decision which games/tools should be chosen in the educational process.

The use of games in teaching obviously has many advantages, and as a future work, more examples of games and tools will be evaluated using the information provided by MEDGE+.

ACKNOWLEDGEMENTS

This paper is supported by Erasmus+ project "GLAT – Games for learning algorithmic thinking", 2017-1-HR01-KA201-035362.

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Serious Games for Learning Programming Concepts

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Abstract

Serious games are specially designed computer games in which education is the primary goal, rather than entertainment. They are interactive competitive lessons with defined learning outcomes and their importance in contemporary educational practice is increasing. The implementation of serious games in teaching has a potential to facilitate the learning process in terms of increasing students' interest in learning to ensure better understanding of learning materials and application of acquired knowledge. Serious games can be used to stimulate programming learning. Besides learning coding skills, programming supports the development of computational thinking, which is widely applicable and useful, not just in computer science, but also in everyday life. Programming is recognized as a crucial skill, even a new literacy, for all children, and there is the emerging need to introduce programming concepts into primary schools from the first to the fourth grade. Computational thinking represents an increasingly important focus in informatics (computer science), and ways of incorporating it into the school curricula are being explored. Serious games offer an exciting opportunity for learners to engage in computational thinking. This paper presents an overview of the game genres suitable for better understanding of certain programming concepts. Games and tasks that were taken into consideration trigger the development of computational thinking skills by incorporating components such as abstraction, decomposition, evaluation, and generalization. The examples of serious games are given and classified according to the main programming concepts. This classification can be a starting point for selecting and designing adequate serious games to support the effective learning of programming concepts in the classroom.

Keywords: *serious games, computational thinking, primary education, game-based learning;*

1. Introduction

Didactic games can be defined as interactive, competitive lessons with defined learning outcomes that enable students to have fun during acquiring knowledge. Their goal is not merely fun but they contain an educational component as well [1][2].

As didactic video games encourage student motivation and facilitate the learning of complex materials, they are increasingly being used in informatics (computer science) teaching [3]. The main goal of the games in informatics teaching is to introduce students to the world of complex problems, and they are particularly important for the development of computational thinking (CT) and programming learning [4].

The question that arises is to what extent the CT development is associated with programming and whether it should be developed before the programming learning itself, or it is sufficient to introduce it simultaneously at the same time when programming. According to [5] CT can be separated from programming, and should be taught before programming teaching starts.

In order to successfully use games for CT and programming, it is necessary to explore which games and logical tasks are appropriate for the development of particular concepts, i.e. a framework for programming learning for younger students using game based learning (GBL) needs to be developed. As a first step of this research, this paper presents work-in-progress with the aim to identify serious games that are suitable for understanding basic concepts of computational thinking.

2. Computational thinking

The best way to teach students coding is to teach the key coding skills first. It is necessary to start with the essential elements for the key building blocks of computer literacy. Many coding skills are not just important for programming, they are critical skills for any career. It is more important to help children gain the thinking skills than to actually write codes. It is widely accepted that students need to demonstrate an understanding of the patterns evident in programming rather than focusing only on syntax and semantics of programming [6][7].

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Computational thinking is a general analytic approach to problem-solving, designing systems and understanding human behaviour concerned with conceptualizing, developing abstractions and designing systems that overlap with logical thinking and requires concept fundamental to computing [8][9]. Some studies support the idea that everyone should think computational and that it is crucial for children to develop CT skills before formal programming learning [10] [11], while others claim it is questionable what skills and abilities develop CT and how it should be integrated into education [12].
The most suitable game types for problem solving are puzzles, simulation games, strategy games, adventure games, artificial life and management games [13]. The need for the introduction of coding and the development of computational thinking in primary schools has already been recognized and competitions such as Hackathon on Coding, Bebras are one way of rewarding excellence in that area.

3. Games and logical tasks for learning computational thinking

The aim of the Bebras challenge [14] is to promote students' interest in informatics learning from the beginning of their education by solving short tasks, and deepen computational thinking. The most important components for developing computational thinking are interesting logical tasks or puzzles.
In the papers [15] and [6], five key computational thinking skills are suggested:

- **Abstraction** makes problems easier to think about by spotting key elements in certain problem/task and removing unnecessary details without losing any important information.
- **Decomposition** is the way of thinking about problems in terms of their component parts that can be understood, solved, developed and evaluated separately.
- **Algorithmic thinking** is the ability to think in terms of sequence and rules as a way of solving problems and it needs to be applied when steps of problems repeat in similar sequence. It involves creating and executing an algorithm.
- **Evaluation** is the process of ensuring that the obtained solution is suitable for the given purpose.
- **Generalization** is a way of quickly solving new problems based on the previous solutions, and building on the earlier experience. It is related to identifying patterns, similarities and connections.

In [15] a two-dimensional categorization system, which incorporates CT skills and informatics concepts is introduced. A task should be assigned to only one informatics concept and up to three CT skills.
Brennan & Resnick [16] define a framework for CT which is composed of three key dimensions: computational thinking concepts, computational thinking practices, computational thinking. They have also defined the following concepts that can apply to programming and non-programming context: sequence, loops, events, conditionals, operators, data and parallelism.
The most interesting dimensions at the beginning of our research are computational thinking concepts, which are common in programming approach. As a first step, we wanted to show the connections of the CT concepts with the particular games and tasks (Table 1). The examples of the tasks are taken from the Bebras contest [14], while the examples of the games are taken from the following sites: *Education, Blockly games* and similar. It is planned to create such types of games in the Croatian language.

Table 1. Connections of the CT concepts with the particular games and tasks

Computational thinking concepts	**Game genre**	**Game example**	**Task example**	**Description**
Decomposition	Sudoku	Picture sudoku Kakuro for kids	Animation Beach Flags Broken Window Beaver Code	Solving the sudoku encourages the discerning of the exact rules of character scheduling. It is important to understand the rule and know how to apply it in different situations – from the easier ones when only one character is missing to the ones that are more difficult when more characters are missing.
Abstraction	Doodle dots Tetris Jigsaw puzzle Tangram games	Patchwork Doodle dots	Mushrooms Bracelet Walnut Animals Geocaching	By solving these tasks and games, children learn to use and interpret symbols or representations in order to think through and solve a variety of problems.
Algorithmic Thinking	Puzzle games Maze games	Blockly Games: Bird Run Marco Blockly Games: Maze	Setting the Table Crane Operating Fair Share Candy jar Cross Country Beaver Code	To solve these tasks, it is important to set a proper sequence of steps/commands. If they are not set in the proper order, the task cannot be solved. By identifying the patterns in the tasks, we can make predictions, create rules and solve problems that are more general.
Evaluation	Memory game Jigsaw puzzle	Blockly Games: Puzzle Matching games	Dream Dress Geocaching Cross Country	The tasks involve statements (conditions/requirements) that must be evaluated (determined to be true or false) for a set of objects. Conditions and their evaluation are important because the decisions are made based on them.
Generalization	Pattern games	Pattern games	Beaver Code Birthday Balloons Animation	Resolving a sequence of items enables students to practice the ability to recognize the rules of changing the elements in a row and to use these rules to predict the next step. These tasks help us to realize that certain information can assist in the prediction of what follows.

3. Conclusion and future work

This paper presents a work-in-progress research with the aim of creating a framework for programming learning in the younger age of students. The basis of the framework will be a two-dimensional categorization consisting of programming concepts and computational thinking concepts. CT concepts and concepts of programming will be linked to the games and logical tasks that help in their learning.

So far, the construction of the classification for CT has begun and the first version is presented in this paper. The following steps include extending the classification with the games for programming concepts, game collection, game and logical tasks development in the Croatian language, as well as the implementation of experiments in primary schools, where students from first to fourth grade will test the proposed framework in programming learning.

4. Acknowledgment

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).

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Games for Learning Algorithmic Thinking – GLAT Project

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Abstract

The project „Games for Learning Algorithmic Thinking“ (GLAT) is funded by the Erasmus+ Programme of the European Union under the Key Action 2: Cooperation for innovation and the exchange of good practices (Action Type: Strategic Partnerships for school education). The coordinator is University of Rijeka, Department of Informatics and the project lasts until October 2019. Project consortium brings together European experts in the field of didactics of informatics, e-learning and programming from Croatia, Slovenia, Estonia, Macedonia and Bulgaria. The main objective of the project is encouraging the integration of coding and algorithmic thinking into the daily teaching through different subjects in students' younger ages in a fun and attractive way. Special focus will be on using educational strategies of Game Based Learning (GBL) and gamification in order to foster creativity, logical thinking, and problem-solving skills.

This paper describes context and reasons for starting the project, planned activities and intellectual outputs as well as expected impact. The main project activities include professional development of primary junior grade teachers who will take part in workshops designed according to the blended model of e-learning.

Experts from partner organizations will help teachers to acquire the knowledge on using GBL in teaching the concepts of coding and algorithmic thinking and to use it for

developing learning scenarios. They will implement the learning scenarios in classes with their students. An important element will be a collection of teachers' and students' opinions through surveys and interviews which will be used as a feedback to improve the designed workshops.

Keywords: Project GLAT, algorithmic thinking, programming, didactic games, learning scenarios.

Introduction

Information and communication technologies (ICT) represent one of the fastest growing fields and the main generator of economic and society developments (European Commission, 2012). Nevertheless, learning outcomes related not only to ICT but also to the development of general digital competences are still insufficiently represented as part of curriculum in primary schools in Croatia and other European countries (Balanskat and Engelhardt, 2014).

According to The DigiComp Framework (Vuorikari *et al.*, 2016), digital content creation represents one of the five major competence areas which includes the competence of programming described as the ability "to plan and develop a sequence of understandable instructions for a computing system to solve a given problem or perform a specific task". This area is particularly neglected in schools where students are not given enough opportunities to explore programming and learn algorithmic thinking and coding skills (Balanskat and Engelhardt, 2014). The learning outcomes related to the programming should be represented not only in school subjects directly related to information technology but also integrated into the daily learning through different school subjects starting already with the youngest age students, for example by using digital serious games.

One of the projects which deals with these concerns is *GLAT - Games for Learning Algorithmic Thinking*. The project is funded by the Erasmus+ Programme of the European Union under the Key Action 2: Cooperation for innovation and the exchange of good practices (Action Type: Strategic Partnerships for school education). The main objective of the GLAT project is encouraging the integration of coding and algorithmic thinking into the daily teaching through different subjects in students' younger ages (from first to fourth grade of primary school).

The project consortium brings together European experts in the field of didactics and methodic of informatics and computing, e-learning and innovative teaching methods who will work on the developing of training course for a group of Croatian teachers but it can be applied to all teachers across Europe. Project coordinator is University of Rijeka, Department of Informatics (Croatia), and the partners are: Faculty of Teacher Education University of Rijeka (Croatia), Tallinn University (Estonia), Faculty of Education, University of Ljubljana (Slovenia), Ss. Cyril and Methodius University in Skopje (Macedonia) and South-West University Neofit Rilski, Blagoevgrad (Bulgaria).

The project started in October 2017 and will last two years. The most important project activities will include professional development for teachers using three workshops where they will be introduced to innovative methods for teaching in the field

of ICT. The emphasis will be on algorithmic and computational way of thinking, problem-solving skills, logic and creativity integrated into the daily learning through different school subjects.

The main project results will consist of an enhanced syllabus of workshops with the materials for learning in Croatian and English language, complemented by the examples of best practices, and available at online platform for e-learning that will at the same time enable teachers the exchange of experiences and ideas on the application of innovative teaching methodologies. Syllabus will be used in the future for the organization of a program of professional development of teachers, course or similar forms of education in Croatia, partner countries and beyond.

The paper is organized as follows: the context and the importance of the research is described in the second section. Third section gives an overview of initiatives to encourage coding at a young age and highlights the need for education of teachers. Fourth section presents intellectual outputs of the GLAT project while fifth section describes workshops for teachers. Future plans and expected impact are described in the sixth section and the last section points out the main conclusions.

Context and the importance of research

One of the most important problem of the ICT industry is the lack of educational structures, and in the near future, the demand for IT occupations, especially those related to coding will grow even more. Therefore along with STEM (acronym for Science, Technology, Engineering, and Mathematics) related skills, greater efforts must now be made to highlight ICT as a priority area of education, and increase engagement at all levels (European Commission, 2012). This is in line with the "Europe 2020 targets" that are related to education and to reaching greater number of citizens completing the 3rd level education as well as to achieve increased employability (European Commission, 2010).

However, learning outcomes connected to ICT and to the development of general digital competences are still underrepresented as part of the school curriculum, especially in primary schools in Croatia as well as in other countries in Europe (Balanskat and Engelhardt, 2014).

According to the European Schoolnet research (European Schoolnet and University of Liège, 2012), the frequency of use of ICT equipment by students and teachers in Croatia is generally close to the EU averages but confidence in their ICT skills tend to be below EU averages. Newer European Schoolnet research „Computing our future - Computer programming and coding“ (Balanskat and Engelhardt, 2014) did not include Croatia (nor some other EU or European countries such as Slovenia, Macedonia) but it is known based on some other studies that schools in Croatia are in average placed under the category "digital beginners" in which teachers are insufficiently using ICT to improve teaching (European Commission, 2015), (Center for Applied Psychology Faculty of Humanities and Social Sciences in Rijeka, 2016).

In addition, despite some announcements that there will be changes regarding the status of informatics as a subject in schools within the curricular reform which preparation began in 2015, informatics is still only an elective subject in primary schools for students from 5th to 8th grade. Based on authors’ experience, learning to code is not sufficiently present in schools because it is considered that students find

coding too difficult and uninteresting. The development of computational and algorithmic thinking of students from first to fourth grade is also neglected and insufficient.

In the Proposal of National curriculum for the teaching subject of Computer Science/Informatics, one of the structural domains is Computational Thinking and Programming. This domain highlights the development of skills needed for logical and algorithmic thinking and application in different situations. The algorithmic way of thinking is primarily developed by solving various problems that reflect real-life problems and situations where it is necessary to apply knowledge from other areas, especially natural sciences, mathematics and logic ('Proposal of National curriculum for the teaching subject of Computer Science/Informatics', 2016).

The insufficient attention is also paid to the development of competences for the application of digital technology in education for future teachers. There is not enough appropriate subjects in studies that train future primary junior grade teachers in that field and as a start point, it should be enabled that teachers continue to improve their skills and knowledge in this area through a programme of lifelong learning, and in the future to incorporate the appropriate subjects as mandatory in the formal study programmes.

Review of initiatives to encourage coding and teacher education

The need for the introduction of coding and development of algorithmic thinking in schools has already been recognized in Europe. According to „Computing our future - Computer programming and coding - Priorities, school curricula and initiatives across Europe" (Balanskat and Engelhardt, 2014) some EU countries integrate coding in their curricula. It is mainly integrated at secondary level and as a part of a computer science or informatics course or separate subject but only for some school programmes. Therefore, across Europe the need for students' curiosity about coding, and building their confidence to pursue scientific careers already in primary school is recognized. Competitions that are offered in several European countries are one way of rewarding excellence in that area. Good examples are Hackathon on Coding (*All you need is {C<3DE}*, 2017) and Bebras (*The Bebras Computing Challenge*, 2018).

European Schoolnet launched the European Coding Initiative (*European Coding Initiative*, 2015) for the promotion of teaching and learning programming and coding and stronger integration of coding in K12 education. Teachers have also been supported directly in teaching programming and coding. Website for students, teachers and adults who want to try out coding for the first time have been built and open online courses have been conducted. These are for example All you need is {C<3DE} (*All you need is {C<3DE}*, 2014), Hour of Code (*Hour of Code*, 2015), Code Club (*Code club*, 2018). Also, collection and curation of teaching materials, tools and lessons plans has been carried out, for example on European Schoolnet Academy platform (*European Schoolnet Academy*, 2018).

These resources are intended primarily for informal learning and self-study with the possible help of online tutors. In addition, although it is stated that the resources can be used by anyone interested to learn programming, a high degree of motivation is needed in order to learn in such a way. From authors' experience, it is unlikely that they are suitable for primary junior grade teachers.

It has already been pointed out that not sufficient attention is being paid to the development of competences for the application of digital technology in education for future teachers in their formal education. There are not enough appropriate subjects in studies for future primary junior grade teachers, and especially not enough subjects within which models such as Game Based Learning or introducing elements of creating content and coding into teaching could be implemented. Even if there are such subjects present, they cover only a part of the competences and they are mainly elective. For example, at the Faculty of Teacher Education, University of Rijeka, one of the elective courses in the Graduate study of primary school education is "Extracurricular Informatics and Technical Activities". The situation is similar in most study programs for teachers across Europe which was one of the reasons for connecting partners from different EU countries.

Project objectives

The general goal of the GLAT project is improving students' attitudes towards coding and the development of algorithmic thinking of younger students, reducing the "fear" towards coding and increasing students' interest in the selection of future career in the ICT and STEM areas (in the long term). This will be achieved by professional training of teachers regarding the use of innovative teaching methodologies such as Game Based Learning (GBL).

The main objectives of the project are:

- Encouraging the integration of algorithmic thinking into the daily teaching through different subjects from the first to fourth grade of primary school.
- Training of teachers including the acquisition of contemporary knowledge and skills connected to different ICT related innovative teaching methodologies such as Problem Based Learning (PBL), Inquiry Based Learning (IBL), Game Based Learning (GBL).
- Creating blended learning e-course in LMS (syllabus, materials in English and (partly) in Croatian) for further using in the partner countries and beyond.

The GLAT project is innovative as its results can be used for informal, non-formal and formal learning. The project is not focused only on informal learning but also on non-formal learning and professional development of primary junior grade teacher with the aim to train them for introducing the concepts of coding, algorithmic and computational thinking to the primary junior grade students. It is believed that these teachers have no additional prior knowledge which is needed in order to introduce the before mentioned elements.

Syllabus with the materials for learning and with the examples of good practice and learning scenarios that will be developed by teachers will be available for self-study but it will also be available online for download and customize by all institutions (in Croatia, partner countries and across Europe) in order to develop non-formal lifelong learning programs based on blended e-learning model. The f2f part of these programs is particularly important in order to increase the motivation of the participants and facilitate the exchange of good practice among lecturers and other colleagues. It will also be possible to use the program modules to design courses and implement them as elective or mandatory in the formal primary junior grade teacher education or study programs of institutions that educate future teachers.

Intellectual outputs of GLAT project

The project consortium was set up to ensure effective cooperation and the joint work of experts in order to achieve the objectives of the project and to get high quality outputs. Three intellectual outputs are planned: O1 – Workshop syllabus and materials, O2 – Learning scenarios and O3 – The final version of the syllabus and learning materials.

O1 - Workshop syllabus and materials

Partners of the GLAT project will develop a syllabus and learning materials for 3-day workshops for focus group of teachers for f2f part of a total of 48 hours. The learning outcomes that relate to innovative teaching methodologies in the ICT area such as Problem Based Learning, Inquiry Based Learning, Game Based Learning will be defined. Special attention will be devoted to learning with the help of digital didactic games (serious games) and application of Game Based Learning and gamification.

In addition to the list of teaching topics, the syllabus will include the objectives of the course and elaborate learning outcomes and teaching strategies as well as selected teaching methods and activities which will be realized by the participants of the workshops (including individual and collaborative strategies). The tasks for the participants, with special focus on the development of the learning scenarios and preparations for teaching in a digital form will be planned. The participants will begin to develop learning scenarios and preparations for teaching at the workshops and continue to work on them individually. Content of the workshops, teaching topics in the form of presentations for f2f part of workshops and supporting material containing descriptions, examples and selected tools (e.g. tools for making games, web 2.0 collaboration tools, preparation of multimedia content) will be carefully chosen and prepared based on the learning outcomes. All materials will be published as an e-course in a Learning Management System (LMS).

O2 - Learning scenarios

Learning scenarios include documents in which the teacher develops innovative ideas to carry out educational activities by means of modern teaching methods with the use of appropriate digital content and tools. The most important elements of the scenarios are the description of activities and learning outcomes that are realized by the given activity as well as methods and digital tools used for their realization. Learning scenarios can be incorporated into the teaching of each subject in whole or as a part of a lesson (CARNet, 2017).

Tools that enable graphical representation of scenario elements facilitate the process of creating learning scenarios. One of these graphical tools is LePlanner (TLU School of Digital Technologies, 2018) that was developed at the Tallinn University for the project Creative Classroom (Hoic-Bozic *et al.*, 2016).

When creating learning scenarios within GLAT project, the main goal will be to encourage algorithmic and computational thinking of students as preparation for later learning of coding. The student will be in the centre of the teaching process and she/he will be encouraged to explore, think, reason and act. Learning scenarios are going to be designed in the way that students will become familiar with the teaching content, which

will be related to the situations from everyday life and are integrated into different school subjects. As the prevailing teaching strategy GBL, elements of PBL, IBL and other strategies that teachers will get familiar with at the workshops will be used. Since the ICT equipment vary in different schools, although the emphasis will be on using digital tools, attention will also be paid to those scenarios that will not use the technology and the examples. For example, games that take place in the classroom without using a computer, the so-called unplugged activities (Tsarava *et al.*, 2017), will be presented.

Teachers gathered in a focus group will start designing their learning scenarios which will include ways in which activities that promote algorithmic way of thinking and are related to coding could be included in different subjects. They will be able to decide independently which subject to choose, which lesson within the subject, which methodology and activities they will use and whether they will use ICT (computer, tablets, ...) in conducting the activities or not. During the workshop, experts will guide them and assist them in defining the initial ideas, but later after the workshop, they will continue to work independently. Online mentoring by experts and sharing ideas and tips with other colleagues will be provided through the communication channels available in LMS e-course. The final versions of scenarios will be tested in classrooms with the students.

O3 – The final version of the syllabus and learning materials

The last output of the project is related to the evaluation of the results of the workshops and learning scenarios in order to get the final result, which consists of an enhanced syllabus of workshops with the materials for learning complemented by the examples of best practices (among 60 learning scenarios the best ones will be chosen and translated into English).

While modifying syllabus, the experience of the experts gained during the workshops with the focus groups and during the process of reviewing learning scenarios as well as the opinions given by teachers and students through surveys and interviews will be taken into consideration. Although the evaluation of the workshops will take place immediately at the end of each f2f workshop, it is necessary to conduct a comprehensive research after the completion of all workshops. Psychologists in the Faculty of Teacher Education team will prepare questionnaires and interview questions that will check not only the satisfaction of teachers with the education, but also to collect suggestions for its improvement. The questionnaire will also be prepared for students who took part in testing of the learning scenarios.

Syllabus with supporting materials will be prepared in Croatian and English and it will be available to all interested parties through an online platform for e-learning even after the completion of the project.

Workshops for teachers

The most important activities of the project include professional training of teachers, who will be introduced to different innovative teaching methodologies that include the use of information and communication technologies, and the emphasis will be on using educational strategies of Game Based Learning and gamification in order to foster creativity, logical thinking, and problem-solving skills.

During the project, teachers will be gathered in the focus group to participate in education designed according to the blended model of e-learning. The key part will be three two-day workshops (three modules) that will be held in Croatia at the Department of Informatics, University of Rijeka, while online part of the education will take place using a learning management system. The learning management system MoD which is based on the Moodle platform was selected and the e-course "Games for Learning Algorithmic Thinking" was created (Figure 1).

The focus group includes 24 primary junior grade teachers from Croatia who are selected by the Faculty of Teacher Education with the help of Education and Teacher Training Agency (AZOO). Participation in the workshops will represent a form of professional development for teachers. Members of the focus group will meet three times in the two-day workshops. Dates of the workshops are in the periods of school holidays for students when professional developments of teachers usually take place.

The experts from partner organizations will lead teachers through a programme introducing them first in the area through theoretical topics, and continuing by showing examples, games, and appropriate tools. With the help of experts and based on acquired knowledge and skills, teachers will start with designing learning scenarios and preparations for lessons in digital format, which will include covered methodologies of learning and digital resources.

Topics of the three workshops/modules are:

1. Game based learning and unplugged activities
2. Problem based learning, online quizzes and logical tasks
3. Games and tools for learning programming

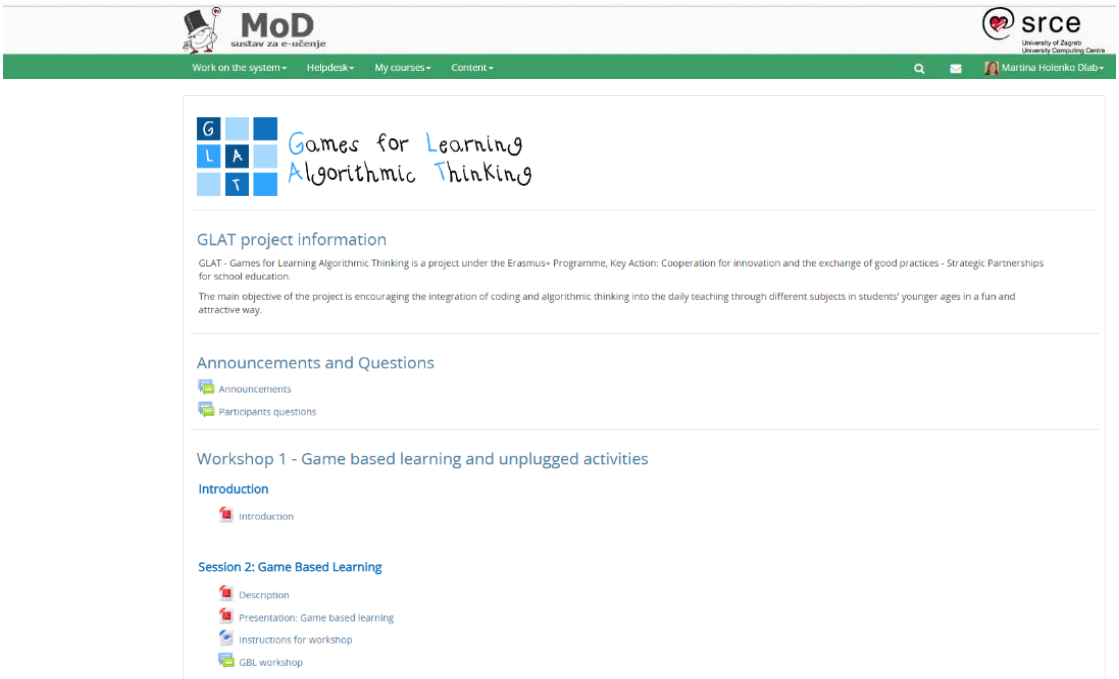

Figure 1 – E-course "Games for Learning algorithmic Thinking" in MoD LMS

First workshop

Workshop "Game based learning and unplugged activities" was held at the Department of Informatics, University of Rijeka, on 5th and 6th of April 2018. A focus group of 24 junior grade teachers participated in the workshop (Figure 2).

The main learning outcomes of this workshop were:

- describe principles of Game Based Learning,
- use Web 2.0 tools for creating content for unplugged activities,
- create learning scenarios in order to develop innovative ideas for carrying out unplugged activities.

Teachers attended lectures during which they were introduced to the concepts of Game Based Learning and unplugged activities. They also participated in individual and group activities, and analyzed examples of games and unplugged activities for different school subjects.

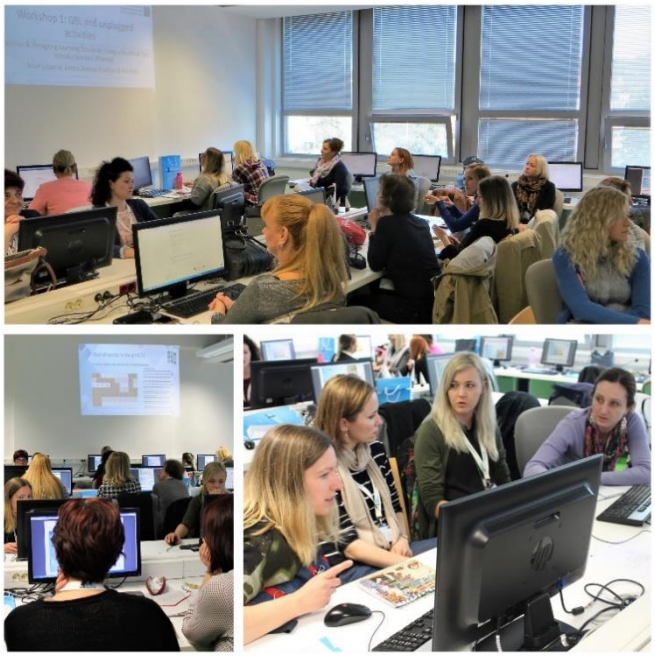

Figure 2 – Participants during the first GLAT workshop

There were several practical sessions where teachers had the opportunity to get to know and try out the learning scenario authoring tool LePlanner (Figure 3) and Web 2.0 tools Canva and Sketchpad for creating materials for unplugged activities.

At the end of the workshop, they started to apply newly acquired knowledge through the development of their own learning scenarios. Their task was to design a learning scenario for a selected subject (e.g. mathematics, nature and society, Croatian) that will include games and unplugged activities which will encourage students' creativity, logical thinking, and problem-solving skills. During learning scenario development, teachers could independently choose school subject and lesson within the subject as well as methodology and activities that promote algorithmic way of thinking and are related to coding.

Second workshop

The topic of the second workshop will be “Problem based learning, online quizzes and logical tasks” and the workshop will take place at the end of August 2018.

The main learning outcomes of the second workshop are:

- describe principles of Problem Based Learning and teamwork,
- use Web 2.0 tools for creating logical tasks and online quizzes,
- apply digital didactic games into different school subjects,
- create learning scenarios in order to develop innovative ideas for carrying out logical tasks and online quizzes.

In order to achieve learning outcomes, teachers from the focus group will be introduced to the concepts of Problem Based Learning, teamwork, digital literacy and digital content creation, online quizzes and logical tasks.

Practical part will include exploring the existing examples of games for different school subjects as well as activities like finding the appropriate period for implementation of the games within the lessons, deliberating how to match games with the learning outcomes and evaluating the existing games using the serious games evaluation framework. The participant will also have opportunity to work with digital tools that enhance the process of problem solving and Web 2.0 tools for creating online quizzes and logical tasks.

During the second workshop, teachers will start developing the first version of the second learning scenario that will include problem based learning activities, online quizzes and logical tasks.

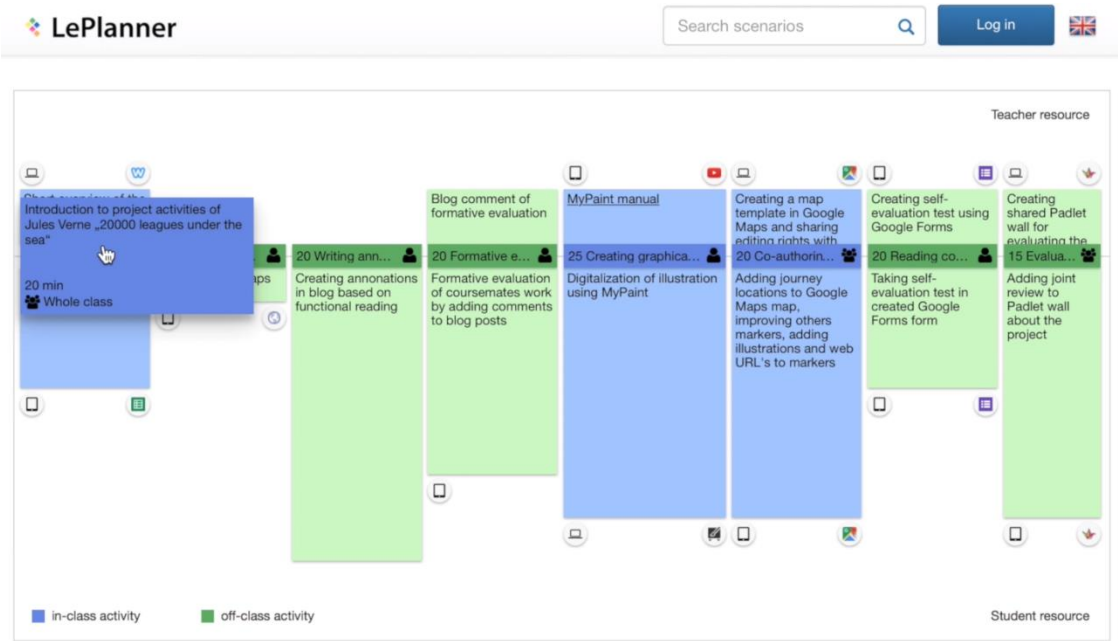

Figure 3 – Example of learning scenario created with LePlanner

Third workshop

The topic of the third workshop that will take place in January 2019 will be “Games and tools for programming”.

The main learning outcomes of the third workshop are:

- describe principles of Inquiry Based Learning,
- understand basic concepts of programming,
- create simple programmes (e.g. with ScratchJr),
- create learning scenarios in order to develop innovative ideas for applying programming concepts through game-based tools.

In accordance with the above listed learning outcomes, workshop participants will acquire elementary knowledge about the Inquiry based learning. They will also learn basic programming concepts (algorithms, sequence of instructions, conditional sentence, loop, variable) and will be introduced to games and tools for programming.

Throughout the practical sessions, teachers will be exploring existing games and tools like playing robot turtles, ScratchJr, and Micro:bits. They will also have chance to explore physical computing with Sphero SPRK+.

During the third workshop, teachers will start developing the first version of the third learning scenario that will include inquiry based learning activities, board games and other activities for applying programming concepts.

Future plans and expected impact

Currently, project team members are evaluating learning scenarios that teachers created after the first workshop. Based on the feedback from the experts, teachers will create improved versions of scenarios and then test them in classrooms with their students. In addition, project team members are working on learning materials and activities for participants that will be conducted during the second workshop. All designed learning materials will be available within the e-course in the MoD LMS.

During the project, a series of activities for the dissemination and popularization of results will be continuously carried out in all participating countries, including the final video conference where project's outputs will be addressed to teachers and all relevant stakeholders in partner countries. With the aim of informing on the project and its results, website glat.uniri.hr (Figure 4) was designed (*GLAT project website*, 2018). The web site and the e-course will remain available for further use after the completion of the project.

It is expected that the project will have an impact not only on the direct participants, but also on a much broader audience. The direct participants - primary school junior grade teachers gathered in the focus group will gain valuable experience by participating in the workshops and the development of learning scenarios together with European experts who will share their expertise and practices. The project is directed towards all other teachers as well because the results of the project will be presented in all partner countries, and developed learning materials with examples of good practice will be available to teachers to improve their competences and acquire contemporary knowledge and skills aimed at innovative teaching in the field of ICT and coding.

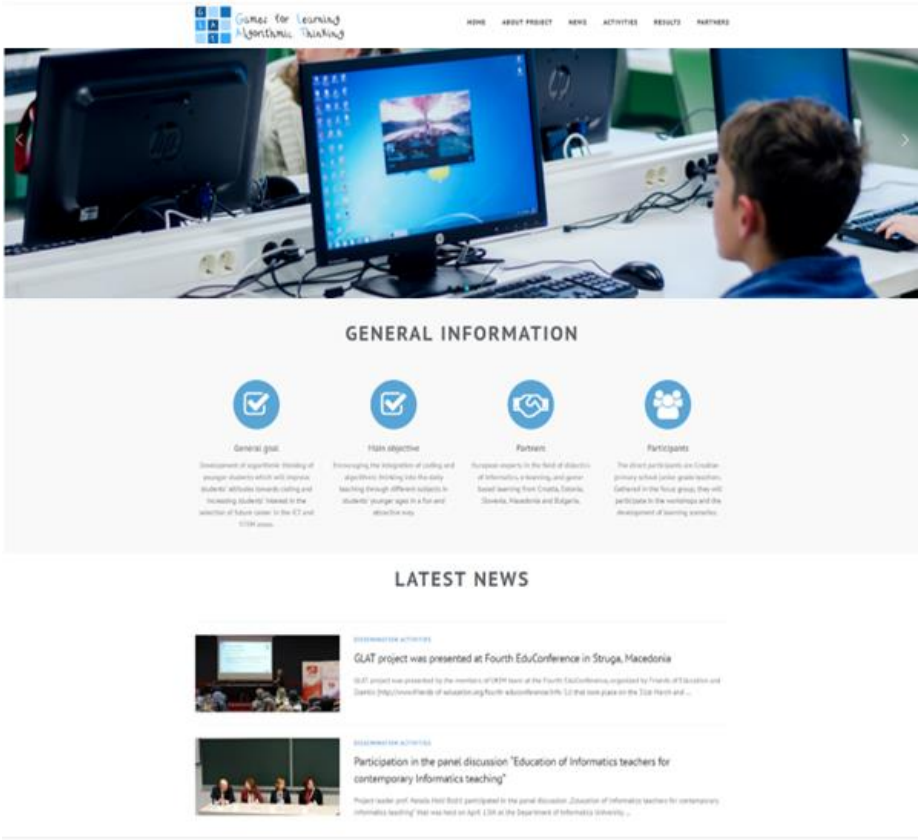

Figure 4 – Website glat.uniri.hr

Besides informal self-learning, after the completion of the project, the plans for the future include the accreditation of the program of lifelong learning for primary school junior grade teachers as a form of non-formal education at the University of Rijeka, organized by Faculty of Teacher Education and in cooperation with the Department of Informatics, University of Rijeka. The program will allow the strengthening of teachers' profession and improve teachers' competences. Finally, the project results will be used in formal education as a complement to the curricula at the Faculty of Teacher Education and to the mandatory and/or elective courses at the teaching oriented graduate study program at the Department of Informatics. In that way, the project will have an impact on the students - future teachers, as well. The project results will be readily available to use for informal learning in the partner countries and beyond because they will be translated into English, and in the future, it will be possible to organize and accredit appropriate forms of non-formal and/or formal education in a similar manner as in Croatia. It is expected that teachers will show interest in attending new training programs.

The impact of the project on students will be directly reflected in schools where new scenarios of learning will be implemented by the teachers who make up the focus group. In that way students will get the opportunities to explore and learn algorithmic thinking and coding skills from an early age through GBL and other modern teaching approaches. The future expansion of the impact of the project results to a larger group of teachers and students is expected. It will also result in a general improvement of students' attitudes towards programming and the development of algorithmic and computational thinking of younger age students, which will have a long-term impact

on the increase of their interest in the selection of future occupations in ICT and STEM fields. In this way, all involved partners who perform study programs in Informatics and Computer Science as well as all other higher education institutions that educate these profiles will gain direct benefit since it will enable the enrolment of higher number of quality students.

Conclusions

The GLAT project provides students and teachers with the support for the acquiring of relevant and high-quality digital skills and competencies in order to foster employability, socio-educational and professional development.

Among primary school teachers a training program, which promotes innovative methods and pedagogical approaches for the introduction of the teaching concepts related to coding and those that encourage the development of algorithmic thinking of younger students, will be implemented. The training also provides support for efficient use of ICT in education. Besides, materials for learning with the examples of best practices are being developed and activities for the dissemination and popularization of the results will be carried out. 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. Creativity, algorithmic thinking and problem solving skills will be encouraged already from the first grade of primary school in a fun and attractive way using didactical games.

The project team believes that the results of this project will contribute to the field of education supported by ICT technologies in Croatia, partner countries and beyond. The final goal of the project is the development of algorithmic thinking of younger students and improvement of students' attitudes towards coding. In the long term, it will contribute to reducing the "fear" towards programming and to increasing students' interest in the selection of future career in the ICT and STEM areas.

Acknowledgment

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 “E-learning Recommender System” (reference number 13.13.1.3.05).

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Projekt GLAT - poticanje algoritamskog razmišljanja korištenjem didaktičkih igara

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Sažetak **- Projekt „Games for Learning Algorithmic Thinking" (GLAT) sufinanciran je Erasmus+ programom Strateška partnerstva za područje općeg obrazovanja i traje do listopada 2019. godine. Koordinator projekta je Sveučilište u Rijeci – Odjel za informatiku, a projektni tim čine eksperti iz područja e-učenja i programiranja iz Hrvatske, Slovenije, Estonije, Makedonije i Bugarske. Glavni je cilj projekta poticanje uključivanja elemenata programiranja i algoritamskog razmišljanja u poučavanje različitih predmeta u nižim razredima osnovne škole na zabavan i atraktivan način. Naglasak je na korištenju obrazovnih strategija učenja uz pomoć igara koje će kod učenika potaknuti kreativnost, logičko razmišljanje i vještine rješavanja problema.**

U radu se opisuje kontekst i razlozi za pokretanje GLAT projekta, planirani intelektualni rezultati, aktivnosti projekta te njegov očekivani učinak. Najvažnije aktivnosti uključuju stručno usavršavanje učitelja razredne nastave koji će se na radionicama upoznati s inovativnim metodama izvođenja nastave pomoću IKT, a naglasak će biti na korištenju didaktičkih igara. Planirani intelektualni rezultati uključuju silabus radionica i materijale za učenje te scenarije poučavanja koje će učitelji provoditi u nastavi sa svojim učenicima. Silabus s materijalima za učenje i najboljim primjerima scenarija bit će objavljen na hrvatskom i engleskom jeziku, pa će ga uz hrvatske nastavnike moći koristiti i nastavnici diljem Europe.

Ključne riječi – projekt GLAT; algoritamsko razmišljanje; programiranje; didaktičke igre; scenarij poučavanja

I. UVOD

Informacijsko-komunikacijske tehnologije (IKT) predstavljaju jedno od područja koje se danas najbrže razvija i koje predstavlja glavni pokretač razvoja gospodarstva i društva [1]. Unatoč tome ishodi učenja vezani ne samo uz IKT teme nego i razvoj općih digitalnih kompetencija su i dalje nedovoljno zastupljeni kao dio školskog kurikuluma. To je slučaj u osnovnim školama u Hrvatskoj ali i u drugim zemljama Europske unije [2]. Prema [3], među pet osnovnih područja digitalnih kompetencija pripada i kreiranje digitalnih sadržaja koje uključuje i kompetenciju *programiranje* opisanu kao sposobnost planiranja i razvoja niza naredbi razumljivih računalu za rješavanje zadanog problema ili izvođenje određene zadaće. Ovo je područje posebno zanemareno u obrazovanju. U europskim školama se ne pruža dovoljno mogućnosti učenicima za istraživanje programiranja niti se učenici uče algoritamskom načinu razmišljanja i vještinama kodiranja [2]. Ishodi učenja koji se odnose na programiranje trebali bi biti zastupljeni ne samo u informatičkim predmetima već posredno uključeni i u svakodnevno učenje različitih predmeta od najranijeg uzrasta učenika.

Jedan od projekata s temom iz spomenutog područja je GLAT - *Games for Learning Algorithmic Thinking* sufinanciran Erasmus+ programom u okviru Ključne aktivnosti 2, Strateška partnerstva za područje općeg obrazovanja. Glavni je cilj projekta poticanje uključivanja elemenata programiranja i algoritamskog razmišljanja u poučavanje različitih predmeta u nižim razredima osnovne škole na zabavan i atraktivan način.

Projektom će se nastojati potaknuti integraciju elemenata učenja programiranja u svakodnevno učenje kod učenika mlađeg uzrasta (od prvog do četvrtog razreda osnovne škole) kroz stručno usavršavanje učitelja razredne nastave za stjecanje digitalnih vještina, ali i suvremenih znanja i vještina usmjerenih k inovativnom poučavanju u području IKT. Tako će se učitelji upoznati s inovativnim metodologijama poučavanja koje koriste IKT poput problemskog učenja, učenja propitivanjem, učenja uz pomoć igara (eng. *Game Based Learning* - GBL). Posebna pažnja će se posvetiti učenju uz pomoć didaktičkih igara (eng. *serious games*) odnosno konkretnoj primjeni GBL i igrifikacije (eng. *gamification*) za učenje digitalnih vještina općenito te posebice vještina programiranja. Nastavnici će novousvojena znanja i vještine primjenjivati u svojoj nastavnoj praksi u školama te se kao krajnji cilj očekuje poboljšanje stavova učenika prema programiranju i razvoj algoritamskog načina razmišljanja kod učenika mlađe dobi što će dugoročno doprinijeti povećanju i njihova interesa za odabir budućih zanimanja iz STEM i IKT područja.

Projektni tim okuplja europske stručnjake na području metodike nastave informatike i e-učenja koji će raditi na osmišljavanju edukacije izravno usmjerene na grupu hrvatskih učitelja no koju će biti moguće primijeniti na učitelje širom Europe. Koordinator projekta je Sveučilište u Rijeci – Odjel za informatiku, a partneri su: Učiteljski fakultet Sveučilišta u Rijeci, Sveučilište u Tallinnu (Estonija), Pedagoški fakultet Sveučilišta u Ljubljani

(Slovenija), Sveučilište Sv. Ćiril i Metod u Skopju (Makedonija) i Jugozapadno sveučilište "Neofit Rilski" u Blagoevgradu (Bugarska).

Projekt je započeo u listopadu 2017. godine i trajat će dvije godine, a najvažnije aktivnosti uključuju stručno usavršavanje nastavnika putem tri radionice na kojima će biti upoznati s različitim inovativnim metodama izvođenja nastave uz uporabu informacijsko-komunikacijske tehnologije (IKT). Naglasak će biti na korištenju obrazovnih strategija učenja uz pomoć igara te poticanju kreativnosti, logičkog razmišljanja i vještine rješavanja problema.

Glavni rezultat projekta predstavljat će zaokružena cjelina silabusa radionica i materijala za polaznike na hrvatskom i engleskom jeziku, upotpunjena primjerima dobre prakse nastavnika i objedinjena pomoću online platforme za e-učenje koja će ujedno omogućiti nastavnicima razmjenu iskustava i ideja o primjeni inovativnih metodologija poučavanja u njihovoj nastavi. Silabus će se i ubuduće moći koristiti za organizaciju programa stručnog usavršavanja nastavnika, tečaja ili sličnog oblika edukacije u Hrvatskoj, zemljama partnerima i šire.

II. KONTEKST I VAŽNOST ISTRAŽIVANJA

Unatoč prepoznatoj važnosti STEM (akronim sastavljen od eng. riječi *science, technology, engineering i mathematics* - znanost, tehnologija, inženjerstvo i matematika) i IKT područja, ne samo u Hrvatskoj nego i u velikom broju ostalih europskih zemalja, ishodi učenja vezani uz IKT kao i uz razvoj općih digitalnih kompetencija nisu dovoljno zastupljeni u obrazovnim kurikulima posebice osnovnih škola [2]. Na osnovu provedenih istraživanja [4], [5] je poznato kako se u Hrvatskoj škole u prosjeku svrstavaju u kategoriju „digitalnih početnica“ u kojima nastavnici nedovoljno koriste IKT za unaprjeđenje poučavanja.

Za sada je u Hrvatskoj Informatika još uvijek samo izborni predmet u osnovnoj školi od 5. do 8. razreda. Prema saznanjima predlagača projekta, ona često ne uključuje u dovoljnoj mjeri učenje programiranja jer ga učenici smatraju preteškim i nezanimljivim. Također je razvijanje algoritamskog načina razmišljanja kod učenika od prvog do četvrtog razreda osnovne škole zanemareno i nedovoljno prisutno. Promjene su najavljene u sklopu kurikularne reforme koja je započela 2015. Tako se u Prijedlogu kurikuluma za OŠ kao jedna od domena tehničkoga i informatičkog područja kurikuluma navodi rješavanje problema i programiranje [6].

Isto tako, u Hrvatskoj je nedovoljna pažnja posvećena i razvoju kompetencija za primjenu digitalne tehnologije kod formalnog obrazovanja kod budućih učitelja i nastavnika. Odgovarajućih predmeta na studijima koji školuju buduće učitelje razredne nastave nema dovoljno, a posebice ne onih koje bi uvele modele poput GBL i uvođenja elemenata kreiranja sadržaja i kodiranja u nastavu. Ukoliko takvi predmeti i postoje, oni pokrivaju samo dio kompetencija i većinom su izborni. Primjerice, na Učiteljskom fakultetu Sveučilišta u Rijeci jedan od izbornih predmeta na Učiteljskom studiju je „Izvannastavne informatičke i tehničke aktivnosti“. Slična je situacija i s većinom studijskih programa za učitelje diljem Europe. Za početak bi trebalo omogućiti da se zainteresirani učitelji dalje usavršavaju u ovom području putem programa cjeloživotnog učenja no u budućnosti bi se odgovarajući predmeti trebali ugraditi u studijske programe.

U projektu GLAT inovativno je to što će se njegovi rezultati moći iskoristiti za informalno, neformalno i formalno učenje. Projekt tako nije usmjeren samo na samostalno učenje već i neformalno učenje odnosno stručno usavršavanje nastavnika razredne nastave s ciljem njihova osposobljavanja za uvođenje koncepata kodiranja i algoritamskog načina razmišljanja za učenika mlađih razreda osnovne škole. Smatramo kako ovi nastavnici nemaju dodatna predznanja da bi ove elemente samostalno uvodili.

Razvijeni silabus programa s materijalima za učenje i primjerima dobre prakse moći će se koristiti i za samostalno učenje jer će biti dostupan online za sve nastavnike zainteresirane za takav oblik učenja. Isto tako, moći će ga preuzeti i prilagoditi sve institucije (u Hrvatskoj, zemljama partnerima i šire u Europi) koje žele razviti programe cjeloživotnog neformalnog učenja po mješovitom modelu e-učenja. Smatramo da je dio ovakvih programa koji se izvodi u klasičnom obliku nastave (eng. *face-to-face*, f2f) posebice značajan kako bi se povećala motivacija polaznika i omogućila razmjena dobre prakse s predavačima i ostalim kolegama. Također će se moduli programa moći koristiti kako bi se dizajnirali predmeti i uključili kao izborni ili obavezni u formalno obrazovanje nastavnika, odnosno studijske programe institucija koje obrazuju buduće učitelje.

III. INTELEKTUALNI REZULTATI I AKTIVNOSTI PROJEKTA GLAT

Projektni tim okupljen je na način koji će osigurati uspješnu suradnju i zajednički rad eksperata na ostvarivanju rezultata projekta. Planirana su tri intelektualna rezultata: O1 – silabus i materijali radionica, O2 – scenariji poučavanja i O3 – završna verzija silabusa i materijala za učenje.

A. O1 - Silabus i materijali za radionice

U okviru O1 partneri će razvijati silabus i materijale za učenje za tri dvodnevne radionice za fokus grupu učitelja u ukupnom trajanju od 48 sati za dio koji će se izvoditi f2f. Definirat će se ishodi učenja koji će se odnositi na inovativno poučavanje u području IKT, a posebna pažnja će se posvetiti učenju uz pomoć digitalnih didaktičkih igara.

Osim popisa nastavnih tema, silabus će sadržavati ciljeve tečaja i razrađene ishode učenja te nastavne strategije odnosno odabrane pedagoške metode i aktivnosti koje će se realizirati s polaznicima radionica (uključujući individualne i suradničke strategije). Planirat će se i zadaci za polaznike s posebnim naglaskom na izradu scenarija poučavanja odnosno pripreme za nastavu u digitalnom obliku koje će polaznici započeti pripremati na radionicama, a nastaviti kao individualni rad. Partneri će pripremiti nastavne teme u obliku prezentacija za f2f dio radionica te popratni materijal koji se sastoji od

tekstova, primjera i odabranih IKT alata (npr. alati za izradu igara, gotove igre iz programiranja, alati weba 2.0 i sl.). Svi materijali će biti objavljeni kao e-tečaj u web sustavu za upravljanje učenjem (LMS) Moodle.

B. O2 - Scenariji poučavanja

Scenariji poučavanja su dokumenti u kojima će nastavnik prikazati kako provesti nastavne aktivnosti na inovativan način, suvremenim pedagoškim metodama uz primjenu odgovarajućih digitalnih sadržaja i alata. Najvažniji elementi navedeni u scenarijima su opis aktivnosti i ishoda učenja koji se aktivnostima ostvaruju te metode i digitalni alati korišteni za njihovu realizaciju. Scenariji poučavanja mogu se primijeniti u nastavi svakog predmeta kao cijeli nastavni sat ili njegov dio [7]. Osmišljavanje scenarija poučavanja olakšavaju alati koji omogućuju grafički prikaz elemenata scenarija. Jedan od takvih grafičkih alata je Le Planner [8] koji je razvijen na Sveučilištu u Tallinu za projekt Creative Classroom [9].

Prilikom izrade scenarija u projektu GLAT osnovni cilj će biti potaknuti algoritamski način razmišljanja kod učenika kao priprema za kasnije učenje programiranja. Pri tome će se učenik staviti u središte nastavnoga procesa i potaknut će se ga na istraživanje, razmišljanje, samostalno zaključivanje i djelovanje. Scenariji će biti osmišljeni tako da se sadržaji vezani uz kodiranje približe učenicima na pristupačan način, povezivanjem sa situacijama iz svakodnevnog života i integriranjem u sadržaje različitih nastavnih predmeta. Kao prevladavajuća strategija poučavanja koristiti će se GBL, ali i elementi problemskog učenja i učenja propitivanjem. Vodit će se računa o tome da je opremljenost škola IKT opremom različita. Iako će naglasak biti na korištenju digitalnih alata, pažnja će se posvetiti i onim scenarijima koji neće koristiti IKT te će se razviti primjeri igri i drugih aktivnosti koje se odvijaju u razredu bez uporabe računala (tzv. *unplugged activities* [10]).

Nastavnici okupljeni u fokus grupu sudjelovat će na f2f radionicama te će na kraju svake od njih započeti s osmišljavanjem svojih scenarija učenja koji će uključivati načine na koji bi elemente kodiranja uključili u učenje različitih predmeta. Moći će samostalno odabrati nastavni predmet, nastavnu cjelinu unutar predmeta te metodologiju i aktivnosti za učenike. Tijekom radionice eksperti će ih voditi i pomoći im u definiranju i skiciranju početnih ideja putem alata Le Planner, a nakon radionica nastavit će samostalni rad uz online mentoriranje eksperata te razmjenu ideja i savjeta s ostalim kolegama putem komunikacijskih kanala dostupnih u LMS-u e-tečaja. Konačne dorađene verzije scenarija poučavanja nastavnici će implementirati u razredu sa svojim učenicima.

C. O3 – završna verzija silabusa i materijala za učenje.

Posljednji rezultat projekta je vezan uz evaluaciju rezultata održanih radionica i scenarija poučavanja kako bi se načinila zaokružena cjelina koja se sastoji od unaprijeđenog silabusa radionica s materijalima za učenje upotpunjenim primjerima dobre prakse nastavnika (od svih načinjenih scenarija poučavanja odabrati će se oni najbolji i prevesti na engleski jezik).

Prilikom izrade unaprijeđenog silabusa koristit će se iskustva eksperata stečena tijekom radionica s fokus grupom i prilikom pregledavanja scenarija poučavanja kao i mišljenja nastavnika i učenika prikupljena putem anketiranja i intervjuiranja. Naime, iako će se evaluacija radionica odvijati neposredno na kraju svake f2f radionice, izvršit će se i sveobuhvatno istraživanje po završetku svih radionica. Psiholozi u timu Učiteljskog fakulteta će pripremiti upitnike i intervjue kojima će se provjeriti ne samo zadovoljstvo nastavnika provedenom edukacijom već i prikupiti sugestije za poboljšanje. Upitnik će se pripremiti i za učenike s kojima su učitelji proveli svoje scenarije poučavanja.

Silabus s popratnim materijalima će biti pripremljen na hrvatskom i engleskom jeziku i dostupan putem online platforme za e-učenje ne samo nastavnicima koji su sudjelovali u fokus grupi i njihovim kolegama u školama, već i široj javnosti u zemljama partnera, ali i ostalim Europskim zemljama.

D. Radionice

Najvažnije aktivnosti projekta uključuju stručno usavršavanje nastavnika koji će se upoznati s različitim inovativnim metodama izvođenja nastave uz uporabu informacijsko-komunikacijske tehnologije, a naglasak će biti na korištenju didaktičkih igara te poticanju kreativnosti, logičkog razmišljanja i vještine rješavanja problema.

Tijekom projekta će nastavnici okupljeni u fokus grupu sudjelovati na edukaciji oblikovanoj prema mješovitom modelu e-učenja. Ključni dio će predstavljati tri dvodnevne radionice (tri modula) koje će se održati u Hrvatskoj na Odjelu za informatiku Sveučilišta u Rijeci dok će se online dio edukacije odvijati putem sustava za e-učenje Moodle. Fokus grupu će činiti dvadesetak nastavnika razredne nastave iz Hrvatske koji će biti odabrani u suradnji Agencije za odgoj i obrazovanje (AZOO) i Učiteljskog fakulteta. Sudjelovanje na radionicama predstavljat će oblik stručnog usavršavanja nastavnika koje se standardno provodi u organizaciji AZOO. Za termine radionica odabrani su travanj 2018. godine, zadnji tjedan u kolovozu 2018. i siječanj 2019. kao periodi školskih praznika za učenike koji su uobičajeni za stručna usavršavanja nastavnika.

Eksperti iz partnerskih organizacija će učitelje voditi kroz program silabusa uvodeći ih prvo u područje putem teorijskih tema, a zatim nastavljajući prikazom primjera i odgovarajućih alata. Kao što je već spomenuto, u drugom dijelu svake radionice, učitelji će na osnovu stečenih znanja i vještina, te uz pomoć eksperata, započeti s osmišljavanjem scenarija učenja koji će obuhvaćati obrađene metodologije učenja i digitalne resurse. Teme tri modula su: *Učenje uz pomoć igara u razrednoj nastavi*, *Problemsko učenje, logičke igre i zagonetke*, *Igre i alati za učenje programiranja*.

E. Ostale aktivnosti

Tijekom projekta kontinuirano će se provoditi niz aktivnosti za diseminaciju i popularizaciju rezultata u zemljama svih partnera.

Na različitim događanjima poput konferencija, radionica, seminara s temom uporabe IKT u obrazovanju u zemljama partnerima i ostalim europskim zemljama eksperti koji sudjeluju u projektu će prezentirati rezultate kolegama - stručnjacima iz ovog područja, te posebice učiteljima u osnovnim školama. U Hrvatskoj će vrlo važan kanal diseminacije biti nastavnici u fokus grupi koji će u svojim školama diseminirati razvijene scenarije poučavanja te stručnjaci iz regionalnog ureda AZOO u Rijeci.

Kao završno događanje pri kraju projekta će se organizirati video konferencija na kojoj će se rezultati prezentirati nastavnicima, stručnjacima iz ovog područja, ali i široj zainteresiranoj javnosti.

S ciljem informiranja o projektu i njegovim rezultatima dizajnirano je web sjedište (Slika 1) [11]. Dodatno, materijali za učenje sa scenarijima poučavanja biti će dostupni na platformi za e-učenje (LMS). Odabran je sustav za e-učenje MoD Centra za e-učenje Sveučilišnog računskog centra (SRCE) koji se temelji na platformi Moodle te je kreiran e-kolegij „Games for Learning Algorithmic Thinking“ [12]. I web sjedište i e-kolegij ostat će dostupni online i otvoreni za daljnje korištenje i nakon završetka projekta.

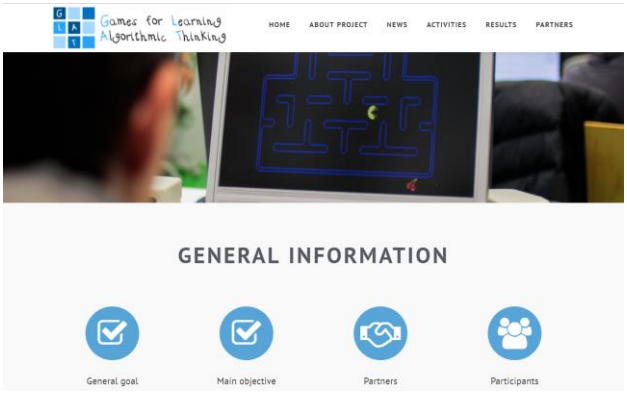
IV. OČEKIVANI UČINAK PROJEKTA

Očekuje se da će projekt GLAT imati utjecaj ne samo na neposredne sudionike, veći i znatno šire. Neposredni sudionici - nastavnici razredne nastave okupljani u fokus grupu steći će značajno iskustvo sudjelovanjem na radionicama i razvojem scenarija učenja. U tome će im pomoći europski eksperti iz područja e-učenja i programiranja koji će s njima podijeliti svoja stručna znanja i primjere iz prakse.

Projekt je usmjeren i prema svim ostalim nastavnicima jer će rezultati projekta biti prezentirani u svim zemljama partnera, a razvijeni materijali za učenje s primjerima dobre prakse će biti dostupni nastavnicima za poboljšanje svojih kompetencija odnosno stjecanje suvremenih znanja i vještina usmjerenih k inovativnom poučavanju u području IKT i kodiranja.

Osim za samostalno, informalno učenje rezultati projekta će se koristiti i za neformalno obrazovanje. Nakon završetka projekta se na Sveučilištu u Rijeci, u organizaciji Učiteljskog fakulteta i u suradnji s Odjelom za informatiku, planira pokrenuti akreditirani program cjeloživotnog učenja namijenjen učiteljima razredne nastave koji će omogućiti jačanje profila zanimanja nastavnik odnosno poboljšati kompetencije nastavnika. U konačnici, rezultati projekta će poslužiti i za formalno obrazovanje odnosno upotpunjavanje planova i programa studija Učiteljskog fakulteta te nastavničkog smjera studija Informatike obaveznim i/ili izbornim predmetima čime će se ostvariti i utjecaj na studente – buduće učitelje.

Rezultati projekta moći će se odmah koristiti za informalno učenje u zemljama partnerima i šire jer će biti prevedeni na engleski jezik, a u budućnosti će se na sličan način kao i u Hrvatskoj moći organizirati i akreditirati i odgovarajući oblici neformalnog i/ili formalnog obrazovanja.



Slika 1. Web sjedište glat.uniri.hr

Utjecaj projekta na učenike će se neposredno odraziti u školama iz kojih su nastavnici koji čine fokus grupu i koji će implementirati nove scenarije poučavanja u svojim razredima. Pritom će se učenici putem GBL i drugih suvremenih pedagoških pristupa dobiti priliku istraživati kodiranje i razvijati algoritamsko razmišljanje već od najranije uzrasta.

Budućim širenjem utjecaja rezultata projekta na veće skupine nastavnika i učenika očekuje se i općenito poboljšanje stava učenika prema programiranju što će rezultirati većim brojem učenika koji će izabrati svoje buduće karijere u IKT i STEM područjima. Na taj će način u konačnici neposrednu korist imati svi uključeni partneri, kao i ostale visokoškolske institucije koje izvode studijske programe iz informatike i računarstva jer će ih upisivati veći broj kvalitetnijih studenata.

V. ZAKLJUČAK

Projektom GLAT se učenicima i nastavnicima pruža potpora za usvajanje digitalnih kompetencija, posebice onih koji se odnose na područje kreiranja digitalnog sadržaja. Među nastavnicima osnovnih škola se provodi osposobljavanje kojim se promoviraju inovativne metode i pedagoški pristupi za uvođenje elemenata kodiranja i algoritamskog razmišljanja u nastavu, daje se podrška za efikasno korištenje IKT u obrazovanju te se razvijaju materijali za učenje s primjerima dobre prakse i provode aktivnosti za diseminaciju i popularizaciju rezultata. Nastavnici će stečene vještine i kompetencije promovirati svojim učenicima tako što će ih koristiti u svom nastavnom radu u školi što će rezultirati razvojem i njihovih digitalnih kompetencija. Kod učenika nižih razreda osnovne škole će se poticati kreativnost, algoritamsko razmišljanje i vještine rješavanja problema na zabavan i atraktivan način pomoću didaktičkih igara.

U tijeku su aktivnosti pripreme silabusa i izrade materijala za prvu radionicu, a započele su i aktivnosti diseminacije. Projektni tim vjeruje da će rezultatima ovoga projekta pridonijeti području obrazovanja potpomognutog IKT tehnologijama u Hrvatskoj, u zemljama partnerima, ali i šire. Kao krajnji cilj projekta očekuje se poboljšanje stavova učenika prema programiranju te razvoj algoritamskog načina razmišljanja kod učenika mlađe dobi što će dugoročno doprinijeti smanjivanju „straha“ od programiranja te povećati njihov

interes za odabir budućih zanimanja iz IKT i STEM područja.

ZAHVALE

Sufinancirano sredstvima programa Europske unije Erasmus+ Ključna aktivnosti 2, Strateška partnerstva za područje općeg obrazovanja, projekt „Games for Learning Algorithmic Thinking“ (2017-1-HR01-KA201-035362).

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The 10th International Conference on eLearning (eLearning-2019), 26 - 27 September 2019, Belgrade, Serbia

DEVELOPMENT OF COMPUTATIONAL THINKING SKILLS IN PRIMARY SCHOOL THROUGH DIGITAL STORYTELLING WITH SCRATCH

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Abstract: *Digital storytelling is a process of telling multimedia stories that can be interactive and contain game elements like labyrinths, sorting games, or puzzles. By combining the steps of the traditional storytelling process, creating multimedia, and defining game elements, teachers can encourage their students to acquire many fundamental skills including computational thinking. As a tool for both digital storytelling and computational thinking development, teachers may use a visual programming language Scratch. This paper presents a model for educating primary junior grade school teachers to use digital storytelling with Scratch for achieving learning outcomes of different school subjects as well as for the development of computational thinking skills of their students. The model is included in the blended learning course developed within the Erasmus+ project GLAT (Games for Learning Algorithmic Thinking). The paper brings experiences about educating the teachers enrolled in the GLAT course and engaged in designing interactive Scratch stories.*

Keywords: *Digital storytelling, Scratch, educational games, GLAT project*

1. INTRODUCTION

Digital storytelling has been recognized as effective way for achieving learning outcomes of different school subjects [1]. It is a process of telling stories by integrating multimedia elements (images, sound, text, animation) using digital tools [2]. By engaging in the process of designing and creating digital stories, students can develop computational thinking skills as well as many other skills such as research, organization, digital literacy, and problem solving skills [3].

The process of computational thinking involves formulating a problem and expressing its solution in a way that a human or a machine can effectively perform [4]. Among fundamental skills needed for that process are [5]: decomposition, abstraction, algorithms, debugging, iteration and generalization. These skills are used to break the problem into smaller parts, logically organize and analyse data, identify and apply existing solutions in order to design efficient solution of the problem, etc. [2]. Computational thinking skills are related to programming skills since some programming techniques are used in the problem solving process. In addition, computational thinking skills are needed to implement the developed solution of the problem using a computer [6]. Computational thinking skills should be encouraged from primary school [7] because these skills are useful for a career in many sectors (e.g. education, healthcare, tourism, business and financial markets) [5].

To motivate students to engage in learning activities that support the development of computational thinking skills, teacher can combine digital storytelling activities with Game Based Learning [1], [7]. Since most of today's students are fond of digital games, they find activities that include playing or designing games very interesting. These activities can also support the learning of basic programming concepts and motivate students to start using programming languages appropriate to their age (i.e. visual programming languages like Scratch) [2].

One of the project that tends to promote development of computational and algorithmic thinking using games is Erasmus+ project GLAT (Games for Learning Algorithmic Thinking) [8], [9]. This paper present a model for educating primary junior grade school teachers to use digital storytelling with Scratch for achieving learning outcomes of different school subjects as well as for the development of computational thinking skills of their students. The model is included in the blended learning course developed within the GLAT project. The paper also brings experiences about educating the teachers enrolled in the GLAT course and engaged in designing interactive Scratch stories and gives overview of the outstanding digital stories created during the project.

2. DIGITAL STORYTELLING

By combining the steps of the traditional storytelling process with gathering and creating digital media, teachers can encourage their students to become creative narrators, enable them to acquire many generic skills, as well as to achieve specific learning outcomes of different school subjects [1], [3]. For example, students can illustrate events from their lives or a plot of a favourite fairy tale [2].

Key elements of the digital story are [3]:

- setting of the story,
- characters,
- scenes,
- sequence of events,
- narrative perspective (point of view).

To make stories interactive, students can add game elements or challenges like mazes, brain teasers, sorting games and puzzles that should be solved by the player [10]. Mentioned games enable the player to develop computational thinking skills [11]. For example, after researching about cultural sights of their region, students can present them using a story and design games in which the player should demonstrate the knowledge of these sights. Students can also illustrate a real life mathematical problem and design logical games combined with mathematical tasks in which the player needs to apply knowledge to achieve the goal of the game.

As shown in Image 1, the teacher can start the digital storytelling process by selecting a topic and, with the help of students, formulate the initial ideas about the story and define its purpose and target audience. The teacher then guides students in exploring the topic and gathering necessary information. In this step students construct knowledge and organize ideas [3].

Students should decide regarding appearance, personality traits, and motivations of characters, describe the setting of the story (time and place), formulate the problem faced by the characters, how it is approached, and about its outcome. They should also design game elements - challenges that should be solved by the player (the playing character) [10]. Besides the player, stories can have narrator, a non-playing character who guides the player through the game and gives instructions and feedback, as well as other non-playing characters [3].

In the next step a script should be defined. An initial ideas need to be further developed and text that will be shown or told by characters prepared. Teacher should help the students to write interesting but focused and concise story that it is easy to understand. Before actual work on creating the digital story using the chosen tool, the storyboard is usually created. It is a written or graphical representation of all the elements that will be a part of the story including media files (images, text, narration, music) [3].

Interactive digital stories with game element can be created using visual programming languages like Scratch which offers a library with numerous sprites (characters), backgrounds, and sounds [2]. While designing and creating

Image 1: Digital storytelling process [3]

interactive stories with game elements, students have the chance to develop their computational thinking skills since they [2]:

- formulate a problem – students determine which elements should be used,
- logically organize and analyse data – students create characters, scenes and sequencing by building blocks of code,
- represent the data – students tell the story by defining movement of characters and dialogs among them, define variables for collecting points and timers,
- identify, analyse, and implement solutions – students ensure that the program works as intended, in the ordered steps.

After combining all elements together and sharing the created story with others, the final step of the process is gathering feedback and reflection [3].

3. PROMOTING DIGITAL STORYTELLING WITHIN THE GLAT PROJECT

During the GLAT project [8], a professional development training was organized for primary junior grade teachers to encourage the integration of activities for development of computational thinking skills into the daily teaching of different subjects (from the first to fourth grade of primary school).

GLAT training for primary junior grade teachers

The participants of the training were Croatian primary junior grade teachers. They attended a blended e-learning [12] training course where three face-to-face workshops were combined with online mentoring in a learning management system. During the training, teachers were introduced to innovative teaching strategies including Game Based Learning (GBL), Problem Based Learning (PBL), and Inquiry Based Learning (IBL) [11]. Besides theoretical topics, examples of games and digital tools that can be used for development of computational thinking were presented and analysed.

The following three two-day workshops were organized:

1. GBL and unplugged activities,
2. PBL, online quizzes and logical tasks,
3. IBL, games and tools for learning programming.

After each workshop, teachers applied acquired knowledge and skills and, with the help of experts from the project team, developed learning scenarios (i.e. preparations for classes in digital form [13]) for different school subjects. Learning scenarios developed by teachers included educational activities for development of algorithmic and computational thinking in line with workshop topic and presented teaching method. Teachers implemented all developed learning scenarios in classes with their students.

Introduction of digital storytelling

Digital storytelling was introduced during the third GLAT workshop so teachers planned activities related to digital storytelling in their learning scenarios. Image 2 shows the sequence of activities performed by the teachers, their students, and university students after the third GLAT workshop. The teachers first developed learning scenarios for the chosen school subject and topic. They included the activity of designing the digital story with game elements as well as IBL activities. Then, teachers developed initial ideas for digital stories related to the chosen topic. In the next phase, the teachers implemented the designed scenarios in the classroom with their students. After a set of activities designed in line with IBL (and other strategies), all the teachers planned the following activities: designing interactive story with game elements, viewing/playing the designed story with game elements, and reflection.

The teachers guided students through the process of designing the story with game elements. They described the setting of the story and decided on names and appearances of characters (playing characters and characters who guide the player through the game and give instructions and feedback). After exploring the topic and gathering necessary information, students also designed game elements that enable the player to develop algorithmic thinking skills (e.g. challenges like labyrinths, brainteasers, sorting games, and puzzles). The students were also included in defining scenes, the sequence of events, and logical conditions for directing the flow of the game.

In the process of designing digital stories with game elements, the students could learn basic programming concepts [2], [14]:

- sequence – students arrange the elements in the chronological order in which they will appear in the story
- data – students define which data need to be stored (e.g. player's name, collected points, remaining time, etc.)
- condition – students direct the story flow, define how the player will collect points, define the end of the game, etc.
- loop – students define challenges for the player, decide how many attempts the player will have to finish the game, etc.

Visual programming language Scratch [15] has been chosen for creating designed digital stories. The participants of the GLAT workshops were junior grade teachers and non-informatics teachers who did not have enough knowledge and skills to independently code in Scratch. Therefore, in the preparation of the stories with game elements university students - future teachers of informatics, helped the teachers. They programmed the stories according to the instructions provided by the teachers and their students. The Table 1 shows outstanding digital stories that were created during this very successful collaboration.

Reflection on the development and implementation of learning scenarios

Most of the learning scenarios developed by teachers were for the Science course and the other scenarios were for Mathematics and Croatian language. After the implementation of learning scenarios in the classroom, a reflection was performed.

During reflection, teachers expressed their comments regarding implementation, how the students accepted the designed activities (especially the parts about designing the game and playing the game), whether all the learning outcomes stated in the learning scenario were realized and the possible changes in the scenario before the next implementation.

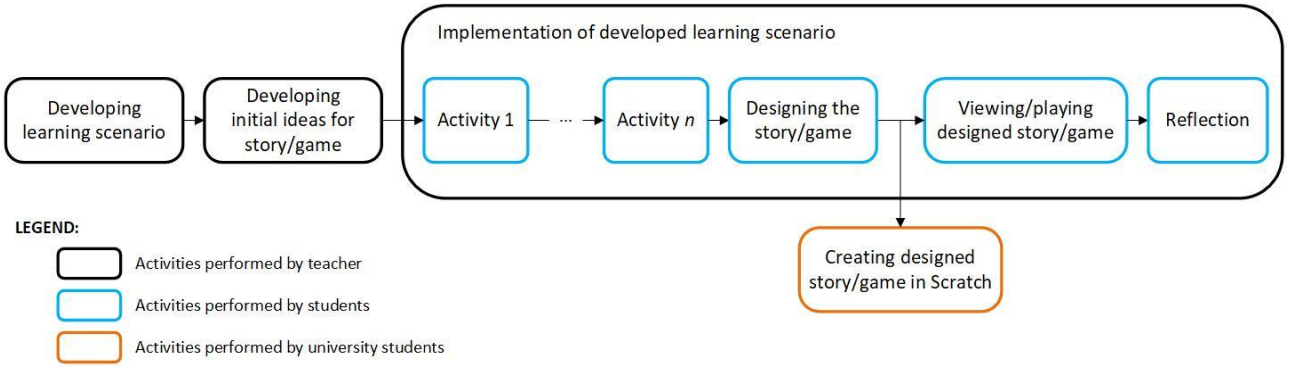

Image 2: Development and implementation of learning scenarios that include digital storytelling

Table 1: Outstanding digital stories with game elements created during the GLAT project

Name	Subject and grade	Story	Game elements	Preview
Seasons [16]	Science 1st grade	A girl named Mia moved from Africa to Croatia and wants to learn about the seasons.	Choose appropriate clothes, seasonal food, and write the names of the seasons.	
Let's eat healthy! [17]	Science 2nd grade	A girl named Tašana goes to the market to buy healthy food for a meal.	Collect healthy food, write the names of the main meals, and put the cutlery next to the plate.	
Cultural heritage [18]	Science 4th grade	A boy named Joseph was abducted by aliens who want to learn about the Croatian cultural heritage.	Mark the Croatian counties where UNESCO sights are located, collect pictures of the intangible cultural heritage.	
Calculation castle [19]	Mathematics 1st grade	To win the princess' hand, young prince must find the golden key and free the princess from the castle.	Collect a number of items (according to given numerical expression), solve word problems.	
Hlapić plays with words [20]	Croatian language	To find his lost friends in a castle, a boy named Hlapić needs to recognize different word classes (nouns, verbs, adjectives).	Sort words, to find a certain word class in a sentence, collect words of a given class.	

Teachers expressed great satisfaction with the prepared scenarios and implementation in the classroom as well as with high motivation of students for creating and playing their own game:

"*The introduction of digital games into teaching greatly enhanced my teaching experience and contributed to the fun of the lesson and the project day."*

"Learning outcome: Searching, finding, and separating relevant information from the irrelevant has been the most difficult, because this is the first grade. However, I believe that this way of working contributes to developing the ability to search, retrieve and extract relevant from irrelevant information, and that each time further, we will be better at achieving this outcome."

"The developed computer game will serve many other generations, and the motivation for further creation in students and teachers is very high."

"The working atmosphere was wonderful. Students were active and eagerly participated in all the steps of creating the game. When they first played the game, they kept repeating that this is exactly how they envisioned their game."

"Most of my students are involved in the program of early learning informatics, so they were very interested in how the game was developed and expressed their desire to learn how to do it, too."

"Designing this learning scenario was the most challenging for me, but the joy and enjoyment that the students showed while working was worth the effort."

Most of the teachers also pointed out that their students played the game multiple times at school and that link to the game was sent to their parents so they can play at home, too. After playing the game, the students were also interviewed about their experiences.

The favourite part for students during the implementation of learning scenarios was the part when they had chance to play the game they had designed together (Image 3).

The students perceived the game as a fun experience through which they could learn. Many of them indicated that their game is better than the existing examples of Scratch games, precisely because they participated in designing it. It is clear from the following students' responses that the experience of designing and playing the game is positive and that students have accepted this approach to teaching and learning very well:

"I liked when we were choosing the characters. We had to draw characters on board. We easily agreed, we voted for ideas. In the game, I liked the maze the most. I learned about the crew of the ship. There was no difficulty, I found it interesting, I felt good. Our game is better because we did it. I would change that game have more levels and tasks because it was too short for me."

"I felt good, a little angry at the first task because I couldn't get through it. There was no difficulty while playing the game. Our game is better because it's more fun and has a lot more colors. I would change the maze to be more difficult and add three more levels."

4. CONCLUSIONS AND FUTURE PLANS

Using digital storytelling, teachers can encourage their students to become creative narrators, but at the same time enable them to acquire many skills, including computational thinking. Digital storytelling activities can be planned for various school subjects. Students eagerly participate in these activities and they enable them to achieve learning outcomes in a fun way.

This paper presents a model for educating primary junior grade school teachers developed during the GLAT project. Digital storytelling with Scratch is used for achieving learning outcomes of different school subjects as well as for the development of computational thinking skills of students. Teachers' and students' engaged in designing interactive Scratch stories expressed positive experiences.

The GLAT project will end in October 2019. However, activities for promoting development of computational thinking skills will continue at University of Rijeka within the project "Digital educational games". During the project "Digital educational games", possibilities of using GBL in the context of learning, teaching, and promoting inclusive education will be further explored. Efforts on building pedagogical-technological frameworks based on GBL to educate the teachers will be made.

Image 3: Students playing the game they designed

ACKNOWLEDGMENT

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).

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Enhancing Teachers' Computational Thinking Skills Through Game Based Learning

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Abstract

Computational thinking is a concept which involves formulating and solving problems in a way computer would do it, though not necessarily with the help of a computer. It is considered to be the necessary skill for successful functioning in the technology driven society of the 21st century, therefore it is important to integrate it into the education system. Since the role of the teacher in that context is important, the paper considers activities in the development of computational thinking of pre-service and in-service teachers, especially through game based learning. Two projects that explore this topic are presented: the Erasmus+ project GLAT and the Digital games project.

1 Introduction

After the influential work of Jeanette M. Wing in 2006, Computational Thinking (CT) became widely accepted term of universally applicable concepts, attitudes and skills characteristic to the STEM and information science way of thinking [Win06].

Most CT related work is focused on students of older age, within STEM areas and subjects, as well as students on various courses within the domain of information science and programming. It is to be expected that the level of CT in such population is above the level in general population. The demand for modern education is to adopt the essential concepts of CT within the population uncomfortable to STEM area, programming and informatics. In order to educate creative and innovative people able to cope with contemporary technology of tomorrows, which are not just technology consumers but their active creator, it is important to influence students as early as possible. When their interests are still shaped and they are still motivated for learning, they experience learning as a game and not as a commitment. Constructive criticism is focused on the lack of research aimed at younger elementary schools students, preschool age groups (K-4; kindergarten through 4th grade) and especially teachers working with these students. For example, of 27 published papers about CT promotion from July of 2015 to April of 2016, only 3 studies are targeted at lower primary school age and teachers as aimed groups of research [deA16].

This paper focuses on the promotion of teacher's CT, both future teachers and teachers already participating in the teaching process (pre-service and in-service teachers). The activities that have started within the Erasmus+ project GLAT - *Games for Learning Algorithmic Thinking* and have continued within the UNIRI project *Digital*

In: Jože Rugelj, Maria Lapina (eds.): Proceedings of SLET-2019 – International Scientic Conference Innovative Approaches to the Application of Digital Technologies in Education and Research, Stavropol – Dombay, Russia, 20-23 May 2019, published at http://ceur-ws.org

games in the context of learning, teaching and promoting inclusive education are presented. One of the projects' objectives is to encourage the integration of CT into the daily teaching of different subjects in the lower grades of primary school using game based learning (GBL). This research will include the design of a model for CT teacher education so that in their future work teachers could stimulate among their students important concepts that CT includes.

The paper is organized as follows: the second chapter provides some of the CT definitions, concepts, and models. The third chapter brings brief description of Game Based Learning (GBL) and Scratch Tool. The fourth chapter deals more closely with CT in the context of teacher education, with reference to the Croatian education system and the new curriculum. Next, there are chapters featuring projects activities: the fifth chapter presents *Games for Learning Algorithmic Thinking* (GLAT) project which ends in 2019 and the sixth chapter presents the project *Digital games in the context of learning, teaching and promoting inclusive education* (Digital Games) which begun in 2019, partly as a continuation of the GLAT project. At the end of the paper, the last chapter points out the main conclusions.

2 Computational Thinking (CT)

CT covers a wide range of features so there is no unambiguous definition of it. The CT definition is often the set of skills it consists of. Most of the authors agree that CT is a set of fundamental skills for everyone, not just computer scientists; it is a thought activity of formulating and solving problems in the way computers do it. Thereby the problem solving process does not necessarily involve computers themselves [Cun10].

A more extensive definition is given by C. Selby and J. Woollard in which the CT is referred to as "a focused approach to problem solving, incorporating thought processes that utilize abstraction, decomposition, algorithmic design, evaluation, and generalizations [Sel13].

Even more complete CT definition is formulated in the *Computational Thinking Toolkit* publication from 2010. Organized by the National Science Foundation (NSF), the International Society for Technology in Education (ISTE) and the Computer Science Teachers Association (CSTA) from USA, by the synergy of a large number of leading education scientists, teachers and computer scientists, the operational CT definition is produced [Com10]:

Computational thinking (CT) is a problem-solving process that includes (but is not limited to) the following characteristics:

- Formulating problems in a way that enables us to use a computer and other tools to help solve them
- Logically organizing and analyzing data
- Representing data through abstractions such as models and simulations
- Automating solutions through algorithmic thinking (a series of ordered steps)
- Identifying, analyzing, and implementing possible solutions with the goal of achieving the most efficient and effective combination of steps and resources
- Generalizing and transferring this problem solving process to a wide variety of problems.

Further, the publication states number of dispositions or attitudes that are essential dimensions of CT, which include:

- Confidence in dealing with complexity
- Persistence in working with difficult problems
- Tolerance for ambiguity
- The ability to deal with open-ended problems
- The ability to communicate and work with others to achieve a common goal or solution

The broad domains to which the CT relates implies that the research is limited to individual CT elements. The authors offer different models trying to classify the aspects of CT on the essential components. The Aspects of CT most commonly analyzed and found in the literature as fundamental are decomposition, abstraction, algorithms, debugging, iteration and generalization [Shu17]. Then the research is designed in such a way that the targeted aspect of the CT can be evaluated.

3 Game Based Learning (GBL)

While playing games children demonstrate many CT qualities [Lee12]. In the early years of schooling (preschool up to 4^{th} grade), children are still motivated to learn because they experience it more like a game and not a commitment. At that time, while their interest is still forming, it is important to focus their learning process in

a way that promotes CT. The GBL approach to learning more demanding content at children retains a sense of play rather than a coercion, which is in line with contemporary theories of learning [Wu12].

Game based learning is a newer theory of learning, accepted as motivating for students, but there is a difference between playing games and building the game itself. In the latter case student's motivation is higher and the learning process is more efficient [Vos11].

Although there are a number of researches on GBL, this area is still relatively new, especially in the context of Croatian education. In order to increase motivation, efficiency, interest and engagement of students, there is a necessity to propose an innovative way of using GBL principles in Croatian education system.

An example of a very popular tool for programming and algorithmic thinking indirect learning is Scratch [Scr19]. The tool is created by the Lifelong Kindergarten Group, the MIT Media Lab. All contents are free for sharing, exploring, and upgrading. Scratch is very easy to use thus suitable for the younger students, offering a significant environment for development creativity, systematicity and cooperativity. Using Scratch, students design their stories, games, animations, and simulations by matching the already programmed code blocks as if they fit Lego dice [Res09].

Scratch is a suitable environment for the constructivist aspect of GBL, suitable for lower grades students and the development of programming concepts through game design [Wil13].

Based on the Scratch activities, Brennan and Resnick have formed a highly cited and accepted CT model [Bre12]. In their model, CT aspects are divided into three dimensions:

- *Computational concepts (the concepts designers employ as they program): sequences,loops, parallelism, events, conditionals, operators, and data*
- *Computational practices (the practices designers develop as they program): being incremental and iterative, testing and debugging, reusing and remixing, and abstracting and modularizing*
- *Computational perspectives (the perspectives designers form about the world around them and about themselves): expressing, connecting and questioning*

Scratch is represented in the curriculum of Faculties of Teacher Education in Croatia, as a part of education program for future teachers. It is also represented in the GLAT project presented in this paper.

There are a whole range of tools like Scratch, all represented in the educational process of different subjects. GBL is thus imposed as a natural medium for promoting concepts and ideas of CT.

4 CT and Teacher Education

Given the interdisciplinarity of primary school junior grade teachers, which are expected to be educated in all subjects, good teacher education is one of the crucial factors in the promotion of CT in the lower grades of elementary school [Adl18].

CT aspects can be taught in a series of school subjects, should not be related solely to math, computer science or natural science subjects. Yadav et al. conducted workshop based research about CT understanding of future teachers. After the completed workshop, the results indicates that future teachers in general are considering CT as integrating technology into teaching, while the experimental group has realized CT as a problem-solving approach, universally applicable in teaching and not related just to technology [Yad17].

Instead of focusing on the application of new technologies, the education of future teachers at universities should concentrate on the acquisition of skills and competences that characterize the CT as part of its primary profession and methodology courses, which can easily be applied to novelties in technology [Yad14]. Yadav et al. suggest that the education of future teachers should include co-operation with information science specialists, in order to incorporate core CT quality into pedagogical and methods course education. They suggest that such education should take into account the following components [Yad17]:

Curriculum. Develop a pre-service teacher education curriculum to prepare teachers to embed computational thinking in their classrooms.

Core ideas. Introduce pre-service teachers to core ideas of computational thinking by redesigning educational technology courses.

Methods courses. Use elementary and secondary methods courses to develop pre-service teachers' understanding of computational thinking in the context of the discipline.

Collaboration. Computer science educators and teacher educators collaborate on developing computational thinking curricula that goes beyond programming.

Teacher education. Use existing resources and curriculum standards to assimilate computational thinking into pre-service teacher education.

Teacher education should not end at formal education during the study. Apart from the fact that study programs are often obsolete or the process of redesigning syllabuses is too slow, the very speed of change in information communication technologies requires continuous teacher education.

A positive thing is the availability of a large number of tools and resources available for free use in teaching, free to use, upgrade and further share. Lockwood and Mooney in the 2017 review [Loc17] list over 50 different tools, software, programming languages, etc., which were the foundation of CT research in education. That the number is constantly increasing as well as the free sharing and usage facilities based on these tools. There is also a positive enthusiasm of a large number of teachers, scientists, and private technology companies to make their work massively available for better education and popularization of CT.

The Croatian educational system is currently implementing an experimental phase of curricular reform [Nac19] named "*School for life*" , which places emphasis on acquiring knowledge, developing ability and willingness of students to solve problems, making decisions, metacognition, critical thinking, creativity and innovation. Students should also be enabled for communication, collaboration, information and digital literacy and the use of technology. The advantage of the game as a natural activity of children which implies the importance of using the GBL especially in the lowest grades is stressed as well.

However, up to now, not sufficient attention is being paid to the development of CT in education for future teachers in their formal education. There are not enough appropriate courses that introduce CT in study programs for future primary junior grade teachers, and not enough courses within which models such as Game Based Learning into teaching could be implemented. Mostly there are implemented as elective courses e.g. one of the elective courses in the Graduate study of primary school education is "Extracurricular Informatics and Technical Activities" at Faculty of Teacher Education, University of Rijeka. The situation is similar in most study programs for teachers across Europe which was one of the reasons for connecting experts from different EU countries and starting a project which deals with these issues.

5 Project GLAT - Education for Teachers

One of the projects about enhancing teachers' CT skills and teaching them applying CT concepts with their students is Erasmus+ project GLAT - *Games for Learning Algorithmic Thinking* [Gla19]. The general goal of the project is development of algorithmic thinking of younger students which will improve students' attitudes towards coding and increasing students' interest in the selection of future career in the ICT and STEM areas. Main objective is encouraging the integration of computational and algorithmic thinking, problem-solving skills, logic and creativity into the daily teaching through different subjects in students' younger ages in a fun and attractive way.

Partners are European experts in the field of didactics of informatics, e-learning, and game-based learning from Croatia, Estonia, Slovenia, Macedonia and Bulgaria. The direct participants are Croatian primary school junior grade teachers and the most important project activities include professional development for teachers using workshops where they are introduced to innovative methods for teaching in the field of ICT.

In the context of the project, syllabus and learning materials for blended learning model of education for primary school junior grade teachers are developed. Learning outcomes are related to innovative teaching methodologies and tools such as: Problem Based Learning (PBL), Inquiry Based Learning (IBL), Game Based Learning (GBL), use of Web 2.0 tools for creating content for unplugged activities, creating logical tasks and online quizzes, games and tools for learning basics of programming.

Teachers were introduced to the learning management system Moodle and provided with access to the e-course "Games for Learning Algorithmic Thinking". Within this e-course, teachers access all learning materials, communicate with project experts, submit created learning scenarios, and share their impressions regarding implementation of learning scenarios in classroom with other participants.

The most important part of GLAT education are 3-day workshops for focus group of about 20 teachers (Figure 1) for f2f part of a total of 48 hours [Hoi18].

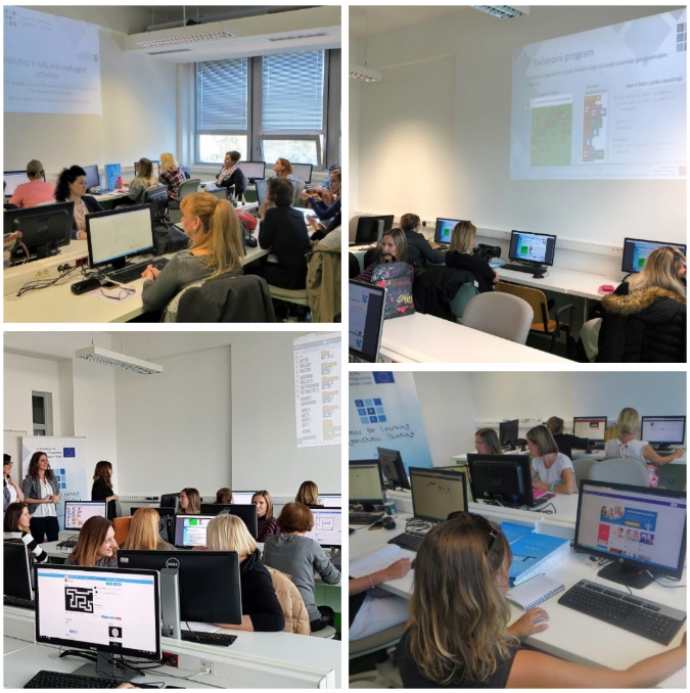

Figure 1: Participants during the GLAT workshops

The goal of the first workshop was to introduce the participants to the concepts and examples of GBL and game-based unplugged activities (activities that take place in the classroom without using a computer) for algorithmic thinking as well as tools for creating content for unplugged activities and designing learning scenarios.

After the second workshop teachers have been able to describe principles of PBL and teamwork, use Web 2.0 tools for creating logical tasks and online quizzes, apply digital didactic games into different school subjects, and create learning scenarios to develop innovative ideas for carrying out logical tasks and online quizzes (Figure 2).

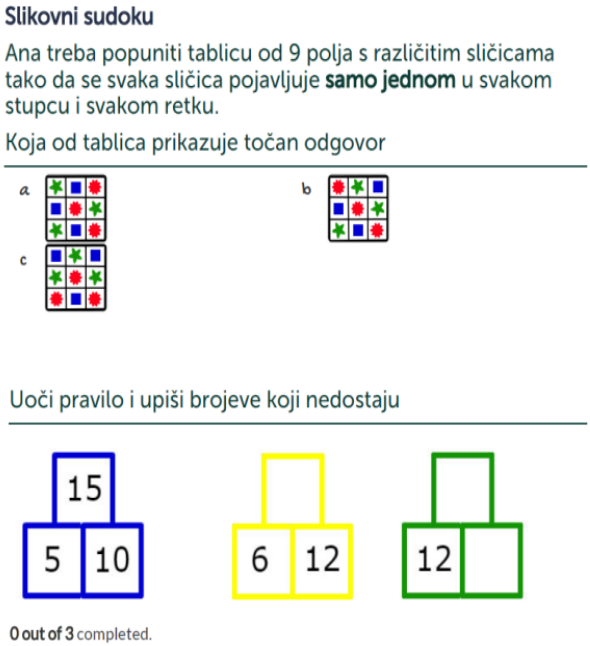

Figure 2: Logical tasks on the second workshop

The third workshop was related to IBL as well as learning CT and basic programming concepts using games and game-based tools. During the workshop, participants attended lectures, demonstrations, and practical work. Through individual and group activities, they analyzed and use games and tools for learning programming like Run Marco!, Code.org, Blockly Games, and Scratch – a block-based visual programming language by which students can program their interactive stories, games, and animations (Figure 3). Participants have also learned how to apply the micro:bit for encouraging algorithmic thinking.

Figure 3: Basic programming concepts through examples of games

During the GLAT workshops, attendants have learned how to prepare learning scenarios: documents in which the teacher develops innovative ideas to carry out educational activities by means of modern teaching methods with the use of appropriate digital content and tools. The most important elements of the scenarios are the learning outcomes and the activities for their realization by using contemporary teaching and learning methods and digital tools [Car17].

After each workshop teachers have started designing their own learning scenarios, with the help of mentors - experts from the project team. The main goal of these scenarios is encouraging algorithmic and computational thinking of students as preparation for later learning of coding. Besides the textual form of the scenario (Figure 4), teachers are supposed to design graphical form using the LePlanner tool [Hoi16]. Final versions of scenarios have been implemented in the classroom with the students from 1st to 4th grades of primary school.

Predložak za izradu scenarija poučavanja

(Learning Scenario Template)

Naziv scenarija (Learning Scenario Title)		
Nastavni predmet/Razred (Course/ Grade)		
Ishodi učenja (Learning Outcomes)		
Ciljevi i kratki opis aktivnosti (Aim and Short Description of Activities)		
Ključni pojmovi (Keywords)		
Korelacija i interdisciplinarnost (Correlation and Interdisciplinarity)		
Trajanje aktivnosti (Duration of Activities)		
Metode poučavanja (Teaching Methods)		
Oblici poučavanja (Teaching Forms)		
Potrebni alati (Tools)		
Materijali za nastavnike (Resources/materials for the Teacher)		
Materijali za učenike (Resources/materials for the Students)		
Razrada aktivnosti (Teching summary)	Motivacija – uvod u aktivnost	Trajanje (Duration)
	Provedba aktivnosti	
	Refleksija na provedenu aktivnost (evaluacija)	
Prilozi (Annexes)		

Figure 4: GLAT Learning Scenario Template

5.1 Evaluation of the GLAT Workshops

An evaluation was conducted after each workshop with aim to establish how participants were satisfied with the workshop content and lecturers. The evaluation in a form of an anonymous survey consisted of first part with Likert scale-based statements and second part with open ended questions. In the first part participants were asked to express their opinions on the applicability of the statement to the workshop using the Likert scale, where 1 refers to "extremely poor" to 5 - "exquisitely" . In open ended questions in the second part, participants were asked to mention the topics for which they considered to be of most use in their job in school (the value of education), and to give some suggestions and proposals for the improvement of the workshops.

The survey was completed by 24, 22 and 19 participants respectively per each workshop which is 65 questionnaires overall for the whole education. As shown on Figure 5 participants highly evaluated six of eight items: the contemporary (up-to-date) content, importance of a workshop for personal professional development, communication and collaboration within a group, preparedness of lecturers, an opportunity to express their own opinions and general evaluation of the workshop. It is significant that all above mentioned statements had high marks (above 4,7) for each workshop separately.

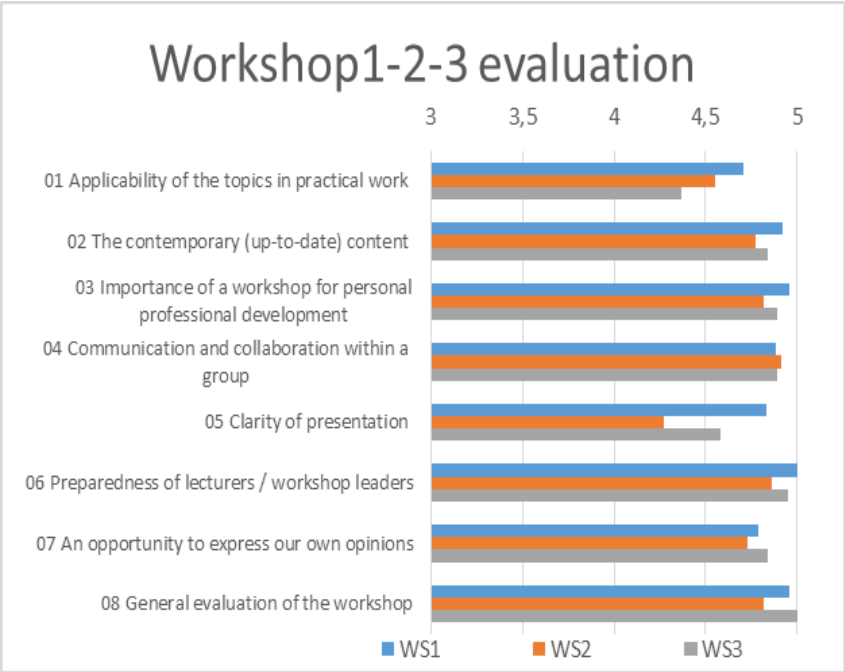

Figure 5: Evaluation items for three GLAT workshops

Generally, looking at the entire education of teachers trough three workshops, participants highly evaluated all statements with means' value above 4,55 as shown in Table 2. Only two statements overall had standard deviation over 0,5.

Table 1: Overall evaluation of the education

	N					
	Valid	Missing	Mean	Median	Mode	Std. Deviation
01 Applicability of the topics in practical work	**65**	**0**	**4,55**	**5,00**	**5**	**,613**
02 The contemporary (up-to-date) content	**65**	**0**	**4,85**	**5,00**	**5**	**,404**
03 Importance for professional development	**65**	**0**	**4,89**	**5,00**	**5**	**,312**
04 Communication and collaboration within a group	**65**	**0**	**4,89**	**5,00**	**5**	**,312**
05 Clarity of presentation	**65**	**0**	**4,57**	**5,00**	**5**	**,585**
06 Preparedness of lecturers / workshop leaders	**65**	**0**	**4,94**	**5,00**	**5**	**,242**
07 An opportunity to express our own opinions	**65**	**0**	**4,78**	**5,00**	**5**	**,450**
08 General evaluation of the workshop	**65**	**0**	**4,92**	**5,00**	**5**	**,269**

The second part with open ended question confirmed the satisfaction of participants. As the value of education, participants emphasized contemporary topics, applicability of presented topics, unique education opportunity, very good organization and preparedness of lecturers, great communication and collaboration with lecturers and colleagues. To point out some of the comments:

„I would emphasize the value of teaching about the use of digital tools; we use them more and more in teaching, especially in the experimental program of curricular reform "School for life".“

„Getting acquainted with new ways of learning that is much more interesting to children because it includes what is close to them, namely, the games and technology. “

„Excellent preparation and expertise of lecturers, the ability to develop creativity, encourage to continuous participation and learning, interesting content, pleasant lecturers, very responsive. Excellent education! Thank you!‘

There were not many suggestions and proposals for the improvement of the education. After the first workshop titled "Game based learning and unplugged activities" there was no suggestions at all, probably because teachers were familiar with topics in general. The last two workshop were more demanding for teachers because they were not familiar enough with digital tools that can be used in classroom, so they stated that there were too many tools to upskill. The comments were:

"More time for a particular application. More details on using a particular tool."

„The pace of presenting new content is too rapid. "

As presumed, our participants had no additional prior knowledge about using and implementing digital tools and game-based tools for learning programming concepts, so they found these tasks demanding.

The teachers will apply their work with students from 1^{st} to 4^{th} grade, and afterwards a more detailed evaluation follows. The interviews and questionnaire will also be prepared for students who took part in testing of the learning scenarios. All results and collected data will be used for improving the GLAT syllabus and teaching materials for formal and non-formal teacher training programs as well as for further research efforts about improvement of the CT education model for primary junior grade teachers in the context of the new project "Digital games".

6 Future plans – project "Digital games"

The above-described 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"*. The project started in January 2019 and lasts for three years.

The purpose of the project is to explore the possibilities of using digital games to improve the quality of learning, teaching and promoting inclusive education, and the development and promotion of contemporary pedagogical-technological frameworks for the use of GBL in schools. The project will cover activities that correspond to specific research objectives, which are the selection and development of games and digital tools, as well as modern teaching models for building the GBL frameworks, and the designing of learning scenarios based on developed frameworks applicable in practice for learning and teaching subjects in primary schools.

Several studies based on the principles of GBL will begin in the context of the project. One of the studies is about encouraging the integration of computational thinking into the daily teaching of different subjects in the lower grades of primary school using GBL, which will stimulate creativity, logical thinking and problem-solving skills among students. In the context of this study, special attention will be given to the development of CT education models for future K-4 teachers to enable the transfer of CT knowledge and skills to their students.

Within the aforementioned study, based on GLAT project results, additional analysis of relevant research and the existing situation in schools, project members will select and develop games and digital tools and appropriate learning models to build pedagogical-technological frameworks based on GBL to educate the teachers for CT. The collaboration will be established with students - future teachers as well as teachers in schools with the help of which learning scenarios and CT learning materials will be built.

The research will use the Design Based Research (DBR) approach [Wan05] which represents a systematic but flexible methodology for research to improve the educational practice through iterative analysis, design, development and implementation based on co-operation between researchers and teachers-practitioners. DBR iteratively designs a learning model which is tested in a natural environment and revised after testing as many times it takes. The basic advantage of DBR in relation to the classical experiment is implementation in a real environment, not in conditions isolated from everyday life.

In order to ensure a balance between existing practice and pedagogical and technological innovations, the role of the teachers in the schools will be important. Quantitative (the software tools event logs, test results, surveys ...) and qualitative data (conversations with teachers and students, observation of class interaction and video analysis, analysis of student activities ...) will be collected during the research to evaluate developed pedagogical-technological frameworks for GBL application.

Design based research (DBR) will include improvement of existing e-learning models for learning CT by introducing GBL and gamification through learning resources with digital games, puzzles, logical tasks and similar elements for encouraging learning (technological aspect) and the contemporary learning and teaching strategies that place students in the center of the educational process (pedagogical aspect).

7 Conclusion

The technology-pervasive modern society, the rapid advancement of ICT, and the new learning strategies are usually seen as a challenge in educating the new-coming generations of students. This is a complex task for teachers who are expected to successfully teach these upcoming generations. More than ever, teachers must be students themselves, be educated on a continuous basis and keep up to date with contemporary tendencies.

Technological aspect of learning needs teacher to be an expert in 21^{st} century skills with the ability to choose appropriate activities and digital tools for their students. This also includes enhancing teachers' CT skills and teaching them how to apply CT concepts with their students.

On the other hand, pedagogical aspect refers to be good methodological expert in order to encourage multiple strategies to foster qualitative discussion and better learning. Teachers need to be flexible with managing new classroom dynamics and be willing to adapt their teaching styles to accommodate new pedagogical approaches to learning such as PBL, IBL, and GBL.

These two aspects require flexible education system as well as personal effort of teachers to communicate and collaborate with each other and with students. For the above to occur, teachers will need professional development opportunities and strong support systems.

This paper presents activities in the promotion of teachers' CT skills based on recent pedagogical methods and contemporary digital tools. Through project GLAT, based on game-based learning approaches, primary school junior grade teachers are educated in developing their own teaching materials that are then applied in class. The GLAT project results demonstrated the participants' satisfaction with the use of digital tools to promote CT skills, communication and collaboration is established. The main project results will consist of syllabus of workshops with the materials for learning in Croatian and English language, complemented by the examples of best practices, and available at online platform for e-learning. Syllabus will be used in the future for the organization of a program of professional development of teachers, course or similar forms of education in Croatia, partner countries and beyond.

In the context of the new project Digital Games, efforts on building pedagogical-technological frameworks based on GBL to educate the teachers for CT will continue.

Acknowledgment

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).

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DIGITAL GAMES AND TOOLS FOR DEVELOPMENT OF COMPUTATIONAL THINKING IN PRIMARY SCHOOL

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Abstract - Computational thinking is the process that involves formulating a problem and expressing its solution in a way that a human or a machine can effectively perform. Computational thinking include skills that are useful for a career in almost every sector and should be encouraged from primary school. Educational games can motivate students to actively participate in learning activities and have a potential to support development of computational thinking as well as programming skills. Games can be integrated in different school subjects as unplugged activities (without the use of technology) or in a digital form, which is more appropriate for today's students who are growing up in the digital age. This paper analyses the potential of using digital games and tools for supporting the development of computational thinking and programming skills and gives overview of examples that are freely available and suitable for primary school students. In addition, the paper describes a model for development of computational thinking skills designed within the project GLAT that will be further developed as one of the aims of the new project "Digital games".

Index Terms - Digital Games, Computational Thinking, Learning Programming, Primary Education, Project GLAT.

I. INTRODUCTION

Computational thinking is considered as one of the fundamental skills for the 21st century, needed to work in the modern business world. Employees that will take an active role in the problem-solving and decision-making are required in all sectors [1], [2].
There are many definitions of the computational thinking. Computational thinking is used to solve the complex problem in algorithmic way and to present the solution so that a computer and a human can understand it [1]. In definitions of the term computational thinking, authors usually list the set of skills needed for that process. Among fundamental skills are [2]: decomposition, abstraction, algorithms, debugging, iteration and generalization. Using these skills one can logically organize and analyse data, break the problem into smaller parts, identify and apply existing solutions in order to design efficient solution of the problem, etc. [3], [4]. Mentioned skills are useful for a career in almost every sector, including business and financial markets, tourism, energy, healthcare, education, etc.

Many researchers are dealing with the question how these skills can be developed and through what technological means. The development of many skills, including computational thinking and programming skills, can be supported by integrating game-based learning (GBL) strategies [5], [6], and gamification into education [4], [7]. Game-based learning refers to approach where games with defined learning outcomes are used to enhance the learning experience while in gamification game elements are added to a non-game situations [8]. It is believed that playing games is a natural way of learning for a child. Through games, children learn and gain skills but they are not aware of it. There are many benefits of using games in education. Educational games stimulate imagination and creativity, enhance concentration, and improve memory. In addition, by playing games students can gains skills for problem solving, logical reasoning, strategic thinking, and management. Today's children are growing up surrounded by digital technology, which affects their way of thinking and processing information.

Therefore, they are more interested in digital games with rich visual elements that attract them into the fantasy world and allow them to forget they are actually learning. Digital games enable students to adapt to new technologies as well as to improve their attention span and spatial vision [6], [9].

Research in the field also deals with the question when to introduce the concepts of computational thinking. Studies has shown that there is no need to wait until students are in college [10] since students can start to adopt these concepts in lower grades of primary school [11], especially when games support them in that process [4], [12]. It is important to educate primary school teachers and encourage them to plan learning scenarios that will include games in different school subjects [13]. The precondition for this is that teachers understand the problem solving process as algorithmic process that can be applied to other settings and used to solve problems in similar situations [10].

It should be stressed out that computational thinking is not the same as programming. Students should have computational thinking skills to develop a solution of the problem and programming skills to tell a computer what to do and how to do it [3]. However, some

programming techniques are also used in the process of problem solving (e.g. iterations). Given the relation between computational thinking and programming, game-based educational environments that support the acquisition of computational thinking skills can include different types of programming tasks, and therefore require the knowledge of programming concepts and/or the usage of programming languages. When such games are intended for primary school students, players are expected to know basic programming concepts (such as sequence, loop, variable, conditionals [14]) and usually need to solve problems (tasks) using block-based instructions or programming languages like Scratch and Blockly [14], [15].

Alternative approach to support the learning of basic programming concepts and the development of computational thinking is with unplugged activities [16]. In such activities students do not use digital devices but physical objects (e.g. board games, cards, strings) or movements (e.g. footsteps, dance) to represent and understand concepts. Thus, unplugged approach is convenient for classrooms without the technology infrastructure [17], [18].

The aim of this paper is to analyse the potential of using digital games and tools for supporting the development of computational thinking and programming skills in primary schools. The paper presents a set of games and tools that are freely available on the Web and can be used for this purpose. The research focuses on games and tools suitable for students in lower grades of primary school. Therefore, only basic computational thinking skills (i.e. decomposition, pattern recognition, abstraction, algorithm development [3]) and basic programming concepts (i.e. sequence, loop, variable, conditionals) are included in the analysis.

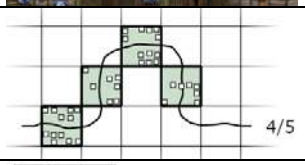
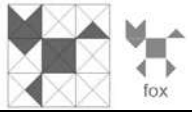
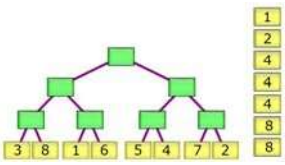
The paper also presents the goals and activities of the two projects that encourage the integration of computational thinking into the daily teaching of different subjects in primary school using games. These are the project "Games for Learning Algorithmic Thinking (GLAT)", funded by the Erasmus+ Programme of the European Union under the Key Action 2: Cooperation for innovation and the exchange of good practices - Strategic Partnerships for school education, and the project "Digital games in the context of learning, teaching and promoting inclusive education (Digital Games)", funded by the University of Rijeka. The paper is organized as follows: Sections II gives overview of examples of digital games and tools for development of computational thinking skills while Section III focuses on examples that can be used for acquiring basic programming concepts. Section IV presents a model for development of computational thinking using games in primary school. Section V brings conclusions and plans for future work.

II. DIGITAL GAMES AND TOOLS FOR DEVELOPMENT OF COMPUTATIONAL THINKING SKILLS

As mentioned before, computational thinking skills which can be developed in primary school students are [3]: decomposition, pattern recognition, abstraction, and algorithm design. By using these skills, one can understand complex problems, develop possible solutions and present these solutions in a way that computers can understand them. Each skill is as important as the other three and if one of them is not applied, the problem cannot be solved successfully.
Decomposition is used to break down a complex problem into smaller problems. In the games that support the development of computational thinking skills, students should recognize smaller problems which are easier to understand, solve them separately, and integrate them in the final (complete) solution. While solving smaller problems, students are expected to recognize patterns (i.e. to notice similarities among and within problems). Pattern recognition enables them to take advantage of previous knowledge, achievements, or experience and reach a solution faster. In addition, during the process of solving the problem, students should focus only on the important details and ignore all irrelevant information. This process is called abstraction. To apply abstraction, students need to know how to choose details that can be ignored in order to make the problem easier, without neglecting the important information. When the similar problem needs to be solved, an algorithm can be designed. By designing the algorithm, students specify steps or rules to solve each of the smaller problems and these steps can be reused whenever needed.

Table 1 shows examples of games and tools for development of all computational skills mentioned above. The most of these games include tasks of various difficulty and therefore can be used in different grades of primary school. All games are freely available on the Web.

Table 1 - Examples of games and tools for development of computational skills

Game with description/rules	Screenshot of task example
Sudoku Jig Saw Doku [19] – The player should fill all empty squares in a grid of 81 squares which is divided into nine blocks. Each of the nine blocks has to contain the numbers 1 to 9 within its squares. Each number can only appear once in a row, a column or a box.	
Kakuro [20] – The player should fill all empty squares using numbers 1 to 9 so the sum of numbers in each row equals the clue on its left, and the sum of numbers in each column the clue on its top.	
Code Combat [21] – The player should write a program to move the main character around a dungeon and perform assigned tasks (e.g. collect all the gems, don't run into spikes, don't let ogre see him).	
Initial simulation [22] – The player should place towns of required size on river(s). Two towns cannot touch horizontally or vertically. Sometimes, additional conditions are given (e.g. town cannot have tiles on more than 1 river).	
Thinking Myself [23] – The player should solve various tasks. Example: Copy the given picture of a fox by clicking on triangles in the square.	
Bebras Challenge [24] – The player should solve various problems. Example: Beaver used the board and numbered cards to represent winners of each stage on a tournament of races. The runners wore the same numbers throughout the tournament. The task is to put the cards that were removed from the board back to the right places.	

III. DIGITAL GAMES AND TOOLS FOR LEARNING BASIC PROGRAMMING CONCEPTS

There are many games and tools that can be used in primary schools to support the learning of the basic concepts needed for programming: sequence, loop, variable, conditionals [14], [15].

One of the basic principles in programming is that a certain activity or task should be expressed as a sequence of instructions that will be executed by the computer. In the games that support the learning of this concept, students are challenged to specify a set of instructions in the appropriate order to solve a given task. By playing such games, the students have the opportunity to observe that different sequences of instructions will give different results.

To use loops while playing games, students need to recognize which instruction or a set of instructions is repeated in the task solution as well as a number of repetitions (iterations). Students have the opportunity to detect that the solution which includes one or more loops has significantly less instructions than the one without loops.

Games can also support students in learning how to store data using variables. While solving tasks, students usually have to store, retrieve and update values of variables. In games for early primary school, the students are not familiar with the different types of data but use only variables that represent integer numbers (e.g. number of collected items) or text (e.g. the text that will the main character say).

Variables are often used in conditionals that enable making decisions based on certain conditions. In games that support learning this concept, students usually need to recognize which conditions could be used to trigger some events and/or direct the flow of the game.

Table 2 shows examples of games and tools that are freely available on the Web and can be used for learning the basic programming concepts. These games and tools are appropriate for primary school

students who are starting with learning programming - instead of writing a code, students are programming using drag and drop code blocks. Figure 1 shows an example of using blocks to solve one task in the game "Bee" [25]: use 'repeat' block to collect all of the nectar and make all of the honey. The illustration given with the task is shown on the left side while the sequence of instructions that represents solution of the task is shown on the right side of the figure.

Figure 1 - Example task and its solution from the game 'Bee'

Most of the games from Table 2 support learning of all four concepts so the game that will be used can be chosen according to student's interests (e.g. depending on the students' preferences regarding the main character in the game). Also, several games can be combined to maintain the motivation for learning.

IV. GLAT MODEL FOR DEVELOPMENT OF COMPUTATIONAL THINKING SKILLS USING GAMES IN PRIMARY SCHOOL

The project GLAT [26] encourages the integration of activities for development of algorithmic and computational thinking skills into the daily teaching of different subjects in primary school (from the first to fourth grade) through organization of professional development training for primary junior grade teachers.

The training course for focus group of Croatian teachers was organized using the blended model of e-learning [27] so face-to-face workshops were combined with online mentoring in learning management system.

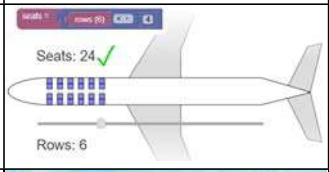
Throughout the course, teachers were introduced to innovative teaching methods including Game Based Learning (GBL), Problem Based Learning (PBL), and Inquiry Based Learning (IBL). Besides theoretical topics, examples of games and digital tools that can be used for development of computational thinking were presented and analysed.

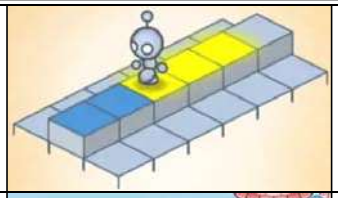
Figure 2 shows the activities for teachers who participated in the training. Participants attended the following two-day workshops: 1) GBL and unplugged activities, 2) PBL, online quizzes and logical tasks, 3) IBL, games and tools for learning programming.

Digital tools presented during the workshop were chosen in accordance with teachers' skills for using ICT. They were introduced to simple digital tools available on the Web which can be used to prepare materials for unplugged activities (1st workshop) or create online quizzes and worksheets with logical tasks (2nd workshop). Unlike teachers of informatics or computer science, primary junior grade teachers are not familiar with programming concepts and do not even know how to use the visual programming languages to create digital games. Therefore, during the third workshop, the basic programming concepts were explained and examples of ready-made games and tasks (shown in Tables 1 and 2) were presented.

Figure 2 – GLAT workshops

Table 2 – Examples of games and tools for learning the basic programming concepts

Game	Screenshot of task example	Description	Sequence	Loops	Variables	Conditionals
Blockly Demo – Plane seats calculator [28]		The player should build a formula that calculates the total number of seats on the airplane as the number of rows change.	-	-	+	-
Code with Anna and Elsa [29]		The player should use instructions to move Ana or Elsa on ice and create various shapes.	+	+	+	-

LightBot [30]		The player should use instructions to move the blue of pink robot around 3D maze and turn on lights on blue fields.	+	+	-	+
Dragon Dash [31]		The player should use instructions to lead the dragon to coins and treasure by skipping obstacles and foes.	+	+	+	+
Robo Garden [31]		The player should use instructions to lead the robot to ornaments by skipping obstacles and respecting given conditions (e.g. the color of the fields on which the robot can step on).	+	+	+	+
Run Marco! [32]		The player should use instructions to lead the main character (Marko or Sophia) around the given path. On his/her way to the yellow star, the character should skip obstacles and collect gems.	+	+	+	+
Bee (Code.org) [33]–[35]		The player should use instructions to move the bee to the flowers, collect given amount of nectars, then move the bee to the honeycomb and make honey.	+	+	+	+

After each workshop, teachers were encouraged to apply acquired knowledge and skills in development of learning scenarios (i.e. preparations for classes in digital form [36]). They were also expected to implement the developed scenarios in classes with their students. With the help of experts from the project team, teachers developed learning scenarios for different school subjects with educational activities for development of algorithmic and computational thinking [37]. Depending on the workshop topic, games and tasks that teachers included in their learning scenarios were unplugged or supported with appropriate digital tools.

Although many of the teachers were using some of the presented types of games and tasks in their everyday teaching practice even before the training (especially tasks like puzzles and mazes), experts from the project team help them to understand the process of solving these tasks as algorithmic process. The connection of particular types of games and tasks with computational thinking skills was also explained, which help the teachers in developing their own innovative ideas for using unplugged activities, logical tasks and games that promote algorithmic and computational thinking in different school subjects.

CONCLUSIONS AND FUTURE PLANS

To many students playing digital games have become the most common activity in their free time, which gives an opportunity for using digital games for educational purposes as well. By playing games, students can start to learn basic programming concepts and develop computational skills in early primary school. By integrating games into educational activities, it is possible to improve students' attitudes towards programming and the development of computational thinking, and, in the long term, increase their interest in the selection of future career in the ICT and STEM areas.

Examples of games presented in this paper are suitable for students with different interests (e.g. girls who are more interested in Disney princesses or boys who are

more interested in robots) and can be used on different devices (desktop computers, tablets, or smartphones). If they know that these games exist and have the appropriate technology in the classroom, teachers can integrate them in the educational activities in various school subjects.

As a result of the GLAT project, the activities for developing computational thinking and integrating educational digital games into daily teaching from the first grade of primary school will be continuously promoted. In addition, activities of the project "Digital games" which started in 2019 will further explore the possibilities of using educational digital games to improve the quality of teaching and learning through development and promotion of contemporary pedagogical-technological frameworks for the use of GBL. The development of the frameworks will include the selection and development of games and digital tools as well as modern teaching models. It will also include the design of learning scenarios based on developed teaching models applicable in practice for learning and teaching subjects in primary schools.

ACKNOWLEDGMENT

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).

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Learning Scenarios and Encouraging Algorithmic Thinking

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***Abstract* - Although contemporary education places learners at the center of the teaching process, in most of our schools, students are mostly educated by traditional outdated teaching methods. Students should be active participants in the educational process that will, through research in collaboration with the teacher and other students, acquire new knowledge and develop various competencies, especially in the STEM field. The traditional role of the teacher, as the main source and knowledge transferor, is changing, so preparation for teaching should be adapted to such changes. Learning scenarios can contribute to the development of innovative ideas for the implementation of educational activities, including modern teaching methods using digital tools and digital contents. The Erasmus+ project "Games for Learning Algorithmic Thinking" begins with the education of primary school junior grade teachers, who will develop such learning scenarios and apply them with their students. The paper presents how the appropriate learning scenarios can stimulate the algorithmic thinking of young students in everyday situations.**

Keywords – learning scenario, algoritmic thinking, games and learning; primary schools teachers

I. INTRODUCTION

Instead of teaching facts, generalizations and content that was characteristic of the traditional school, in contemporary teaching based on the co-constructivist curriculum, emphasis is placed on active learning, affirmation of pupils' potential and the development of specific interests of each individual [27], [24]. Such a contemporary approach continues to reconsider the roles of the participants in the teaching process, placing students at the center of the educational process. There has been a lot of interest in changing the educational process itself, that is, to provide new teaching methods that can structure the learning task, guiding learners through the process of learning and helping them to understand and apply the acquired knowledge.

In the Croatian National Curriculum Framework for preschool education and general compulsory education in primary and secondary schools, explaining the advantages of the curricular concept, it is stated: "Living and working in a modern society of rapid change and sharp competition require a new type of knowledge, skills, values and attitudes, i.e. new competences of the individual, which emphasize the development of innovation, creativity, problem solving, development of critical thinking, entrepreneurship, computer literacy, social and other competences" [12]. Bearing in mind the demands of the time we live in, it is necessary to approach curriculum reforms following the context of global social and educational reforms.

Contemporary teaching approaches like project based learning, problem based learning, inquiry based learning, scenario based learning and reflective learning in teacher education have recently gained considerable attention. Most of the studies have been conducted with the aim of comparing the efficiency of contemporary teaching approaches with traditional methods. The use of technology in all sectors, particularly in education, requires teachers with certain digital competencies in order to use the teaching technology and make the learning process more interesting to students. Schelfhout et al. [26], emphasize that the most fundamental problem encountered during the learning-teaching process is that students memorize the new information and fail to convey what they have learned into new situations. European Schoolnet launched the European Coding Initiative for the promotion of teaching and learning programming and coding and stronger integration of coding in K12 education. Teachers are provided with support in the form of teaching materials, tools and lesson plans for informal learning. In a study on the level of the European Community, Gander et al. [11] point out that European citizens have become consumers of ready-made software products, and conclude that digital literacy (a set of basic skills) and computer science (research subject) are essential components of modern education. Under the influence of various trends, special emphasis has been placed on the development of algorithmic/computational thinking, which becomes one of the core competencies for the 21st Century [3]. According to the research in CARNet project "e-Schools: Establishing a System for Developing Digitally Mature Schools", schools in Croatia are on average placed under the category "digital beginners", where teachers are insufficiently using Information and communication technology (ICT) to improve teaching. Furthermore, learning to code is not sufficiently present in schools because it is considered that students find programming too difficult and uninteresting. The DigComp Framework pointed out that digital content creation represents one of the five major digital competence areas, which includes the competence of programming, described as "the ability to plan and develop a sequence of understandable instructions for a computing system to solve a given problem or perform a

Co-funded by the Erasmus+ Programme of the European Union, Key Activities 2, Strategic Partnerships for school education, Project „Games for Learning Algorithmic Thinking" (2017-1-HR01-KA201-035362).

specific task." This area is mostly abandoned in primary schools, where students do not have the opportunity to learn programming or algorithmic thinking. Learning outcomes related to programming should be represented in various school subjects and integrated into the daily learning through different school subjects starting from the first day of school.

Within this context, teachers who are one of the most outstanding elements of education should possess skills of being able to implement contemporary approaches that would enable students to carry out active learning. Jakee [15], claims that active learning is a much more effective process than the process in which the teacher "spoon-feeds" students. It is the former process that students gain advanced thinking skills from. Therefore, the traditional teaching methods that are mainly based on an objectivist approach are considered unsatisfying. Contemporary education is based on research, exchange of information, teamwork, connecting different cognitions and applying knowledge and skills. Such a curriculum encourages critical thinking, self-conceptualizing conclusions, solving problems, creativity in approach and communication among students.

II. CONTEMPORARY LEARNING AND TEACHING METHODS

A. *Learning strategies toward active learning*

The founding of modernity in teaching activities is reflected in the interactive relationship between all the elements of the didactic-methodical field which are mutually conditioned. The effectiveness of teaching activities at all stages of the teaching process (preparation, implementation and evaluation) implies a modernity in approaches through the application of strategies, methods and techniques of teaching the workshop, project, bulk-research, self-research type of educational work. Creating teaching scenarios in the teaching process, as stated by Buljubašić & Petrović [4], is based on the features of new generations and new ways of communication, an accelerated and changing environment and on technological advances. In this context, there are numerous opportunities for the development and implementation of the teaching process as a partnership based on the maximum involvement of all participants and on mutual co-operation. Emphasis is put on student-centered learning, tailored to the needs of students.

Teaching activities oriented to discovering cognitions and the productive application of knowledge, provide access to the learning and teaching process, where students create, discover, independently plan, give the initiative, ask questions and investigate. Students are asked to understand, to express their own view of certain phenomena, to critically think, to build a creative approach for problem solving, and not just to reproduce content. "Students are especially encouraged to connect knowledge with personal experiences and knowledge, experiences of everyday life and with the knowledge of other subjects' areas" [2]. Teaching, besides explicit theoretical knowledge, should be focused on the process of gaining knowledge, i.e. on understanding of the process of research and discovery.

Therefore, it is necessary to apply teaching strategies which, according to Cindrić et al. [6] include "a thoughtful combination of methods and procedures that encourage the students' activity and enable him to manage his/her own learning process in order to achieve the goals of education." Marzano et al. [17] discuss learning strategies that affect students' achievements. They are differentiating between student-oriented strategies (e.g. summarizing, recording, nonlinguistic representations, cooperative learning, goal settings, creating and verifying hypotheses ...) and putting them into the context of conducting a research in instruction. The teaching methods as a combination of various methods, through which the learning process is structured in order to achieve predetermined goals that teachers and students apply in the educational process [18], should contribute to the individualization in teaching students and thereby respect the different learning styles of students. Fox & Hoffman [10] define individualization of teaching as a flexible, fair and intelligent approach to teaching and learning and use the terms "different assessments", "inclusion", "learner-centered teaching". Other authors conceptualize this term as "adaptive teaching" or "personalized learning" [32] and "unique learning design" [13]. Taking into consideration the specificities of students in the context of individualization of teaching, the use of various methods and teaching strategies is suggested which will lead to active learning. Active learning in the narrow sense of the word is defined as "learning that provides a high level of autonomy and self-control to students, as well as an application of various mental strategies and specific cognitive abilities for distinguishing important and unimportant information, analysis and comparison, knowledge acquisition based on previous experiences and critical thinking" [21]. As Slavin [29] points out, we are talking about collaborative learning methods for which research clearly suggests that they have significantly improved pupil achievements in most subjects and degrees. Students together plan, investigate, co-operate in order to help each other achieve the intended teaching goal. The aforementioned context of the contemporary teaching process determines according to Suprayogi & Valcke [30] the application of strategies, the diversity in learning activities, monitoring individual student needs and achieving learning outcomes. More attention is focused on the application of modern technology in the teaching process. As emphasized by Pejić Papak & Grubišić Krmpotić [20], technology in this sense is not the purpose for itself. Teaching will not be enriched by formal introduction of ICT-based teaching methods and forms without a critical reflection on the reasons for implementation, learning outcomes as well as a didactic modeling for the purpose of improving the teaching process.

B. *ICT in Education*

Information and communication technologies ensured an application of new opportunities in the educational process. Computer science education in primary or secondary schools has reached a significant deflection, changing its focus from ICT-oriented to

essential computer science concepts. In Croatia, computer science education as a school subject is usually named Informatics. At the very beginning, teaching Informatics started with teaching programming. Programming was a good way to convey a process of problem solving. Later on, the content of Informatics switched to the implementation of ICT, mostly assigned to "applied" Informatics. Mark Prensky stated that "The True 21st Century Literacy Is Programming" [23], but on the other hand, Dagiene and Stupuriene [7] allege that we should avoid 'the equation': computer science = programming, which is accused of killing interest in computer science among school students in 1990. Not all students will become professional programmers, but by writing their own programs, they practice creative and computational thinking, and gain skills of the digital era, which are useful for their professional and personal lives [7].

As technology has emerged in all school subjects, not only Computer science teachers are allowed to use it. Teachers of junior grade in primary school, who are one of the most outstanding elements of education, should possess skills of being able to implement contemporary approaches with or without technology that could enable students to carry out active learning. The results of the research [20] showed (N=220) that 80% of the junior grade teachers and 83.5% of the undergraduate students of the Teacher Study agree with the statement that "Using ICT is an indispensable part of teacher education". This provides a space for further use, development and implementation of modern technology in education. Active learning by using technology enables a faster realization of certain activities. However, teachers will be able to conduct effective teaching when they are fully equipped in their professions. Therefore, it is clear why teacher education is crucial in this sense [14].

III. THE ROLE OF LEARNING SCENARIOS IN MODERNIZING THE TEACHING PROCESS

Teaching has always involved some elements of 'design' in the process of preparation and planning. Classroom teaching with minimal equipment allows teachers to adjust their approach to the immediate needs of learners [1]. Teachers can, only by observing, quickly ascertain if learners are fulfilling their tasks, while they can also rearrange groups or reassign activities, give some additional explanations and ask questions to help learners understand and accomplish their tasks.

Despite afore mentioned, teachers have to plan or structure the learning situations in advance. The situation may be as small as a single task or as large as a whole course. In a learning situation, any of the following may be designed with a specific pedagogic intention: learning resources and materials; the learning environment; tools and equipment; learning activities; the learning programme or curriculum [1]. Student activities should be at the center of the design process, and they should be carefully aligned with the desired learning outcomes and with the processes of assessment and review. Learning scenarios are materials intended for teachers that offer innovative and imaginative ideas for conducting teaching activities using modern pedagogical methods with the use of appropriate digital content and tools [5]. Although it has been mentioned that Learning scenarios use digital content and tools, they can be created for other activities that do not use technology. It is useful to distinguish activities from tasks. In a formal educational setting, tasks are required from learners by the demands of the curriculum. Activities are engagement of learners in response to the demands of a task. [1]

Learning scenarios are designed to motivate students, to bring them closer to the content and to link the content of a teaching subject to everyday life situations. In addition, contemporary education strives for a stronger content integration of different school subjects. That is why the learning scenarios should have accentuated correlations with other teaching subjects, as well as designed activities in order to emphasize and encourage this connection. Designing a learning scenario is a process by which teachers plan or structure a learning situation. A scenario consists of a subject and class, a complexity level, key concepts, learning outcomes and a description of activities complemented with materials and resources for the teacher and students [5]. In line with the focus on activity, learning outcomes are typically expressed in the form learners will be able to /*verb*/ /*qualification*/ where the verb describes the kind of an activity that learners will undertake (e.g. describe, interpret) and the qualification describes the context, scope or method to be used. One of the key features of problem-based learning is the use of scenarios relating to the real life as a point of departure for the learning process [8]. The intention is to get the students associate the scenarios with real-life situations. The scenarios are considered to provide a meaningful context for the concepts and principles that will relate to future knowledge acquisition. Although good teachers will provide with a direction on how tasks should be carried out, and even determine students' activities, different learners may still have their own ways of continuing the activities.

IV. ALGORITMIC THINKING

Algorithmic thinking primarily develops solving various problems that reflect real issues, through in which the application of knowledge from other areas, especially science, mathematics and logical disciplines is necessary. In a broader sense, computational thinking includes many components of problem solving: Formulation and restatement of tasks; Data analysis; Decomposition; Modeling and simulation; Recognition of pattern solution components; Automation of decisions; Efficient use of resources; and Abstraction of decision process [7]. Algorithmic thinking skills are supported and enhanced by a number of dispositions or attitudes, which are essential dimensions of Informatics and digital literacy. The concept of Algorithmic thinking has been present since the 1950s and 1960s, referring specifically to using an ordered and precise sequence of steps to solve problems and (when appropriate) a computer to automate that process [31]. Today, it is often replaced with the term "computational thinking". Wing [33] defined computational thinking as "solving problems, designing systems, and understanding human behavior, by drawing on the concepts fundamental to computer science."

The cognitive aspects of algorithmic thinking involve the use of heuristics, a problem-solving approach that involves the application of a general rule of thumb or strategy that may lead to a solution [33]. This heuristic process involves searching for strategies that generally produce the right solution but do not always guarantee a solution to the problem. For example, "asking for directions in an unfamiliar place" from a local usually leads one to the right place, but one could also end up in a wrong place, depending on one's understanding of local geography [31]. Algorithmic thinking concepts have been used in other disciplines through problem-solving processes so it can be included in primary education. Wing [33] said, "we should add computational thinking to every child's analytical ability alongside to reading, writing, and arithmetic." Embedding computational thinking in teaching and learning junior grades of primary school requires teacher educators to prepare teachers to support students' understanding of algorithmic thinking concepts and their application to the disciplinary knowledge of each subject area. Specifically, teacher educators need to provide teachers with the content, pedagogy, and instructional strategies needed to incorporate computational thinking into their curricula and practice in meaningful ways, enabling their students to use its core concepts and dispositions to solve discipline-specific and interdisciplinary problems and to enhance existing learning outcomes.

When explaining a problem as algorithm, it is breaking down in smaller sections, more familiar, that can be solved using a set of rules (algorithms) to find solutions and using abstractions to generalize those solutions to similar problems" [33]. Algorithms are central to both computer science and computational thinking. Algorithms underlie the most basic tasks everyone engages in, from following a simple cooking recipe to providing complicated driving directions. Due to the fact that there is a general misconception that algorithms are used only to solve mathematical problems and are not applicable in other disciplines, [31] it is important to introduce students to algorithms by first using examples from their daily lives. For example, in early grades, teachers could highlight the steps involved in brushing teeth, while in later grades, students could engage in following steps during a lab experiment. However, according to Shelton [28], the development of algorithmic thinking in children at elementary school does not necessarily require the use of a computer, but can also be achieved with "unplugged" methods, which are not an alternative for using a computer but are to be used as an auxiliary activity in understanding and solving the problem. Understanding algorithms as a set of precise steps provides the basis for understanding the manners of the development of an algorithm that can be implemented in a computing program. Students can be exposed to the computational thinking concept of abstraction by creating models of real life [31]. Teachers can have a new role in the teaching process to assists a student, altering the learning task so the student can solve problems or accomplish tasks that would otherwise be out of reach. The teacher intervenes at the appropriate time for a specific student in the context that increases the student abilities for solving the task. For example, a teacher may help a child in a board game by reminding him/her of the rules or by suggesting strategic steps if the child is stuck [25]. As Karadag [16] points out, Game Based Learning (GBL) is generally effective in primary education because primary school learners are at an age when games are particularly efficient. During this period, they also experience difficulty in learning abstract concepts and procedures, requiring both entertaining methods and an active involvement in learning activities.

Algorithmic thinking can be developed through all school subjects for which appropriate teaching methods are needed either with or without technology. Today, there are many different ways in which young children can learn basic programming concepts e.g., educational computer games [22]. Any learning situation can be improved by incorporating such methods in an appropriate learning scenario.

V. THE GLAT PROJECT

Encouraged by thoughts to enhance the teaching skills of primary junior grade teachers, the Erasmus+ project "Games for Learning Algorithmic Thinking" (GLAT) was developed. The main goal of the project is to encourage the inclusion of coding and algorithmic thinking in teaching different subjects in lower grades of elementary school in a fun and attractive way. This project started on October 2, 2017, and will run until September 1, 2019. The project coordinator is the University of Rijeka - Department of Informatics (leader Nataša Hoić Božić, Ph.D.). The partners in the project are: The Faculty of Teacher Education, University of Rijeka, University of Tallinn (Estonia), The Faculty of Pedagogy of the University of Ljubljana (Slovenia), University of St. Cyril and Methodius in Skopje (Macedonia) and Southwest University "Neofit Rilski" in Blagoevgrad (Bulgaria). The most important activities of the project include the professional development of primary school teachers with various innovative teaching methods using information and communication technology. Special focus will be on using educational strategies of Game Based Learning (GBL) and gamification in order to foster creativity, logical thinking, and problem-solving skills. During the project teachers will be grouped in a focus group to participate in education, formulated according to a mixed e-learning model. The key part will be the three workshops to be held in Croatia while the online part of the education will take place through the e-learning system Moodle. The focus group teachers will use the expertise of the project team to apply new knowledge for the development of learning scenarios, and apply those learning scenarios in schools with their students.

The topic of the first workshop, which will be held on April 5 and 6, is Game- Based Learning (GBL) and unplugged activities. The participants will be introduced to the use of games in different school subjects and the conduction of unplugged activities in classroom. The emphasis is on the examples of learning scenarios and the accompanying materials for the implementation of the activities, while the participants will conceive such activities, create a learning scenario and perform it with their students. For this purpose a Learning Scenario Template was produced as shown at Figure 1.

Games for Learning Algorithmic Thinking

Predložak za izradu scenarija učenja i poučavanja

(Learning Scenario Template)

Naziv scenarija (Learning Scenario Title)		
Nastavni predmet/Razred (Course/ Grade)		
Ishodi učenja (Learning Outcomes)		
Cilj, zadaci i kratki opis aktivnosti (Aim, Tasks and Short Description of Activities)		
Ključni pojmovi (Keywords)		
Korelacija i interdisciplinarnost (Correlation and interdisciplinarity)		
Trajanje aktivnosti (Duration of Activities)		
Metode poučavanja (Teaching Methods)		
Oblici poučavanja (Teaching Forms)		
Potrebni alati (Tools)		
Materijali za nastavnike (Resources/materials for the Teacher)		
Materijali za učenike (Resources/materials for the Students)		
Razrada aktivnosti (Teching summary)	Motivacija – uvod u aktivnost (Motivation introduction)	Trajanje (Duration)
	Provedba aktivnosti (implementation)	
	Refleksija na provedenu aktivnost (Reflection and evaluation)	
Prilozi (Annexes)		

Figure 1. Learning Scenario template

One such activity can be spatial orientation or moving through the maze. While engaging in this activity as part of the Science lesson dealing with reviewing and practicing the concepts of left and right, up and down and back and forth, students will mark the route by placing appropriate arrows in the maze as shown on Figure 2.

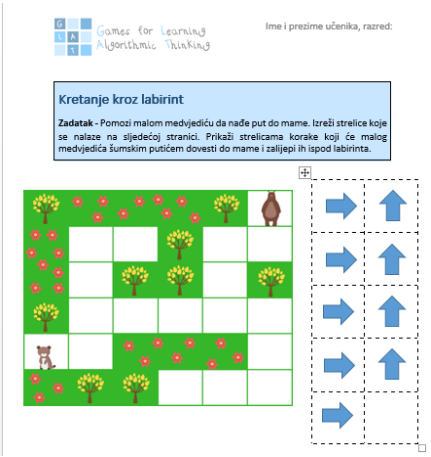

Figure 2. Example of the students' worksheet for unplugged activity "spatial orientation"

Furthermore, students will lead each other from the initial position to the final position in the classroom. Students will also get familiar with the concept of algorithm as a series of commands to be executed for achieving the task - arriving at the assigned location. Besides specifying the learning outcomes, aim, tasks and description of activities, the learning scenario includes a part for teaching summary. In this case, for the motivation part, the teacher can stand next to the door of the classroom and ask the students for help to get to the blackboard. The teacher can write his "path" on the blackboard stating the steps (commands) he has made. Other possible ways of getting from the door to the blackboard can be pointed out in the conversation with students, which brings a conclusion that the same task can be solved in several ways. The term algorithm is explained as a series of actions to be made in order to to accomplish a particular task. The implementation of activities include individual work, i.e. filling the worksheet (Fig.2), and team work in groups of four, where students lead each other in the maze made of desks and chairs in the classroom and write the algorithm of the movement. As a reflection on the conducted activity students are required to provide examples of simple tasks they do every day (getting dressed, washing, preparing school bags ...) and devise an algorithm for solving those tasks. The topic of the second workshop will be Problem Based Learning (PBL), online quizzes and logical tasks, while Games and Tools for Programming will be the topic of the third workshop.

Teacher and student feedback will be used to improve the designed e-learning course, and an improved version of the learning materials and the best examples of learning scenarios will be available as one of the projects results. The aforementioned materials will be published in Croatian and English, so teachers from across Europe can use them together with other Croatian teachers. The general goal of the project is the development of algorithmic thinking of younger students, which will improve students' attitudes towards coding and in the long term contribute to the reduction of the "fear" towards programming. In order to achieve this goal, it is necessary to develop students' digital content creation competence already from the first grade of primary school, and it can only be conducted by the teachers who have been trained for it.

VI. CONLUSION

The need for the introduction of coding and development of algorithmic thinking in schools has been already recognized in Europe. According to "Computing our future - Computer programming and coding - Priorities, School Curricula and Initiatives across Europe", some EU countries integrate coding in their curricula. It is mainly integrated at the secondary level and as a part of a computer science or informatics course or a separate subject but only for some school programmes. There are not enough appropriate subjects in studies for future primary school junior grade teachers, and especially not enough subjects within which the models such as Game Based Learning or the introduction to the elements of creating content and coding into teaching could be implemented. An integration of GBL scenarios in the teaching process can increase teachers' knowledge and skills and enhance their teaching practices.

The GLAT project will try, with contemporary methods and teaching strategies and through different school subjects, to implement the algorithmic way of thinking, problem-solving skills, logic and creativity into the daily learning.

ACKNOWLEDGMENT

This paper is co-funded by the Erasmus+ Programme of the European Union, Key Activities 2, Strategic Partnerships for school education, Project "Games for Learning Algorithmic Thinking" (2017-1-HR01-KA201-035362).

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Problem Based Learning for Primary School Junior Grade Students Using Digital Tools

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***Abstract* - Problem based learning (PBL) is a learning strategy that uses a certain problem to encourage learners' critical thinking, information seeking, and finding solution for solving that problem. Such solutions are mostly identified in collaboration with other students. The role of the teacher is to develop innovative ideas for the implementation of PBL activities, using digital tools and digital contents. Learning scenarios as materials that offer such ideas can contribute in the involvement of young students in the process of PBL. The ongoing Erasmus+ project "GLAT-Games for Learning Algorithmic Thinking" involved 24 primary school junior grade teachers in education with different teaching strategies for stimulating the algorithmic thinking of their students in everyday situations. During the second workshop the participants were introduced to the use of digital tools for developing logical tasks and for the conduction of PBL. The set task for the participants was to conceive such activities, create a learning scenario of PBL and perform it with their students. After performing the activity in the classroom, a qualitative analysis of the preparation and implementation of the conceived activity was carried out. This paper presents a part of the analysis concerning the teachers' attitudes on the preparation of PBL activity using digital tools.**

***Keywords* – problem based learning, logical tasks, digital tools, algorithmic thinking, primary school students**

I. INTRODUCTION

The aim of contemporary teaching is to actively involve students in the learning process, thus expressing their creativity. This can be achieved by using modern approaches and teaching methods like Problem Based Learning. Solving a problem is very usual and important activity in everyday life as well as in professional work. The problem is most often associated with theoretical and practical difficulties that need to be overcome in an appropriate way. Contemporary teaching is based on the co-constructivist curriculum, where the emphasis is placed on active learning, recognition of students' potential and the development of specific interests of each individual [16], [13]. The Croatian National Curriculum Framework for preschool education and general compulsory education in primary and secondary schools was established in line with "The European framework of key competences for lifelong learning" where three out of eight lifelong competences point out "the ability of solving problem". In the context of global social and educational reforms it is necessary to apply such teaching methods that can structure the learning task, guide learners through the process of learning and help them to understand and apply the acquired knowledge. Problem-solving skills and managing new information, as well as logical thinking and linking all aspects of knowledge, are the competences required by every individual and should be developed through the education system. Schelfhout et al. [15], emphasize that the most fundamental problem encountered during the learning-teaching process is that students memorize the new information and fail to convey what they have learned into new situations.

Since Gagné pointed out that "the central point of education is to teach people to think, to use their rational powers, to become better problem solvers" [4], most psychologists and educators regard problem solving as the most important lifelong learning outcome. Ball and Forzani emphasize that the vision of better education includes an innovative use of technology, emphasizes group work, and integrated and problem teaching which should take place on the basis of a changed curricula and higher expectations of students [1]. There is no unique instructional design for the problem solving process, since there are differences among problems in terms of their structure, domain specificity (abstraction), and complexity [8]. Contemporary education is based on research, exchange of information, teamwork, connection between different cognitions and application of knowledge and skills. Such a curriculum encourages critical thinking, self-conceptualizing conclusions, problem solving, and a creativity in approach and communication among students. The use of technology in all sectors, particularly in education, requires teachers with certain digital competencies in order to use the teaching technology and make the learning process more interesting to students. Within this context, primary school teachers should possess skills to implement contemporary approaches and adapt them in order to enable young students to carry out active learning.

II. TEACHING WITH PROBLEM SOLVING

Teaching approaches like project based learning, problem based learning, inquiry based learning, scenario based learning and reflective learning in teacher education have gained considerable attention in the past decade in the area of teacher education [15]. The problem solving

Co-funded by the Erasmus+ Programme of the European Union, Key Activities 2, Strategic Partnerships for school education, 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).

access to educational content is always in the function of enabling students to experience, understand and evaluate the content that is being studied. The student is the researcher and the creator, while the teacher is the organizer, the motivator and the facilitator [8], [9]. Most of the studies have been conducted with the aim of comparing the efficiency of contemporary teaching approaches with traditional methods [5], [10], [21]. Organization and teaching procedures should be chosen to maximize and sustain the student's thought activity and contribute to their conclusions and decision abilities. The organization of teaching with problem solving differs from the classical teaching, it is more in line with scientific research [18]:

- Creating a problem situation
- Formulating of the problem: finding an algorithm of the solution
- Hypothesis setting: selection of methods and forms of research
- Solving problems: verifying the hypothesis
- Analysis of research results that are followed by a conclusion and an application to new problem situations.

Vujičić, Pejic Papak and Valenčić Zuljan [22] emphasize that the key task of teachers in problem teaching is to provide conditions for the creative and research activity of students at all the above mentioned phases. M. Rijavec views teaching with problem solving from a psychological standpoint: "The main shift to the teacher's approach is from deductive thinking to inductive thinking. Instead of expounding the ideas and concepts, he has to take on a more passive role, and by applying Socrates's technique of conducting conversations, let students draw conclusions themselves and try to understand what they learn." [10]. Teaching, besides explicit theoretical knowledge, should be focused on the process of gaining knowledge, i.e. on understanding of the process of research and discovery. Therefore, it is necessary to apply teaching strategies which, according to Cindrić et al. [2] include "a thoughtful combination of methods and procedures that encourage the student's activity and enable him to manage his/her own learning process in order to achieve the goals of education." Students are becoming more independent with the use of learning materials, while with the reflection on their work they are able to take on more and more responsibility for the obtained knowledge [5]. In order to implement creative problem-solving lessons, teachers use diverse methods of modern didactics and different forms of work, with a predominance of collaborative work and work in pairs, but sometimes, individual work, based on individualization and differentiation, is present as well.

Studies conducted in recent years have shown the advantages of collaborative problem-solving prior to the usual teaching methods to enhance students' conceptual understanding in mathematics and problem solving competency [17], but there are rarely found studies that adopt this approach in science learning in primary education. In collaborative problem solving for young learners, structured and guided approaches are recommended. Problem solving competency means engaging students in solving a problem using different strategies, from multiple perspectives and with diverse modalities. Its processes include: exploring and understanding; representing and formulating; planning and executing; and monitoring and reflecting [12]. The research literature shows that project-based learning can help students enhance learning performance in knowledge advancement and skill development, and motivate them to learn [17].

Song also highlights the "productive-failure" as ''a learning design that affords students opportunities to generate solutions to a novel problem that targets a concept they have not learned yet, followed by consolidation and knowledge assembly where they learn the targeted concept'' [17]. This instructional design involves students first in unguided problem solving activities in order to evoke their prior knowledge, particularly the failure to solve the problem. Later students use this information to determine and assemble new knowledge after the teacher helps them solve misconceptions. This approach can be useful for young students to stimulate their active learning process. Active learning is defined as "learning that provides a high level of autonomy and self-control to students, as well as an application of various mental strategies and specific cognitive abilities for distinguishing important and unimportant information, analysis and comparison, knowledge acquisition based on previous experiences and critical thinking" [11]. The aforementioned context of the contemporary teaching process determines according to Suprayogi & Valcke [19] the application of strategies, the diversity in learning activities, monitoring individual student needs and achieving learning outcomes. Although many studies mention that active learning with problem solving should consider ill-structured problems, which will encourage critical thinking and evaluation of solutions [8], [14], it is better to start with well-structured problems with young learners. Novice learners need guidance to develop their problem solving skills, as well as self-directed learning skills. Furthermore, collaboration is yet another important factor in problem solving teaching in younger pupils because individual differences in prior knowledge and critical thinking encourage better achievements.

Nowadays, more attention is paid to the application of modern technology in the teaching process. As technology has emerged in all school subjects, not only Computer science teachers are allowed to use it. Digital tools ensured an application of new opportunities in the educational process. Active learning by using technology enables a faster realization of certain activities. However, teachers will be able to conduct effective teaching when they are fully equipped in their professions. [9] Therefore, it is clear why teacher education is crucial in this sense.

III. THE GLAT PROJECT

With the desire to enhance the teaching skills of primary junior grade teachers, the Erasmus+ project "Games for Learning Algorithmic Thinking" (GLAT) was developed. The main goal of the project is to encourage the inclusion of coding and algorithmic thinking in teaching different subjects in lower grades of elementary

school in a fun and attractive way. This project started on October 2, 2017, and will run until September 1, 2019. The most important activities of the project include the professional development of primary school teachers with various innovative teaching methods using information and communication technology. Special focus is on using educational strategies of Game Based Learning (GBL) and gamification in order to foster creativity, logical thinking, and problem-solving skills. Primary school teachers were participating in education through three workshops and the online part with the e-learning system Moodle. The topic of the second workshop, held on August 2018, was Problem Based Learning (PBL), online quizzes and logical tasks. The emphasis was on the examples of learning scenarios and the accompanying materials for the implementation of problem based activities and logical tasks. This paper presents the results of the GLAT project after the second workshop. The focus group of teachers developed learning scenarios, and applied design activities in schools with their students.

A. Algorithmic thinking

Encouraging algorithmic thinking in younger students is one of the main goals of the project. Algorithmic thinking as part of computer thinking can be stimulated through a series of activities:

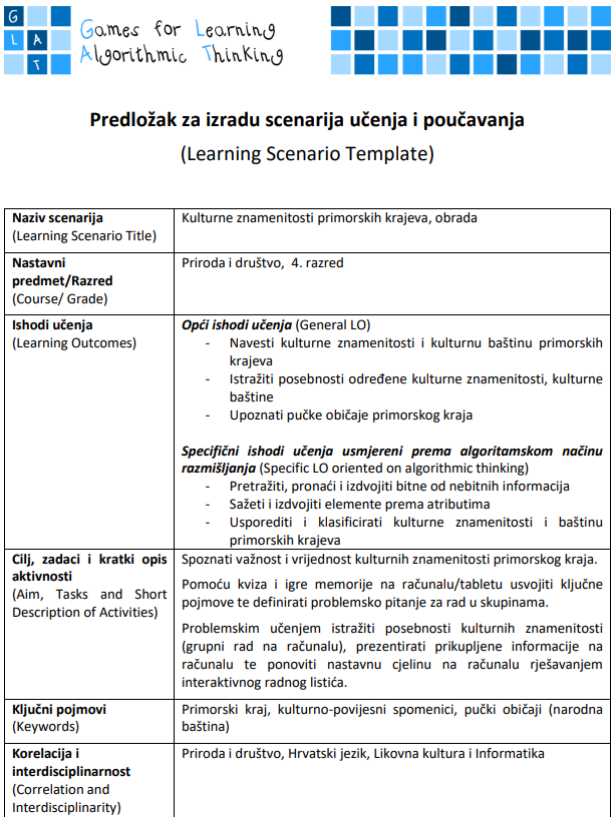
- Searching and sifting essential from non-essential data
- Summarizing and excluding items by attribute
- Comparison and classification of items
- Defining and describing a sequence of actions (algorithm)
- Detecting errors in the algorithm

Since our second workshop related to PBL, online quizzes and logical tasks, algorithmic thinking has played a major role in designing activities. When explaining a problem as algorithm, it is breaking down in smaller, more familiar sections, which can be solved using a set of rules (algorithms) to find solutions and using abstractions to generalize those solutions to similar problems [20]. For example, in early grades, teachers could highlight the steps involved in solving any problem thus explaining the algorithm. Algorithmic thinking can be developed through all school subjects for which appropriate teaching methods are needed either with or without technology. Any learning situation can be improved by incorporating such methods in an appropriate learning scenario from the first grade of primary school, and it can only be conducted by the teachers who have been trained for it.

B. Learning scenarios of PBL

The aim of each of our workshops was that teachers design and develop learning scenarios on the chosen topic of the existing curriculum using the principles of tools highlighted at the workshop. The planned activities should be carried out with their students.

Designing a learning scenario is a process by which teachers plan or structure a learning situation. A scenario consists of a subject and class, a complexity level, key concepts, learning outcomes and a description of activities complemented with materials and resources for the teacher and students [7], [9]. For the purpose of the second workshop a Learning Scenario Example was produced as shown in Figure 1.



Games for Learning Algorithmic Thinking

Predložak za izradu scenarija učenja i poučavanja

(Learning Scenario Template)

Naziv scenarija (Learning Scenario Title)	Kulturne znamenitosti primorskih krajeva, obrada
Nastavni predmet/Razred (Course/ Grade)	Priroda i društvo, 4. razred
Ishodi učenja (Learning Outcomes)	***Opći ishodi učenja*** (General LO) - Navesti kulturne znamenitosti i kulturnu baštinu primorskih krajeva - Istražiti posebnosti određene kulturne znamenitosti, kulturne baštine - Upoznati pučke običaje primorskog kraja ***Specifični ishodi učenja usmjereni prema algoritamskom načinu razmišljanja*** (Specific LO oriented on algorithmic thinking) - Pretražiti, pronaći i izdvojiti bitne od nebitnih informacija - Sažeti i izdvojiti elemente prema atributima - Usporediti i klasificirati kulturne znamenitosti i baštinu primorskih krajeva
Cilj, zadaci i kratki opis aktivnosti (Aim, Tasks and Short Description of Activities)	Spoznati važnost i vrijednost kulturnih znamenitosti primorskog kraja. Pomoću kviza i igre memorije na računalu/tabletu usvojiti ključne pojmove te definirati problemsko pitanje za rad u skupinama. Problemskim učenjem istražiti posebnosti kulturnih znamenitosti (grupni rad na računalu), prezentirati prikupljene informacije na računalu te ponoviti nastavnu cjelinu na računalu rješavanjem interaktivnog radnog listića.
Ključni pojmovi (Keywords)	Primorski kraj, kulturno-povijesni spomenici, pučki običaji (narodna baština)
Korelacija i interdisciplinarnost (Correlation and Interdisciplinarity)	Priroda i društvo, Hrvatski jezik, Likovna kultura i Informatika

Figure 1. Example of PBL learning scenario

The learning scenario should have accentuated correlations with other teaching subjects, as well as designed activities in order to emphasize and encourage this connection. As described in the example, the aim of this activity is to understand the importance and value of the cultural sights of the coastal region. The teacher will use a self-prepared quiz and a memory game on the computer/tablet for students to adopt key concepts and define a problem issue for group work. Via problem-based learning, students will explore the specifics of cultural sights (group work on a computer), present the collected information, and repeat the learning unit by solving an interactive worksheet on the computer. The applications used for conducting online quizzes and logical tasks were Kahoot! quiz, Match the Memory game, Wizer.me and LearningApps interactive worksheets.

During the November and December 2018, teachers implemented their conceived activities in the class and gave a reflection on the conducted activity. Reflection included performance considerations, whether performance required additional assistance to teachers, the number of students involved with the activity, how the students accepted the designed activities, whether all the learning outcomes stated in the learning scenario were realized and the possible changes in the scenario before the next implementation.

IV. TEACHERS' ATTITUDES TO THE PREPARATION OF PBL ACTIVITY USING DIGITAL TOOLS

At the beginning of January 2019, qualitative research was conducted through three focus groups with a total of 24 teachers. Each group consisted of eight teachers deployed per class, where they conducted problem teaching activities using digital tools (1st grade, 2nd grade, 3rd and 4th grade). The focus group method was selected as a preliminary survey of attitudes to education and improving personal competencies as a basis for the preparation of quantitative final evaluation of the entire project.

The aim of the research was to examine the teachers' opinions, attitudes and their personal experience in preparing for problem teaching with the help of the digital tools they had implemented with their students. The focus groups' implementation took place predominantly as a targeted conversation with pre-structured topics and subtopics on the competences of using digital tools in the process of teaching, preparation and implementation of problem based learning scenarios and using digital technology in the teaching process. Teachers expressed their attitudes and opinions through a conversation, describing their experience of problem based learning/teaching. The implementation of each focus group was audio recorded. Based on the obtained transcripts, the results were analyzed by systematizing the participants' answers to a particular question.

For the purpose of this paper the topic *Preparation and implementation of problem based learning scenarios* was analyzed through structured questions:

- How demanding is the preparation for this type of teaching and learning?
- How much time has been invested in developing the learning scenario?
- Do you estimate that your participation in GLAT education enhanced your teaching competences?
- Is the school well-equipped with technology?
- Was additional support of the IT teachers needed before the implementation of the designed scenario?

The systematization of the answers leads to the conclusion that design and writing of preparations for this kind of problem teaching is demanding, with which the group agrees. There has been a small polarization of attitudes in the opinion that the requirement for preparation is reflected only at the beginning of the application of this type of teaching. Here are some answers:

- "Preparation needed a recollection of everything we have learned through training"
- "I had to additionally test and try digital tools we used on the workshop"
- "I solved the doubts with the method of attempts and mistakes and successfully prepared the teaching scenarios"
- "On a scale from 1 to 10 I think the requirement of preparation is somewhere between 8 and 9"…

The group agrees that they have been using this kind of preparation for the first time, with an emphasis on the outcomes and activities that will be achieved with the help of digital tools. They consider: "Any subsequent activity and learning scenario design will be much easier". "This form of preparation is extremely good regarding the direction of the curricular reform we are undergoing". The group concludes that the efforts they have invested in designing activities have resulted in showing interest in the more frequent implementation of the digital tools in teaching activities by students but also themselves in the context of innovation of the teaching process.

Due to the expressed demands of design activities, respondents were asked the question "How much time has been invested in making preparations/learning scenario for one lesson?" The group opinion is several days and stages in the process, because they encountered a new way of preparing lesson. The problem was not to elaborate the course of one lesson, but rather to envisage the time required for preparation of quizzes and logical tasks with digital tools and designing extra activities of the kind. Many teachers especially liked the Leplanner – graphical tool for creating a learning scenario.

The group also emphasizes the improvement of personal competency of teaching after the implementation of the learning scenario. Here are the highlighted answers:

- "The novelty of using digital tools in other subjects and not only informatics and I can do it"
- "The pupils are using computers and digital tools and they are not in the computer class and not with an IT teacher"
- "Students are showing their digital literacy through their work on the computers while the teacher directs it"
- "I am the creator and inventor of games, assignments and quizzes that I have never conducted before"
- "I can devise activities by organizing lessons on computers"
- "Such planned teaching can contribute to the thematic-integrated teaching"
- "The learning scenarios we have created can also be used in our subsequent work, as forms to be revised".

By systematizing the answers to the question: "Is school well equipped with technology?" a good equipment of computer classrooms was confirmed in all schools. The problems that the teachers point out about equipment are as follows:

- "There is only one computer classroom in school."
- "Access to an IT classroom is not always possible in scheduled time."
- "There is only one computer classroom that is permanently locked."
- "Classical classrooms should be equipped with a computer, projector and internet connection."
- "At least one tablet set to be used in parallel classes is required."

However, it is concluded that for all planned scenarios, all teachers managed to organize the classroom availability.

The polarization of attitudes was most apparent in the answers to the question: "Did you need additional help or collaboration with an IT teacher before the implementation of the activity?" The group did not have a common attitude. The most commonly expressed attitudes were:

- "I asked for the collaboration of the IT teacher to assist students during the implementation of activities in terms of typing keywords into a search engine or typing applications links, etc."
- "I did not need any help from colleagues."
- "I did ask for help from my colleague, but it was not adequately achieved."
- "I think that I will be able to bring digital tools into the teaching process more independently with each subsequent activity implementation. "

V. CONLUSION

There is not enough research related to the implementation of Problem Based Learning into teaching very young students. An integration of PBL scenarios in the teaching process can increase teachers' knowledge and skills and enhance their teaching practices. Furthermore, such method can contribute to developing creativity and logical thinking in young students so they will be able to convey what they have learned in new situations. The GLAT project will try, with contemporary methods and teaching strategies and through different school subjects, to implement the algorithmic way of thinking, problem-solving skills, logic and creativity into the daily learning.

All teachers involved in focus groups emphasize the improvement of personal competency of teaching after the implementation of a learning scenario, as well as the novelty of the use of digital tools in other subjects, not only informatics. Finally, teachers point out that overall GLAT education will be useful to them in regard to the changes in the education system and the transition to a curricular approach, as the learning platforms are similar. They have regularly exchanged reflections on the forum and thus also learned. Teachers showed great satisfaction with the prepared scenarios and readiness for investing further efforts.

The learning scenarios are based on general and specific learning outcomes and activities that deliver the outcomes, and the greatest novelty is the use of digital teaching tools, as well as the high motivation of students for game and problem based learning. The results obtained through the focus group will be used to improve the training syllabus, which is one of the goals of the GLAT project. Teachers consider that additional educational cycles for primary school junior grade teachers about the learning scenarios and the use of educational technology and web tools should be carried out and that they should become part of a continuous lifelong training of primary school junior grade teachers.

ACKNOWLEDGMENT

This paper is co-funded by the Erasmus+ Programme of the European Union, Key Activities 2, Strategic Partnerships for school education, 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).

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SUPPORTING CONTEMPORARY LEARNING AND TEACHING METHODS THROUGH GLAT PROJECT

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Abstract

The use of technology in education requires teachers with certain digital competencies to use the teaching technology and make the learning process more interesting to students. The ongoing Erasmus+ project "Games for Learning Algorithmic Thinking" provided 20 primary school junior grade teachers with education on different teaching strategies for stimulating the algorithmic thinking of their pupils in everyday situations.

Through lectures, demonstrations and practical work in three workshops participants were introduced to the concepts of Game Based Learning and unplugged activities, Problem Based Learning and the possibilities for integration of problem-solving tasks into the lecturing process. They were also introduced to the concept of Inquiry Based Learning and possibilities for learning basic programming concepts using games.

Also, teachers applied newly acquired knowledge through the development of their own learning scenarios. Learning scenarios are materials and procedures intended to support teachers in using innovative and imaginative ideas for teaching activities by means of modern pedagogical methods, with the use of appropriate digital content and tools. So, their task was to design a learning scenario for a selected subject that will include activities which will encourage creativity, logical thinking, and problem-solving skills in students. They were also expected to implement such activities with their students and to share their experiences with other participants.

After each workshop participants provided structured evaluations and reflections aimed at the improvement of teaching and practical exercises provided through this project. The initial and final evaluation was used to identify how this project contributed to teachers knowledge, skills, and how it changed the pattern of teaching methods that they use in classrooms.

The syllabus and teaching materials developed during the teacher training program will be used to organize a lifelong learning program at the Faculty of Teacher Education in Rijeka. Certain segments of syllabi and teaching materials will also be included in the new Integrated University Teacher Study plan and program.

Key words: Game Based Learning, Inquiry Based Learning, Problem Based Learning, algorithmic thinking, teachers

Games for Learning Algorithmic Thinking (GLAT) Project: The influence of personal and environmental factors on perceived usefulness and usage of the LePlanner - learning scenario design tool

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Preamble

GLAT Project

The Project GLAT – Games for Learning Algorithmic Thinking is an Erasmus Plus Programme of the European Union under the Key Action 2, which is Cooperation for innovation and the exchange of good practices. The action type of the project is" Strategic Partnership for school education" The main objective of the project is to introduce the integration of coding and algorithmic thinking into daily teaching through different subjects at the primary school level in Croatia.

Consequently, the project involves training selected teachers in different innovative teaching and learning methodologies that stimulates logical thinking and problem-solving skills; with or without technology. As Five (5) institutions (University of Rijeka, Rijeka, Croatia; Tallinn University, Tallinn, Estonia; University of Ljubljana, Ljubljana, Slovenia; Ss Cyril and Methodius University in Skopje, Macedonia; and South-West University Neofit Rilski. Blagoevgrad, Bulgaria) are engaged in the project, with the University of Rijeka being the project Centre and coordinating institution. At the end of the day, the expected project outcomes are to: a) Compile workshop syllabuses and materials to facilitate teacher training workshops, b) equip Teachers with skills to design and share learning scenarios that facilitates coding and critical thinking, and problem-solving skills. The Leplanner was introduced as a tool for designing learning scenarios.

The LePlanner

The LePlanner was designed by a doctoral student of School of Digital Technologies in the Tallinn University, Estonia. The tool offers the opportunity for designing learning scenarios, visualizing the scenarios and sharing them. It enables teachers to archive their teaching and learning martials perpetually and those materials could be reused with or without modification. LePlanner had been used in various projects to promote innovative teaching and learning (Pata, Beliaev, Robtsenkov, & Laanpere, 2017).

The Problem

Training students to be critical thinkers has become essential based on the demands and the need for developing new skills for the job market and social developments (Bacigalupo, Kampylis, Punie, & Van den Brande, 2016; Vuorikari, Punie, Carretero, & Van Den Brande,

2016). GLAT is an Erasmus funded institutional partnership project that seeks to prepare teachers with innovative teaching skills to achieve this feat. In line with the aims of the project, teachers have been drawn from schools in Croatia to undergo a training in innovative teaching and learning practices; covering topics such as Game-based learning approaches, developing learning scenarios, how to use multimedia tools and resources, Problem-based learning, Inquiry learning, and programming skills.

This study assumes that the subjects of the GLAT project are non-ICT related teachers and taking up new role as coding teachers and the pursuance of technology-driven lesson and use of online design tools might be challenging in the face of their digital disposition and age. Stakeholders on the GLAT project will not be able remedy teacher concerns unless they are known; therefore, among other studies this current research sought to elicit the possible challenges, needs and the digital endowments the teachers bring on board the project. Inputs from the teachers would enable the stakeholders in GLAT to use them to prepare them for the new professional roles as algorithmic thinking teachers. Hence, this article gives a report on the investigations done regarding the raised concerns.

Objective

The overall objective of this paper is to undertake a descriptive overview about the perceptions of the teachers participating in the project on a) digital self-efficacy, b) Digital ICT usage c) the digital supports in their schools, the perceived usefulness and the actual use of LePlanner – a new tool introduced; and further explore how the age of the teachers influence the perceptions. Ultimately, the study is to unearth the strengths and challenges of the teachers as they prepare to introduce coding in their respective schools. In the light of the forgone, answers were sought for the following research questions;

- **RQ 1**: What perceptions do teachers hold about their a) personal digital dispositions (self-efficacy and technology appropriation), b) digital support in schools and c) the usefulness and possible usage of new digital tool (LePlanner) which was introduced to them.

- **RQ 2:** In what is age influencing the perceptions of the teachers as indicated **RQ1?**

Methods

The study was organised as an online survey for purposively sampled subjects (Cohen, Manion, & Morrison, 2007). These are teachers from schools in Croatia, who are being trained to facilitate the teaching of coding to their children – under the curriculum theme Games for Algorithmic Thinking, in all 24 of them participated in the online survey. The subjects are non-ICT teachers, and they come on board the course from varied knowledge backgrounds. An online questionnaire was administered to the teachers during the first workshop meeting of the project, which was organised on the 5th and 6th of April in Rijeka, Croatia. The instrument sought elicit the perceptions of the teachers in the dimensions of; their personal dispositions towards their capacities to use digital tools and resources and the kind of support their school offer in this direction.

In addition, the instrument elicited perceptions of the teachers regarding the usefulness of the new tool that has been introduced (LePlanner) and their opinion of whether to adopt it as a professional working tool or not. To obtain the descriptive statistics of the subjects, descriptive analysis was done using the SPSS. Similarly, cluster analysis and comparison of differences in

mean vales was done to obtain information about the influence of the ages of the subjects on their perceptions and its related issues.

Findings

Most of the teachers have an above average perception rating across all the five variables under consideration. The responses were homogeneous implying shared perceptions by teachers.

The study discovered two cluster groupings: Cluster 1; had 16 members (66.7% of the sample); Cluster 2, had 8 members, (33.3% of the sample); and did not display exclusive age groupings. Hence age is not an influencing factor in how far teachers will function in their new roles. There is are 66.7% percentage of teachers who do require some attention.

Teachers had concerns; Perceptions teacher hold about their Digital/Computer Self-efficacy and b) perception about school based support - Digital/Computer Self-efficacy was statistically significant across Cluster 1(M =2.547, SD = .410) and Cluster 2 (M = 2.906, SD = .186), t (22) = -2.339, $p = .029$; *and* Perceived Available Support was significantly different across Cluster 1 (M=2.083, SD =.410) and Cluster 2 (M = 2.625, SD = .415). t (19) = -2.575, $p = .018$

Recommendations

This report constitutes part of the formative assessment process of the project; and aid stakeholders of the project into putting in place post-project sustainability schemes to support the teachers. In this light, it is suggested that concerns arising from the perceptions teachers have about their digital self-efficacy and support in the schools be remedied.

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GAMES FOR LEARNING ALGORITHMIC THINKING (GLAT) PROJECT: PERCEIVED FACTORS ACCOUNTING FOR TEACHER ACCEPTANCE AND USAGE OF A NEW LEARNING SCENARIOS DESIGN TOOL – THE LEPLANNER

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Abstract

Training students to be critical thinkers has become essential in today's education. GLAT (Games for Learning Algorithmic Thinking) is an Erasmus funded institutional partnership project that seeks to prepare teachers with innovative teaching skills to achieve the feat of teaching coding. Teachers drawn from schools in Croatia were trained in innovative teaching and learning practices to acquire programming and critical thinking skills to facilitate the teaching of coding in schools. In this paper a descriptive overview of the perceptions of the teachers participating in the project are explored in the dimensions of a) digital self-efficacy, b) Digital/ICT Usage, c) the digital supports in their schools, the perceived usefulness and the actual use of LePlanner – a new tool introduced; and further explore how the age of the teachers could influence the perceptions they hold. The study was organized as an online survey for purposively sampled subjects who were non-ICT teachers. In all 24 teachers participated in the survey. Most teachers had an above average perception rating across all the five variables that were measured. The responses were homogeneous implying shared perceptions by teachers. However, the study discovered two cluster groupings: Cluster 1; had 16 members (66.7% of the sample); Cluster 2, had 8 members, (33.3% of the sample); the clusters did not display exclusive age groupings. Hence, age could not be argued as an influencing factor for determining how far the teachers will be successful in their new roles as programming teachers. Nonetheless, a total of 66.7% of the teachers seemed to require some form of attention in the light of their Digital/Computer Self-efficacy and school-based support perceptions towards the usage of digital tools and the acceptance of the LePlanner. GLAT is an ongoing project, therefore subsequent workshops would factor in training components that will address the concerns of the teachers.

Keywords: Games for Learning Algorithmic Thinking, GLAT, Computation thinking, Learning Scenarios design, LePlanner, Game-based Learning, Project Based Learning, Inquiry.

1 INTRODUCTION

Training students to be critical thinkers has become essential in this knowledge age. Using approaches such as design thinking, problem-based learning and project-based learning among other approaches had been ways in which learning is organised to stimulate the mental faculties of learners [1], [2]. Like every aspect of the school curriculum the teacher is a key hub around which the teaching and learning organization revolves. The teachers' challenges, strengths, needs, ICT conflicts among others should to be established, understood and the needed motivational action plans drawn to mitigate any adverse effects[3], [4]

The subject of self-efficacy, technology use and age, among other factors continue to receive attention by researchers in the various fields including health and education [5], [6]. In the school settings it is crucial for stakeholders in education to know the factors leveraging teachers' appropriation of technology; in the context of the teachers' personal dispositions[7]. This paves the way for authentic interventions and schemes to be drawn for the schools in relation to the teachers' professional roles. This line of action become more crucial in situations where the new teacher role is to be accomplished within a technology mediated learning environment and associated with teaching coding; as in the case of the GLAT Project - Games for Learning Algorithmic Thinking.

GLAT is an Erasmus funded institutional partnership project. It seeks to encourage the introduction of coding and algorithmic thinking into every day teaching and learning activities in schools. This objective in part is tied to pursuance of the European Union Digital Competence Framework – DigComp [8]. Ultimately, GLAT is intended to allay the fears of the students about coding by creating

fun-based learning patterns that equip them with algorithmic thinking skills. The protect consortium is made up five institutions, namely University of Rijeka, Tallinn University (Estonia), University of Ljubljana, South-West University “Neofit Rilski” (Bulgaria) and St. Cyril and Methodius University in Skopje. University of Rijeka, Croatia is the project management institution and center of all workshops.

To achieve the set goals for the GLAT project, teachers have been drawn from schools in Croatia to undergo a training in innovative teaching and learning practices, and coding. The teacher training scheme is organised into three separate workshops, where teachers will be taken through topics such Game-based learning approaches, developing learning scenarios, using Multimedia tools and resources, Problem-based learning, Inquiry learning, and Programming skills. So far, as at the time of conducting this study, the first out of the three scheduled workshops have been successfully carried out in Rijeka, Croatia. In this workshop, teachers had two sessions of training on designing learning scenarios – firstly as an unplugged activity, and secondly as a wired activity. With the unplugged lesson scenarios as a backdrop, teachers were then introduced to a new tool - the LePlanner. Practically, teachers would be expected to use the tool in designing learning scenarios throughout the project.

The LePlanner is an application designed at the Tallinn University. It offers the functionality of designing lesson scenarios, visualizing lesson plans, promoting co-authorship between teacher and students, creating repositories of teaching and learning materials and facilitation of learning modes (see Fig 1a). It offers an opportunity for blended lessons to be designed by designating which learning activities would be done in class and which are to be done out of the class. LePlanner offers a flexible feature where both the teaching and learning resources to be used by both the teacher and students are displayed on the timeline of the lesson plan. Fig 1a shows the digital tools and resources associated with a lesson and it is organised under two domains, I) teacher resources and ii) student resources. Interestingly, LePlanner helps teachers to manage the lesson delivery time, visualize how much students are functioning as co-creators in the teaching and learning process; all these are visualized on the timeline as shown on Fig 1a.

Fig 1a. Timeline representation of lesson scenario

Fig 1a. Timeline representation of a lesson scenario

The tool (LePlanner) is the outcome of a participatory design-research activity, which was underpinned with the intent to facilitate social networking learning spaces, sharing knowledge and archiving teaching and learning resources (see Fig 1b). In practice, empirically studies relating to this usefulness of the LePlanner is found in [9]. On Fig 1b, an extract of already published learning scenarios is displayed. LePlanner is a free and open tool and currently functional in three languages. English Language, Estonia and Croatian. All users have their designed lesson scenarios archived and other users of the platform could search and reuse the resources that are relevant to their needs.

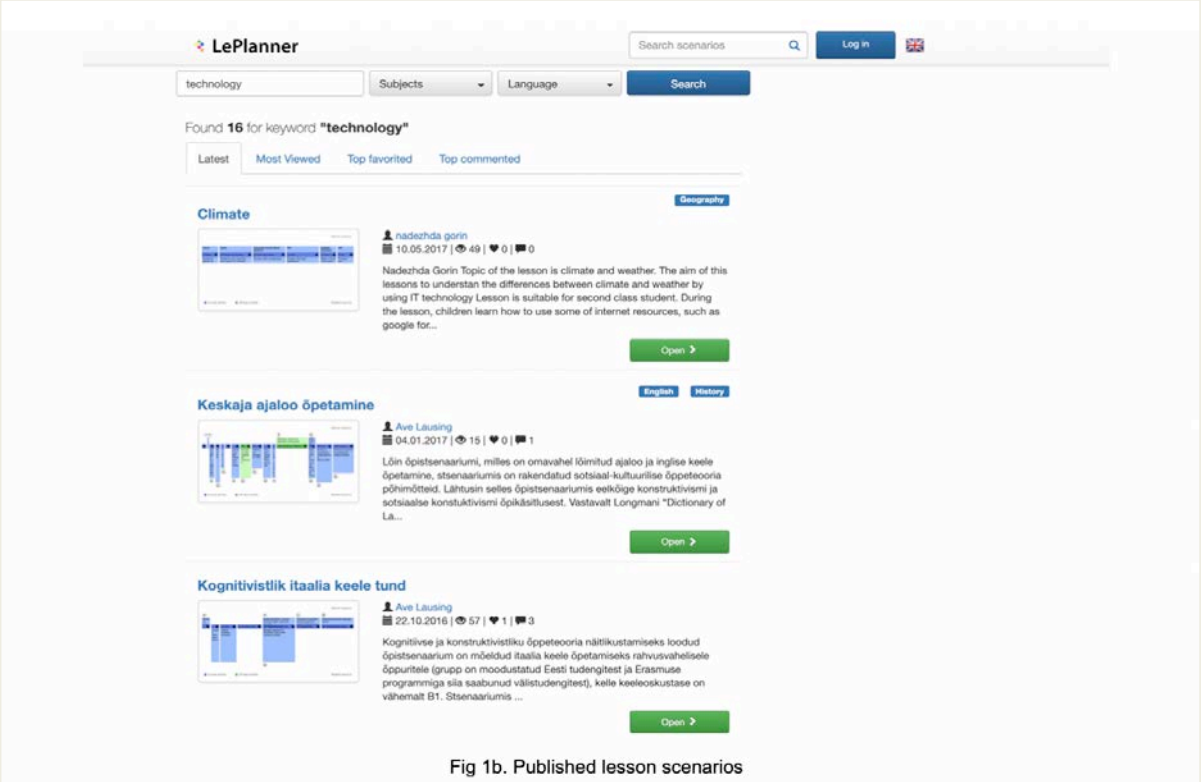


Fig 1b. Published lesson scenarios

Fig 1b. Published lesson scenarios

This paper thrived on the assumption that since the subjects of the GLAT project are non-ICT related teachers there is the possibility of taking up the new role as coding teachers might be challenging; and not only that but the pursuance of technology-driven lesson and use of design tools might be new in professional practices. The relevance of the teacher in promoting meaningful learning outcomes cannot be ignored in the quest for innovations in schools[10]. Teachers require some digital and professional competence coupled with consistent supporting structures to enable them to function as expected. The needs of the teacher would be better met only when the concerns are brought to the fore. Stakeholders on the GLAT project will not be able remedy teacher concerns unless they are known; therefore, among other studies this current research sought to elicit the possible challenges, needs and the digital endowments the teachers bring on board the project. Inputs from the teachers would enable the stakeholders in GLAT to use them to prepare the participants adequately for the new professional roles - as algorithmic thinking and coding teachers. Hence, this article gives a report on the investigations done regarding the raised concerns.

The overall objective of this paper is to report a descriptive overview about the perceptions of the teachers participating in the GLAT project on; a) digital self-efficacy, b) Digital ICT usage c) the digital supports in their schools, the perceived usefulness and the actual use of LePlanner – a new tool introduced; and further explore how the age of the teachers influence the perceptions. Ultimately, the study is to unearth the strengths and challenges of the teachers as they prepare to introduce coding in their respective schools.

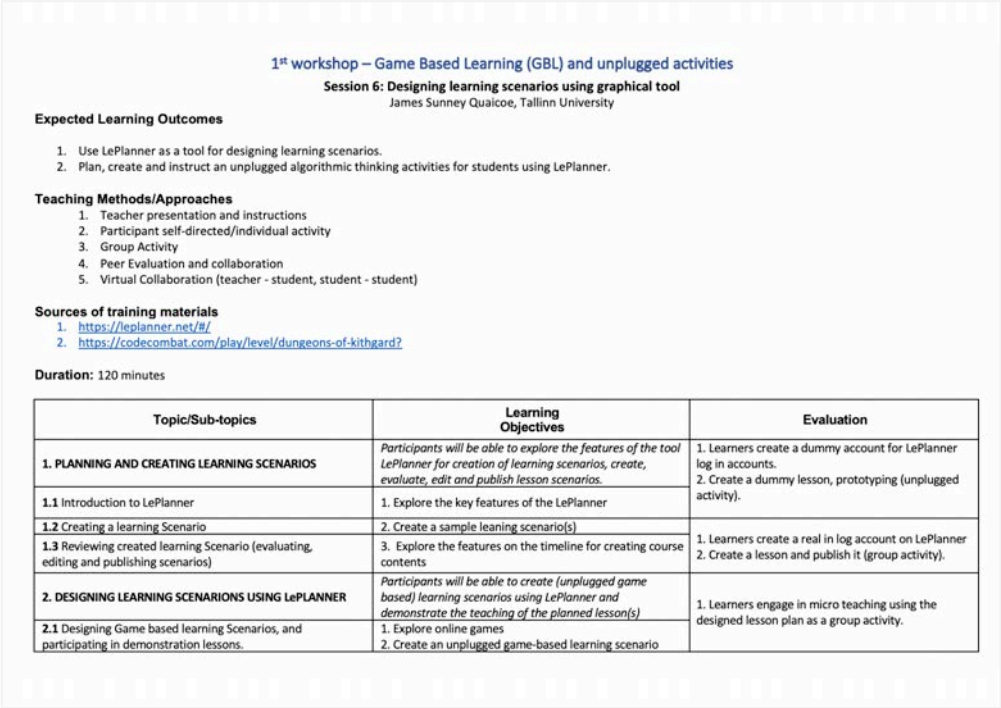
In the light of the forgone, answers were sought for the following research questions;

- **RQ 1**: What perceptions do teachers hold about their a) personal digital dispositions (self-efficacy and technology appropriation), b) digital support in schools and c) the usefulness and possible usage of new digital tool (LePlanner) which was introduced to them.
- **RQ 2:** Is age a factor influencing teachers' perceptions as indicated in **RQ1?**

2 METHODOLOGY

The study was organised as an online survey for purposively sampled subjects. These were teachers from elementary schools in Croatia, who were being trained to facilitate the teaching of coding to their children – under the curriculum theme Games for Algorithmic Thinking. In all 24 teachers participated in an online survey. It is worth mentioning that the subjects were non-ICT teachers, and they came on board the project with varied subject specialties and age groups. An online questionnaire was administered to the teachers during the first workshop meeting of the project; after they had received training on the use of the LePlanner. The instrument sought to elicit the perceptions of the teachers in the dimensions of their personal dispositions towards their capacities to use digital tools and resources and the kind of support their school would offer in this direction. In addition, the instrument gathered data on the perceptions of the teachers regarding the usefulness of the new tool (the LePlanner) that has been introduced to them; and further explore their readiness to adopt it as a professional working tool or otherwise.

As part of the whole project agenda, the research instruments were administered to the teachers after they had received two sessions of training on unplugged version of designing learning scenarios. The LePlanner was introduced as a digital tool and resource for designing learning scenarios. Fig 2 shows the syllabus designed for teacher training on the usage of the LePlanner.



1st workshop – Game Based Learning (GBL) and unplugged activities

Session 6: Designing learning scenarios using graphical tool

James Sunney Quaicoe, Tallinn University

Expected Learning Outcomes

1. Use LePlanner as a tool for designing learning scenarios.
2. Plan, create and instruct an unplugged algorithmic thinking activities for students using LePlanner.

Teaching Methods/Approaches

1. Teacher presentation and instructions
2. Participant self-directed/individual activity
3. Group Activity
4. Peer Evaluation and collaboration
5. Virtual Collaboration (teacher - student, student - student)

Sources of training materials

1. https://leplanner.net/#/
2. https://codecombat.com/play/level/dungeons-of-kithgard?

Duration: 120 minutes

Topic/Sub-topics	Learning Objectives	Evaluation
1. PLANNING AND CREATING LEARNING SCENARIOS	*Participants will be able to explore the features of the tool LePlanner for creation of learning scenarios, create, evaluate, edit and publish lesson scenarios.*	1. Learners create a dummy account for LePlanner log in accounts. 2. Create a dummy lesson, prototyping (unplugged activity).
1.1 Introduction to LePlanner	1. Explore the key features of the LePlanner	
1.2 Creating a learning Scenario	2. Create a sample leaning scenario(s)	1. Learners create a real in log account on LePlanner 2. Create a lesson and publish it (group activity).
1.3 Reviewing created learning Scenario (evaluating, editing and publishing scenarios)	3. Explore the features on the timeline for creating course contents	
2. DESIGNING LEARNING SCENARIONS USING LePLANNER	*Participants will be able to create (unplugged game based) learning scenarios using LePlanner and demonstrate the teaching of the planned lesson(s)*	1. Learners engage in micro teaching using the designed lesson plan as a group activity.
2.1 Designing Game based learning Scenarios, and participating in demonstration lessons.	1. Explore online games 2. Create an unplugged game-based learning scenario	

Fig 2. GLAT Workshop training Syllabus on designing learning scenarios using graphical tool (the LePlanner)

Various data analysis approaches were used to give meaning to the responses of the teachers. All analyses were done using the SPSS. Descriptive statistical technique was used in obtaining the perceptions of the teachers on the respective variables; with the focus being on the mean and standard deviations of the responses. Subsequently, series of cluster analysis were done to determine possible cluster groupings across the subjects. Finally, K-means cluster analysis was carried out – where k = 2. This activity offered bases to identify the differences among the teachers, and which factors could be responsible.

Finally, an individual sample t-test was conducted to compare differences in mean values across factors and the cluster groupings. This was done in order to obtain information about which factor(s) are significantly accounting for differences across the subject's under observation.

3 RESULTS

This paper sought to explore the perceptions of teachers in relation to the emerging new roles ahead of them due to the GLAT project objectives. Thus, the overall objective of this paper is to report the descriptive overview of the perceptions of the teachers participating in the project on in the context of: a) digital self-efficacy, b) Digital ICT usage c) the digital supports in their schools, the perceived usefulness and the actual use of LePlanner – a new tool introduced; and further explore how the age of the teachers could influence the perceptions. Ultimately, the study is to unearth the strengths and challenges of the teachers as they prepare to introduce coding in their respective schools. The outcomes of the study were as follows:

3.1 Descriptive overview of Teacher perceptions

An overview of the perceptions of the teacher participants during the first GLAT workshop were considered essential, because it sets to tone for appreciation of the dispositions of the teachers. Thus, in line with the objectives of this paper, RQ1 offered leads into the inquiry of the perceptions of the teachers regarding the factors associated with their new professional roles (see Table 1). On Table 1 the descriptive statistics of the teacher responses are provided.

Holistically, it is observed that most of the teachers have an above average perception ratings across all the five variables under consideration; and the distributions of the responses seems to be relatively homogeneous (standard deviations ranged from .354 to .597). This finding suggests that most of the teachers share common perceptions across the variables being measured and it could be inferred that they come on board the GLAT project with no extreme diverged professional backgrounds.

The findings however indicated that teacher could be saddled with some challenges relating to appropriation of digital tools and resources. For instance, the variables were measured on a five-continuous scale but as shown from Table 1 average maximum perception rating from the subjects was three (3) for all the five factors. The higher scales of 4 and 5 were not attained by the respondents. Meanwhile, the minimum value of scale which ranged from 1 to 2 were the starting point of the responses.

Table 1. Descriptive Statistics of Teacher perceptions

Variables	N	Minimum	Maximum	Mean	Std. Deviation
Digital/Computer Self-efficacy	24	2.00	3.00	2.66	.387
Digital Tool Usage	24	1.00	3.00	2.28	.489
Perceived usefulness of LePlanner	24	1.75	3.00	2.48	.417
Perceived available school support	24	1.00	3.00	2.26	.597
Perceived actual usage of LePlanner	24	2.00	3.00	2.45	.354

Literal observation of the results on the table, suggest that teachers appear to have concerns about their *usage of digital tools and resources (M = 2.28, SD = .489),* and *availability of school support (M = 2.26, SD = .597).* The result shows that these variables are the ones with the least mean scores, and furthermore have the lowest minimum rating. However, further analysis will tend to offer an alternative impression. Focusing on evidences of possible acceptance and use of the Leaner the following were found; *Perceived usefulness of LePlanner* (M = 2.48, SD = .417) and Perceived *actual usage of LePlanner* (M = 2.26, SD = 2.45). The findings seem to suggest that there is a highly likelihood that teachers would use the LePlanner, they were not are not quite sure about its usefulness.

3.1.1 Age as influencing factor on teacher perceptions

This section of the article dealt with the subject of how the age of the teachers might relate to their perceptions. Preceding this quest, a cluster analysis was carried out to classify the teachers across the predicting variable items. The study discovered two main cluster groupings: Cluster 1, which denotes low rated perceptions had 16 members. This amounted to 66.7% of the sample; whereas, Cluster 2, representing the higher rated perceptions had 8 members, thus forming 33.3% of the sample.

The cluster groupings were further analysed in order to determine the age distributions across the sample. Two main teacher groupings were identified. These are teachers aged from 30 through 39 years, and the other being teachers aged 40 years and above. In practice, Cluster 1- members (age 30 – 39 years) were 7, whiles in the case of members in Cluster 2 (aged 40 years and above) were 9, totalling 16 members. In the case of Cluster 2- for the ages 30 through 39 years membership was zero (0), and for age 40 years and above the members hip were 8. From Table 2, it was observed that all the members of cluster two – constituting the higher rating group were within the age group of 40 years and above. Contrary to the initial assumption that age could influence the perceptions of teachers regarding their duties in the GLAT project, the results suggest that age is not defining the perceptions the teachers had regarding the five variables in relation to the expected new teaching roles. Rather, differences are existing based on the cluster groupings and this not depended on the ages of the teachers (see Table 2).

Table 2. Descriptive statistics about teacher perceptions based on the Cluster groupings

Cluster Number of Case	N	Minimum	Maximum	Mean	Std. Deviation
Digital/Computer Self-efficacy	16	2.00	3.00	2.5469	.41047
Digital Tool Usage	16	1.00	3.00	2.1719	.50595
Perceived usefulness of LePlanner	16	1.75	3.00	2.4427	.38278
Perceived available school support	16	1.00	3.00	2.0833	.60246
Perceived actual usage of LePlanner	16	2.00	3.00	2.3906	.34118
Valid N (listwise) Cluster 1	16				
Digital/Computer Self-efficacy	8	2.50	3.00	2.9063	.18601
Digital Tool Usage	8	2.00	3.00	2.5208	.38253
Perceived usefulness of LePlanner	8	1.80	3.00	2.5750	.49497
Perceived available school support	8	2.00	3.00	2.6250	.41547
Perceived actual usage of LePlanner	8	2.00	3.00	2.5938	.36307
Valid N (listwise) Cluster 2	8				

Table 2 shows the cluster distributions and their respective descriptive statistics. The results show that most of the lowest perception ratings indicated by the minimum point of the scale were found under Cluster 1 cases. The variables *digital tool usage*, *perceived usefulness of LePlanner*, *school support and perception on actual usage of LePlanner* were found to be below average, this is in contrast to the perceptions of Cluster 2 which has above average score across all the variables. Further analysis offered room for the extraction of the variables influencing the differences across the clusters.

Focusing on evidences of possible acceptance and use of the Leaner the following across the clusters the following unfolded: *Cluster 1: Perceived usefulness of LePlanner* (M = 2.44, SD = .382) and Perceived *actual usage of LePlanner* (M = 2.39, SD = .341). *Cluster 2: Perceived usefulness of LePlanner* (M = 2.57, SD = .494) and Perceived *actual usage of LePlanner* (M = 2.59, SD = .363 These findings seem to suggest that there is a highly likelihood that teachers in cluster 2 would accept and use the LePlanner, more than their colleagues Cluster 1. It is worth mentioning that these inferences are premature until the actual evidences of usage of the LePlanner is established in the subsequent studies. Till then it is sufficient to rely on the outcome of the current study to put in place interventions to forestall any possible professional setbacks in the course of the project.

3.1.2 Factors accounting for differences in teacher perceptions

From the write-up of section 3.1.1 of this paper, the cluster groupings (Cluster 1 and Cluster 2) of the teachers were reported. The study suggested that there is about (66.7%) teachers who would need support in order to enhance their perception ratings. To obtain further insight into the assertion made that 66.7% require attention, further analysis was conducted. An independent sample T- test was carried out using the cluster groupings as the group variable and the five variables (see Table 2) as

the predictors. Table 3 contains the relevant extract of the outcome of the analysis. The study brought to the fore some crucial concerns of the teachers that were found in the dimensions of:

- *Perceptions teacher hold about their Digital/Computer Self-efficacy*
- *The perception* about school-based support for their professional responsibilities

Table 3. Results of Independent Sample T-test

Variable	Cluster	Mean	Std. Deviation	t	df	Sig. (2-tailed)
Digital/Computer Self-efficacy	1	2.5469	.41047	-2.339	22	.029
	2	2.9063	.18601			
Perceived available school support	1	2.0833	.60246	-2.575	19.432	.018
	2	2.6250	.41547			

Based on the reported results on Table 3, the variable *Digital/Computer Self-efficacy* was found to be statistically significant across Cluster 1 (M =2.547, SD = .410) and Cluster 2 (M = 2.906, SD = .186), t(22) = -2.339, *p = .029;* while, the variable *Perceived Available Support* was found also to be significantly different across Cluster 1 (M=2.083, SD =.410) and Cluster 2 (M = 2.625, SD = .415), t (19) = -2.575, *p* = .018. Interestingly, the results as shown on Table 3 do not completely differ from inferences made from the Table 1 results, which suggested that teachers appear to have concerns about their *usage of digital tools and resources (M = 2.28, SD = .489),* and *availability of school support (M = 2.26, SD = .597).* The difference however, is in the highlight that is placed on the variable *Digital/Computer Self-efficacy.* In this light, the study suggests that the following three factors a) *Digital/Computer Self-efficacy,* b) *usage of digital tools and resources and* c) *availability of school support* which appear to be associated with the professional needs of the teachers should be given the require emphasis during the subsequent project training sessions. It is expected that such a professional boost will impact on teacher acceptance and usage of the LePlanner for lesson scenario designs.

4 CONCLUSIONS

Games for Learning Algorithmic Thinking – GLAT is an Erasmus funded project with a five-member institutional consortium - University of Rijeka (Croatia), Tallinn University (Estonia), University of Ljubljana (Slovenia), South-West University “Neofit Rilski” (Bulgaria) and St. Cyril and Methodius University in Skopje (Republic of North Macedonia). The GLAT project is intended to allay the fears of students about studying coding and engaging in computational and algorithmic activities. This is be attained by training teachers to teach and facilitate fun-based learning that equips them with algorithmic thinking skills for their professional practice. Croatia was the hosting nation of the project; with Rijeka University as the project management center.

In this paper attempt is made to explore the entrant perceptions of the teachers on the GLAT project in the context of a) digital self-efficacy, b) Digital ICT usage c) the digital supports in their schools, the perceived usefulness and the actual use of LePlanner – a new tool introduced; and further explore how the age of the teachers might influence their perceptions. This study was based on the assumptions that as non-ICT teachers, the 24 Croatian teachers participating might encounter some professional challenges as result of their age and usage of digital tools and resources – with a particular emphasis on the use of the LePlanner to prepare and teach coding in schools.

The result of study brings to the fore very important issues for discussion. Firstly, in this study teacher self-evaluations were used to establish the digital statuses of the teachers across five variables. In the works of [11] this approach is essential in opening doors to offer the project facilitators to understand the teachers’ needs in order to evolve the appropriate support. Complementing this point [12] was on the view that providing resources and tools is not enough to promote technology usage in schools, rather teachers need to be supported. Basically, this is the essence of this current paper in relation to the GLAT project. Thus, in this paper the digital statuses of the teachers are explored in order to offer leverage to remedy any professional digital shortcomings or shortfalls. Fortunately, the results do

suggest extreme professional digital challenges among the teachers. Literally, this is a good start for the project because the teachers come on board with similar digital capacities and competences.

Secondly, this paper argues that age is not a factor influencing the extent to which the teachers will take up their new professional roles. This finding is supported by various empirical studies [13]–[15]. Initial empirical studies had sustained the notion of the impact of age on technology usage, however later studies tend to refute is notion. Practically, the results of this current study suggest that the age of the teachers is not a significant factor in determining the digital perceptions they hold. The implication of the findings on the GLAT project is that facilitators need not worry about setting varying remedial training scheme based on ages, instead supporting teachers based on specific professional needs and competence as demanded by the project.

Finally, teacher acceptance of the LePlanner as a professional tool was explored with the variables Perceived usefulness of LePlanner and Perceived actual usage of LePlanner. It is worth mentioning that those variables measured the perceptions of the teachers so it could bae argues as to how perceptions will inform the extent of acceptance of the LePlanner. Nonetheless, because teachers have had some training on the usage of the LePlanner their perceptions based on the initial interactions with tool is relevant. In light on the overall findings this current study, it could be inferred that there is an immense likelihood that teachers would use the LePlanner as a professional tool, though they may not be quite sure about its usefulness – this position should be seen as normal since they yet to use the LePlanner extensively. In sum, it is recommended that based on the cluster groupings of the teachers, the respective digital professional gaps identified would need some attention. So far, the study suggests that *Digital/Computer Self-efficacy* and *Perceived available school support* should be critically looked at in the course of the training. By way of planning for future studies, the actual acceptance and usage of the LePlanner needs to be explored.

ACKNOWLEDGEMENTS

Games for Learning Algorithmic Thinking

Co-funded by the Erasmus+ Programme of the European Union

TALLINN UNIVERSITY

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Izlaganje

Projekt GLAT - Jačanje kompetencija učitelja za inovativno poučavanje korištenjem obrazovnih igara

Sažetak

Predstavit će se aktivnosti projekta GLAT – Games for Learning Algorithmic Thinking koji je sufinanciran Erasmus+ programom. Aktivnosti projekta su usmjerene jačanju kompetencija učitelja za primjenu inovativnih pristupa poučavanju uz pomoć informacijsko-komunikacijske tehnologije (IKT). Naglasak je na primjeni učenja uz pomoć obrazovnih igara (eng. *Game Based Learning*) koje se kombinira s ostalim pristupima (problemsko učenje, projektno učenje, učenje propitivanjem) kako bi se kod učenika potaknulo logičko razmišljanje, kreativnost i razvoj vještina rješavanja problema.

Razvijen je model stručnog usavršavanja učitelja razredne nastave. Cilj usavršavanja je poticanje učitelja da na zabavan i atraktivan način u poučavanje različitih predmeta uključuju elemente za razvoj digitalnih kompetencija, posebno onih koji se odnose na algoritamsko razmišljanje i programiranje. Stručno usavršavanje učitelja u okviru projekta GLAT ima tri modula: 1) Učenje uz pomoć igara i aktivnosti bez upotrebe računala, 2) Problemsko učenje, logičke igre i zagonetke, 3) Igre i alati za učenje programiranja. Osmišljeno je prema mješovitom modelu e-učenja te svaki modul uključuje radionicu i nastavu uz pomoć sustava za e-učenje. Nakon upoznavanja s teoretskim temama i primjerima inovativnih pristupa poučavanju na radionici, od nastavnika se očekuje da primijene stečeno znanje i razviju scenarij učenja i poučavanja za odabrani nastavni predmet te ga izvedu sa svojim učenicima. Nastavnici u sustavu za e-učenje MoD pristupaju materijalima za učenje, komuniciraju s mentorima i dijele svoje utiske o provedbi scenarija u razredu s drugim sudionicima.

U stručnom usavršavanju tijekom trajanja projekta GLAT sudjelovala je fokus grupa od dvadesetak nastavnika s riječkog područja no rezultati projekta nisu namijenjeni samo njima i njihovim učenicima već i svim ostalim učiteljima u Hrvatskoj, ali i šire. Rezultati uključuju razvijen silabus radionica i materijale za stručno usavršavanje koji su upotpunjeni primjerima dobre prakse, uključujući i najbolje primjere scenarija učenja i poučavanja koje su razvili učitelji iz fokus grupe. Svi materijali razvijeni tijekom projekta bit će i nakon njegova završetka javno dostupni na hrvatskom i engleskom jeziku putem mrežnih stranica projekta (https://glat.uniri.hr), sustava za e-učenje MoD i različitih portala za objavu i razmjenu digitalnih obrazovnih materijala. Tako će ih moći koristiti svi zainteresirani koji žele razvijati kompetencije za inovativno poučavanje uz pomoć IKT-a i obrazovnih igara.

***Ključne riječi**: algoritamsko razmišljanje; digitalne obrazovne igre; obrazovanje učitelja; osnovnoškolsko obrazovanje; projekt GLAT.*

Presentation

Project GLAT - Activities for improving teachers' competences for innovative teaching using educational games

Abstract

The activities of the Erasmus+ project GLAT - Games for Learning Algorithmic Thinking that promote improvement of teachers' competences for the application of innovative teaching approaches using ICT will be presented. The emphasis is on using Game Based Learning approach in combination with other approaches (problem based learning, project based learning, inquiry based learning) to encourage students' creativity, logical thinking and development of their problem-solving skills.

A model for professional development training of primary junior grade teachers has been developed. The aim of the training is to encourage teachers to include elements for development of students' digital competences, especially those related to algorithmic thinking and programming, in different schools subjects in a fun and attractive way. The training within the GLAT project has three modules: 1) Game based learning and unplugged activities, 2) Problem based learning, online quizzes and logical tasks, 3) Games and tools for programming. It is designed according to the mixed model of e-learning so each module includes a face-to-face workshop followed by online learning. Teachers are first introduced to theoretical topics and examples of innovative teaching approaches at the workshop. Afterwards, they are expected to apply the acquired knowledge and develop a learning scenario for the chosen subject and implement it in the classroom with their students. Teachers access learning materials, communicate with mentors, and share their impressions regarding learning scenario implementation with other participants in the e-learning system MoD.

During the duration of the project, a focus group of twenty teachers from the Rijeka region participated in the GLAT training. The results of the project are not intended only for them and their students but also for all other teachers in Croatia and beyond. The results include workshops syllabus and learning materials with examples of good practice, including the best learning scenarios developed by the teachers from the focus group. All materials developed during the project will be available in Croatian and English language on GLAT website (https://glat.uniri.hr), e-learning system MoD and various portals for the publication and exchange of digital educational materials. Therefore, all interested parties will be able to use them for improving competences for innovative teaching using educational games.

Key words: *algorithmic thinking; digital educational games; primary education; project GLAT; teacher education.*

Teaching of computer programming in Bulgarian primary school – challenges and solutions

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***Abstract* - In this paper the new school subject in Bulgarian primary school - "Computer modelling" is presented. The subject is introduced to all Bulgarian schools in 2018/2019 year as a core course in third grade (9-year-old students). The curricula for 3rd and 4th grade are outlined and some challenges and problems in implementation of the new school subject are discussed. Also several examples for solutions of main challenges are presented..**

***Keywords* – computer programming, computational thinking, primary school, teaching methods**

I. INTRODUCTION

The world around us becomes more and more digitalized. Nowadays the society needs people that not only use digital devices, but also people with computational thinking who will develop high-tech environment. In [1] authors point out that "To be prepared for the jobs of the 21st century, students must not only be digitally literate but also understand key concepts of informatics." To answer the new requirements of digital society and future jobs a lot of countries started to develop and implement new curricula in their schools with focus on informatics concepts, computational thinking, and algorithmic thinking. A lot of countries started rethinking strategies for informatics education. The school subject Informatics or Computer Science (or similar) has been introduced in different school level in different countries.

Informatics education in Bulgaria started in end of 60s years of 20th century as elective courses in Mathematical gymnasiums. As a compulsory subject it has been involved into school curricula from 1986/1987 year. During the years there were tides according place of informatics education in the school curricula. At 2016 year started new school curricula and new school subject "Computer modeling" was involved for primary school students at 3rd and 4th grade (9-10 years old). The education in the new subject started from 2018/2019 school year.

The new subject in Bulgarian primary school, problems with its implementation and possible solutions are in the focus of this paper.

II. RELATED STUDIES

In several countries informatics concepts and programming are introduced in primary schools as compulsory courses in the curricula. In England the computing curricula for primary school is involved at 2014. [2]

Slovakia has a huge experience in informatics education at school – primary and secondary level. [3] As a mandatory course informatics is involved in Slovakian schools at 2008 year "from year 2 (7 to 8 year olds) to mid-upper secondary stage (16 to 17 year olds)". In 2011 Slovak National Curriculum (2011) outlines two core school subjects – Elementary Informatics for grades 2 to 4 (pupils aged 7 to 10) and Informatics, for school years 5 to 11 (pupils aged 10 to 17). Since 2015 both subject are called Informatics. The subject covers domain from ICT and programming.

In other countries computer science is presented into primary school curricula as an optional course: Slovenia [4] – "Slovenian schools offer an optional elective course Computer Science to the students in the second three-year cycle of primary schools since school year 2014/2015. "

Very popular among children and parents are computing clubs provided by different organizations and companies. Also international online initiatives stimulate children, parents and teachers to self-explore concepts and ideas of informatics and programming.

Independent if computing, or computer science or informatics, are part of informal or formal education, several common problems arise:

- lack of well-prepared teachers to teach the subject in primary school or to integrate elements of programming and computing in other subjects;
- needs of adequate pedagogical approaches related to psychological and cognitive characteristics of children in primary school;
- introducing of abstract informatics concepts in understandable and accessible manner for children;
- choose of appropriate programming environment.

Regarding the pedagogical approaches, it should be mentioned that constructionism based methods create good conditions for implementation of computer programming in primary school. Some example of good practices could be found in [4], [5], [6]. In the frame of ScratchMath project [5] outline "5E" framework of activities: Explore, Explain, Envisage, Exchange, bridgE.

Authors of [7] proposed unplugged game based method for introducing computer memory, basic arithmetic operations and the idea of variables.

The study is partially supported by projects GLAT- 2017-1-HR01-KA201-035362 and Coding4Girls - 2018-1-SI01-KA201-047013

III. CURRICULA "COMPUTER MODELING" IN BULGARIAN PRIMARY SCHOOLS

A. Structure of the school educational system in Bulgaria

In Bulgarian educational system three school subjects related to computer science are part of the school curricula: Information technology, Informatics, and Computer modeling. Courses in Information technology are focused on computer system, application software – graphical editors, word-processing, spreadsheets, presentations, internet services, safety in internet, computer viruses etc. Courses in informatics are directed to algorithms, numbers systems, Boolean algebra, programming. Subject Computer modeling is directed to primary school and joins topics from domain of ICT and Informatics.

In primary school (1st-4th grade) students can study computing in three basic forms:

- 3rd (9 years old students) – 4th (10 years old students) grade - Compulsory subject "Computer modeling" – 1 hour per week;
- 1st – 4th grade - elective or optional – Information technology, 1 or 2 hours per week;
- Extracurricular courses in IT and Informatics – 1 or 2 hours per week, funded by National programs of Ministry of Education.

The compulsory subject "Computer modeling" has been involved since 2018/2019.

Educational process in compulsory subjects is regulated by several state documents:

- State standards – outlines competences in form of learning outcomes (LO) for every educational level.
- Syllabus for every grade - developed by the Ministry of Education; unified form for description; outlines the learning outcomes; compulsory topics; requirements for distribution of hours for different type of lessons and assessment; suggestions for activities that help to achieve LO and development of 9 competences;
- Topic schedules for the academic year, developed by teachers.

For elective or optional courses teachers develop own syllabus, that have to be approved by regional educational inspectorate.

The textbooks are free of charge for students from 1st till 7th grade. Also e-textbooks with extended interactive exercises are provided by the publishers of printed textbooks. The teachers are supported by teacher's book with didactical suggestions for learning scenarios development and lesson implementation.

B. Main topics and learning outcomes in curricula "Computer modeling"

Main topics for 3rd grade are outlined in state syllabus [8] and include core knowledge domains: Digital Devices, Digital Identity, Information, and Algorithms.

The accent is on the obtaining knowledge and skills for: working with files; creating animated projects with use of algorithms with loops in visual environment for block programming; safe and healthy working with computers.

Implementation of the computer models in visual environment could be prepared by: unplugged activities with visual materials – mosaic, jigsaw etc.; working in simulation environment; performing algorithms in programming environment; use of easy for handling robotic devices; etc.

Key concepts are digital device, user, user name, user password, algorithm, code, command, loop, menu, button, animation, animated image, slide, information and data, branching, random number, variable, arithmetic and logical operators, conditions.

C. Chalanges and problems with implementation of the curricula

As every new entity the new school subject and curricula set challenges and problems in front of all stakeholders – teachers, parents, students, etc.

- Providing enough prepared teachers with relevant competency to teach the new subject in primary school. According to the state documents the subject has to be taught by primary school teachers, regardless of their qualification in ICT.
- Choice of appropriate programming environment. The environment has to provide conditions for implementation of the curricula. It should be based on block programming and to be free for the schools and students.
- The syllabuses include a lot of abstract concepts like algorithm, loops, branching, variables, digital identity etc. These concepts have to be precisely defined and in the same time to be explored in accessible manner for the 9-10-year-old students.
- Implementation of basic concepts in block programming environment and main topics of the syllabus requires usage of concepts that are part of mathematics curricula in next grades - negative numbers, coordinates and coordinate system, measurement of angles in degrees, random number.

IV. SOME DIDACTICAL APPROACHES FOR IMPLEMENTATION OF THE CURRICULA

One of the challenges for implementation of the curricula is abstraction of the concepts. For Introduction of the concepts could be applied adequate pedagogical methods and tools as:

- Show of objects with illustration of the concepts.

- Indication of properties of concepts.
- Use of analogies and examples from everyday life.
- Use of fun elements - challenges, riddles, anecdotes, puzzles.
- Use of computer educational games, simulations or demonstrations.
- Interactive tests and an electronic textbook.
- Use of unplugged activities.
- Problem solving.
- Experiments with "backed" (prepared in advance by teachers) and "half backed" codes.

Another challenge is choosing programming environment for implementation of curricula in primary schools. Most of schools have chosen the popular environment Scratch (scratch. mit.edu) due to its intuitive interface, well established community of teachers and other users, localization in many languages, guides for teachers and students.

Aside from well-known real-life algorithms for preparing of sandwiches, doing gymnastic or dancing, for the illustration of loop algorithm algorithms from known tales could also be used.

Example 1: Algorithm from tales

Cinderella – Find Cinderella

1. Find a girl;

2. Try the shoe

3. If the shoe fits, then Cinderella is found, in other case go to step 1.

This example illustrates one of the constructions in programming languages - loop with post condition.

Example 2: Unplugged game activity for digital devices.

In the table are hidden the names of 3 digital devices. Find them. Which are their common elements?

a	l	t	o	p	a	r	i	s	a
s	m	a	r	t	p	h	o	n	e
s	i	b	g	o	a	l	r	o	w
e	a	l	a	p	t	o	p	r	i
t	m	e	m	i	r	a	n	d	y
o	p	t	e	c	o	d	a	n	c

Example 3: Unplugged activity. Find of words in the grid integrates Math, Computer science (Informatics).

1. Find the two-digit numbers with equal digit.

2. Order them in ascending order.

3. Replace the numbers with relevant alphabet sign.

4. Which word do you obtain?

5. Explain how to use it?

34-m	11-P	43-n	25-F	12-b	31-G
43-n	22-a	33-s	33-s	13-c	12-b
21-l	12-b	21-l	44-w	13-c	13-c
23-E	13-c	23-E	55-o	66-r	77-d
13-c	25-F	43-n	23-E	13-c	25-F

To avoid the problem with coordinate system and negative numbers when sprites have to be positioned, it is suitable to use direct manipulation of the sprite, colors for different quadrants [6], experiments and discussion.

Example 4: Use colors to explain coordinate system. This idea was given by prof. Ivan Kalas from Comenius University, Bratislava during a training workshop.

The students work with "half baked" file with colored quadrants in coordinate system as a stage and one sprite (cat). The first task is to move the cat in differently colored areas and to observe the numbers changing in block 

.

After experiment with direct manipulation teacher or students can do conclusions abot use of sign minus, without explanation about negative numbers. The concept about negative numbers is part of 5th grade math curricula. In this way the teacher can do propedeutics of negative numbers and coordinate system and coordinates that are part from 6th grade mathematics curriculum.

A simmilar situation occurs when students have to use blocks for turn

Measurement of the angles is part of 4th grade Math curricula. To reduce level of abstraction, it is suitable to use experiment with clock. The teacher can explain that when the hour arrow is turned from 12 to 1 o'clock it makes an angle from 30 degrees.

Example 5: The task is:

Use file clock.sb2. (Figure 1.) Click on the green flag and after that on the red arrow. What happens? Look at the code. Which new commands are used? Start file again and click 3 times on the red arrow. Which number will show the arrow? In the code 

change number 30 to 60, 90, 15. After every change start code and observe which number shows the arrow.

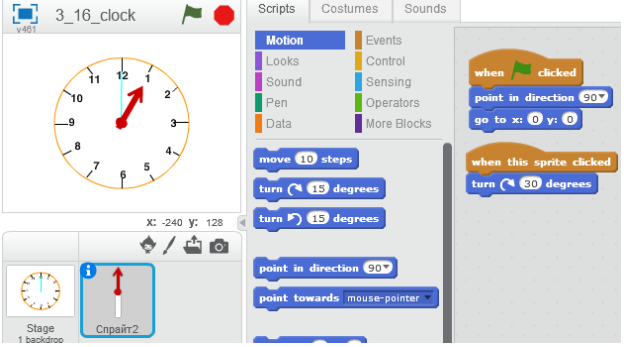

Figure 1. Clock experiment

In this way students will have visual performance of abstraction for angle's metrics.

Example 4 and Example 5 give also a good propaedeutic of math concepts.

Example 6: Use of experiment to involve concept animation. The task is presented in [9].

Open file pinokio.sb2 (Figure 2). Click on the green flag. What kind of activities is Pinocchio performing? See costumes and click on the costumes. What happens? Check the code. Do you find motion blocks?

After this experiment, teachers could involve easy concept animation as a quick change of images.

Experiments at different levels of object controlling help students to better understand concepts and principles of programming.

Example 7:

Along with the experimental work teachers can use tasks that could be enlarged step by step. The example of set of extended tasks is performed in [9]. In the ground of the task is the tale "The Gigantic Turnip".

This is a folklore tale with six characters – grandfather, grandmother, granddaughter, dog, cat and mouse. The grandfather plants a turnip. The turnip grows so big and the grandfather cannot pull it. He thinks: "I have to call grandmother to help me." He calls grandmother and together they try to pull the turnip. They still don't succeed. Grandmother thinks: "I have to call granddaughter." She calls the granddaughter and once again they all together try to pull the turnip, but still unsuccessfully. The granddaughter thinks: "I have to call my dog". She calls the dog. The dog comes. All together they try to pull the turnip. Again they cannot pull it. Dog thinks: "I have to call the cat." The dog calls the cat and cat comes. All together they try to pull the turnip. Again the try is without success. The cat thinks: "I have to call the mouse." The cat calls the mouse. The mouse comes. At the end they all together pull the turnip.

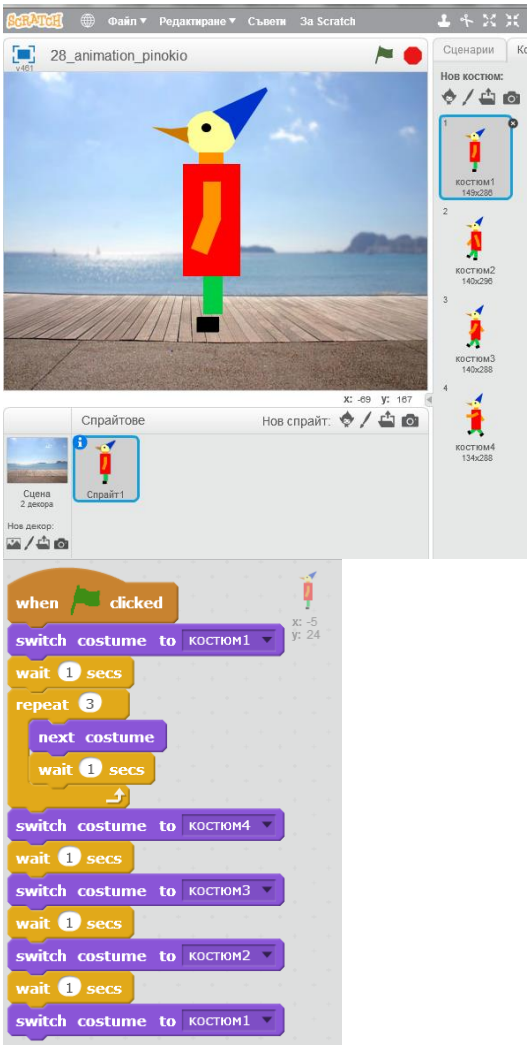

Figure 2. Animation experiment [9]

This tale is well-known by the students. When students learn about algorithms they use interactive micro game to order heroes in the tale (Figure 3).

When students explore Scratch programming environment they can step by step:

- develop stage backdrops;
- use "half backed" file for experiments and observation of code and behavior of part of sprites;
- continue scenario description and implementation;
- implement story telling with costumes changing, events driving with broadcasts (Figure 4.).

The teacher can use slide with codes of grandfather, grandmother and granddaughter. With the help of this slide, similarities and differences could be discussed.

V. CONLUSION

Teaching computer programming in primary schools has many challenges, some of which are outlined and discussed in the paper.

The new school subject was brought to Bulgarian school curricula in the current 2018/2019 school year. There are a lot of challenges in the process of implementation of the curricula. These challenges could be solved with the use of an adequate teaching methods, grounded on the constructionism, with selection of

Figure 3. Micro game for ordering characters from the tale "Gigantic Turnipt " [9]

appropriate tasks – close to the students' everyday practice and their interests. The tasks have to be fun and in the same time help students develop algorithmic thinking and achieve the desired learning outcomes.

ACKNOWLEDGMENT

This study is partially supported by projects GLAT-2017-1-HR01-KA201-035362 and Coding4Girls - 2018-1-SI01-KA201-047013.

Thanks to my colleagues Maya Kaseva and Georgi Tuparov.

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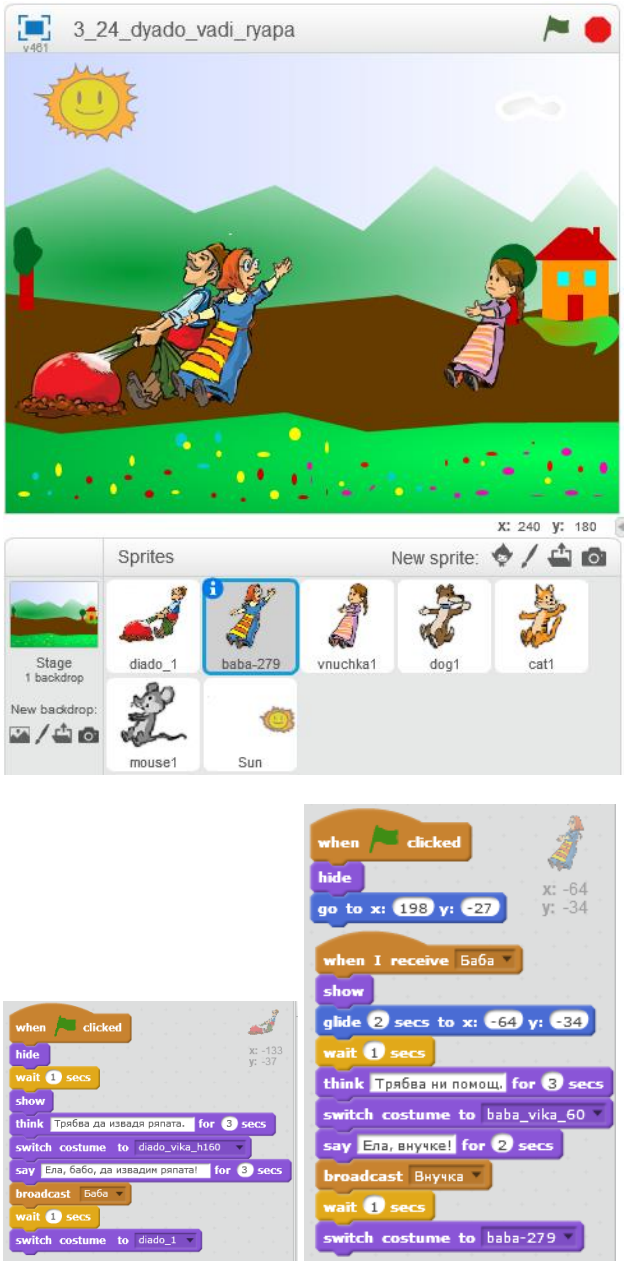

Figure 4. The tale "The Gigantic Turnip" [9]

ПРОЕКТ GLAT – GAMES FOR LEARNING ALGORITHMIC THINKING

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***Резюме**: В доклада се представят основните цели и дейности на международния проект GLAT, програма Еразъм+*

***Ключови думи**: образователна компютърна игра; алгоритмично мислене, начално училище, обучение на учители*

1. Въведение

Проектът GLAT – Games for Learning Algorithmic Thinking е проект по програма Еразъм +, Ключова дейност 2: Сътрудничество за иновации и обмен на добри практики – Стратегически партньорства за училищното образование., договор 2017-1-HR01-KA201-035362. Актуална информация може да бъде открита на уебсайта на проекта https://glat.uniri.hr/. Съдържанието в доклада е базирано на информацията във уебсайта на проекта.

2. Основни цели, подходи и задачи

Основната цел на проекта е да се насърчи включването на кодирането и алгоритмичното мислене в практиката на обучението на учениците в по-ранна възраст чрез интегрирането им в учебните програми на различни учебни предмети по забавен и атрактивен начин.

Проектът е насочен към подобряването на отношението на учениците към кодирането и развитието на алгоритмично мислене в най-ранния етап на училищното образование. Необходимо е да се работи за намаляване на „страха" от кодирането и повишаване на интереса на учениците към евентуална бъдеща кариера в областта на точните науки и информационните технологии в дългосрочен план.

Един от начините да се постигне тази цел е професионалното обучение на началните учители за прилагане на иновативни методи за обучение като обучение базирано на игри (GBL – Game Based Learning) за развитие на алгоритмичното мислене на учениците.

Експертните задачи включват разработването на учебна програма и учебни материали за курса на обучение на началните учители и провеждането на обучението под формата на работни семинари и онлайн обучение.

3. Партньори и участници

Проектът се координира от департамент Информатика на университета в Риека, Република Хърватия. Партньори по проекта са Педагогически факултет на университета в Риека, Университет на Любляна, Словения, Университет на Талин, Естония, Университет „Св. Св. Кирил и Методий", Скопие, Бивша Югославска Република Македония и ЮЗУ „Неофит Рилски", Благоевград, България.

Преки участници в проекта са 24 хърватски начални учители, които ще вземат участие в пилотното тестване на създадените учебни материали и ще предложат сценарии за приложение на игрови подход в обучението по различни предмети с цел развитие на алгоритмично мислене у учениците в начална училищна възраст.

Работните срещи са планирани в смесен модел на обучение, в който са комбинирани дигиталните технологии и традиционните методи на обучение. Учителите ще присъстват на работни срещи, които ще бъдат проведени в Хърватия, а онлайн обучението ще се осъществява посредством системата за електронно обучение Moodle. Експертите от партньорските организации ще осигуряват подкрепа на участниците, за да могат те да използват придобитите знания и умения за разработването на сценарии за обучение, след което да приложат тези сценарии в класната стая.

Анкетно проучване ще позволи на участниците да оценят работата си по проекта и да предложат подобрения.

4. Първи присъствен семинар

Първата работна среща на тема „Обучение базирано на игрите и дейности без компютър (unplugged activities)" се проведе в Университета на Риека, катедрата по информатика, на 5 и 6 април, 2018. Педагогическият факултет организира сформирането на фокус група от 24 начални учители от 13 начални училища с помощта на AZOO, Агенция за образование и обучение на учители. Участието във форума представлява форма на професионално обучение за учителите.

Целта на този работен семинар е участниците да бъдат въведени в проблематиката на игрово базираното обучение, да им се даде възможност да придобият практически опит с конкретни примерни дейности и инструменти за създаване на учебно съдържание за дейности без компютър (unplugged activities) и на сценарии за обучение.

Очакваните резултати са насочени към:

- Усвояване на принципите на игрово базирано обучение (GBL) и дейности без използване на компютър;

- Придобиване на умения за работа с Web 2.0 инструменти за създаване на учебно съдържание за дейности без използването на компютър;
- Създаване на сценарии за обучение с разработване на иновативни идеи за дейности без използването на компютър.

Обучението беше проведено от Наташа Хоич-Божич, Мартина Холенко Длаб и Ивона Франкович от катедрата по информатика на Университета на Риека, Ясминка Мезак, Петра Пейич Папак и Дарко Лонджарич от Университета на Риека, Педагогически факултет, Виктория Хумал от Талинския университет, Йоже Ругел, Матея Бевчич и Аня Луштек от Университета в Любляна, Даниела Тупарова и Иваничка Несторова от ЮЗУ „Неофит Рилски", Благоевград, България.

Участниците бяха запознати със средата за електронно обучение Moodle и получиха достъп до курса за електронно обучение GLAT, за да могат да използват учебните материали, да комуникират помежду си и с експертите, да предават създадените от тях сценарии и да споделят впечатленията и опита си от прилагането им на практика в класната стая. Беше проведена и анкета, за да се установи до каква степен участниците са запознати с определени теоретични понятия, методи и инструменти за обучение.

Представени и анализирани бяха игри,приложими при преподаването на различни учебни дисциплини и подходящи за развитие на алгоритмични умения, формиране на основни понятия от програмирането като алгоритъм, цикъл и др. Практическите дейности включваха работа с Web 2.0 инструментите Canva и Sketchpad за създаване на учебни материали за дейности без компютър (unplugged activities). Авторският инструмент LePlanner беше използван за създаване и визуализиране на сценарии за обучение в графичен формат.

Следващи стъпки

Следващите дейности предвиждат учителите да създадат сценарии за обучение с помощта на GLAT експертите като онлайн ментори за прецизиране на сценариите, като окончателните версии ще бъдат приложени в процеса на обучение в началния курс.

Вторият семинар ще бъде на тема „Онлайн викторини и логически задачи за насърчаване на алгоритмичното мислене" и ще се проведе в края на август 2018г.

Благодарности

GLAT – Games for Learning Algorithmic Thinking е проект по програма Еразъм +, Ключова дейност 2: Сътрудничество за иновации и обмен на добри практики

– Стратегически партньорства за училищното образование., договор 2017-1-HR01-KA201-035362

PROJECT GLAT – GAMES FOR LEARNING ALGORITHMIC THINKING

Daniela Tuparova, Ivanichka Nestorova, Kostadin Samardzhiev

Abstract: *In the presentation we outline main goals, approaches, objectives and activities in Erasmus+ project GLAT – Games for Learning Algorithmic Thinking. Actual information could be find at the project web site https://glat.uniri.hr/*

Key words*: educational computer games, primary school, teacher training, algorithmic thinking*

USING SCOTTIE GO! AS GAME BASED LEARNING TOOL FOR COMPUTATIONAL THINKING COURSE

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Abstract

The pervasiveness of information and communication technologies in everyday life imposes the need to be digitally proficient. Computational thinking and learning to code are necessary 21st century skills for students. Those skills can drastically influence future labor market. Carefully planned educational approaches must be used in order to develop computational thinking skills at primary school level. We propose to use game based learning combined with flipped classroom and collaborative team work. This can utilize students' energy and enthusiasm they have when playing games, in achieving educational goals. This methodological approach is also very useful to develop different level of digital competences focusing on a technology as a tool for achieving certain goal.

Scottie Go! is an interactive puzzle-based mobile game which aims to involve primary school children in coding using approach similar to popular block based coding approaches such as Scratch coding environment. The coding is very similar to making the ordinary paper puzzle, where each part of the puzzle is one coding instruction. The "compiling" of code is done using mobile app camera-based interface that is very popular among students. This simple and tactile approach makes easier for young learners to deal with abstract coding concepts without depending on technology at one side, and developing sophisticated digital competences (simplified augmented reality) at other side. The collaborative game approach is used in order to integrate less interested or talented students in achieving learning outcomes in a very natural way. By playing the game students have both fun and possibility to learn from the other in the flipped classroom manner.

The proposed approach was used with 120 students from six different primary schools over a period of two months. The students than took part in the survey concerning their overall experience in using the game for development of computational skills. Information concerning students' interest in the game, ease of use, students' quality of experience and correspondence to educational goals were obtained using the survey. In addition, An exam has been carried out to evaluate students' learning achievements and long term knowledge. Survey results together with exams' results indicate that the proposed approach has created collaborative, stimulating and motivational learning environments which lead to successful achieving of learning outcomes. Proposed teaching methodology and results of the survey are presented in the paper.

Keywords: Computational thinking, game based learning, mobile game, coding, collaboration.

1 INTRODUCTION

Development of students' 21st century skills, necessary for living in this constantly changing world, is the main goal of the contemporary education. The education must shift its focus from transmitting isolated knowledge and skills to acquiring complex competences, guiding learners in developing skills for learning and getting information from the diverse range of sources available in modern society [1]. In this way, education is increasingly becoming learner-centred and competence-based. Rapid developments in technology and ease of technology access, have determined the direction in which the educational process will change. International Society for Technology in Education (ISTE) emphasized the need of possessing digital competencies and skills by the students. ISTE underlines the importance of regular use of certain digital tools in teaching practices which will lead to empowerment of students' 21st century knowledge and skills [2].

In order to equip students with these competencies and skills, some educational reforms must be made concerning integration of ICT usage and coding in the curriculum, including ideas and tools for computer science, computing and computational thinking according to the age level. The rationale for integrating coding in school curricula is twofold: to equip all students with skills that are increasingly

perceived as important in today's digital society, such as problem solving and logical thinking skills, and, but to a slightly lesser extent, to respond to the lack of IT-skilled labour force in Europe [3].

There are many different pedagogical approaches for the delivery and practice of computer science education deployed in different countries: unplugged activities [4], block-based programming [5], use of coding in different subjects [6] etc. The selection of the approach depends on many factors, such are: the students' age, available resources in the school, teachers digital competences etc. Generally, computer science and computational thinking can be taught through technology-free activities, namely procedures such are: computer science unplugged, initial tools for learning coding concepts, robotic coding, and cross-curricular activities [7]. However, there is still no evidence which approach is better than the other [8].

Today's students are "digital natives", spending the majority of their time playing games on their computers, mobile phones or tablets on daily bases. Many studies demonstrated that using students' interest in playing games in educational context can be highly beneficial [9]. Digital games have become powerful contexts for learning by providing people with the opportunity to join new worlds by thinking, talking and acting, taking roles otherwise inaccessible to them [10]. The findings of a review study 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 [11]. Digital games offer students opportunities to reach goals that are not focused just on learning facts, but enable development of skills such as problem solving, decision making and strategic planning at the same time [12].

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. On the whole, educational digital games constitute an innovative learning process where teachers act as facilitators [13]. Game-based environments in which students can learn the basics of coding while playing games and having fun, is very popular in the last few years. These environments present a good opportunity for students to realise positive thoughts about coding, to learn coding while having fun, to gain experience in creating algorithms and directives, and to learn computer concepts at an early age [8].

Game based learning combined with flipped classroom and collaborative team work can utilize students' energy and enthusiasm in playing games in achieving educational goals. Flipped classroom approach can be used in encouraging the students to be active and make use of their own experiences. The game based learning is different from the traditional classrooms in terms of its objectives, which include creating a competitive environment where students are entertained, and their interests and motivation levels are elevated [9]. Flipped classroom can be defined as a class that utilizes practices and problem solving led primarily by the students [14]. Students are put in various more entertaining and creative situations, where searching for the solution of the problems they experienced during learning is the way of learning and achieving learning outcomes. This flipped classroom is a form of student-centered learning. It reduces the achievement gap among students and personalize the learning in the classroom [15]. At the same time, learning process is less depended on the teacher; teachers' role is just to facilitate the learning and lead the students in collaboration and sharing knowledge and skills.

This paper presents a methodological approach for using interactive mobile game for developing computational thinking in the classroom. The cooperative game-based learning and flipped classroom are used for introducing basic concepts of coding and problem-solving among primary school students Results about students' overall experience and achievement of learning outcomes give an insight into the possibility to use this kind of approach for developing computational thinking skills.

In the next section, the proposed methodology is elaborated in more details. The third section presents both results and discussion of the results. The last, fourth section, draws the conclusions.

2 METHODOLOGY

2.1 Description of used tool

Scottie Go! is an interactive puzzle-based mobile game for teaching coding to the young children in an interactive way. It uses similar block-based coding approach as Scratch coding environment, which is widely used in coding classes. The basic idea of this mobile game is to help a friendly alien Scottie to

get back home to the outer space. The game offers many levels, and offers opportunity to create dozens of codes.

The game is a combination of cardboard tiles (Fig. 1a), which are used by the players to create coding instructions, and a mobile application (Fig 1b) that sets tasks and scans the proposed code solutions that enable Scottie and other characters to move. The tiles are used to write instructions which will be performed by Scottie in order to complete the task. The mobile application can be downloaded on smart phones, tablets or any other computer device. After the installation on a device, the game does not require internet connection, and it can be played anytime and anywhere, even in a place where there is no IT infrastructure, e.g. school common rooms, corridors or even outside the building.

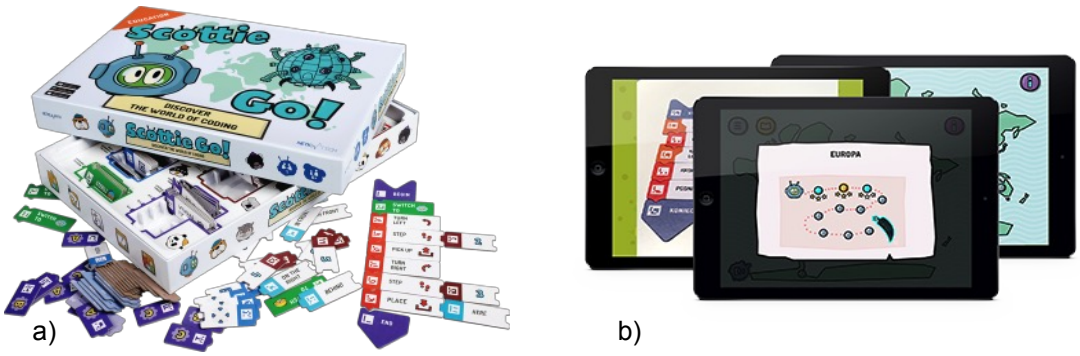

Figure 1. Scottie Go! a) box with tiles b) mobile application.

The game starts when the application assigns a task to the player. The player must analyze the task and plan the sequence of instruction that will lead Scottie Go! to the right spot, avoiding obstacles, picking up objects, etc. The coding is very similar to making the puzzle. The player "write" the code by arranging tiles in the right order on the game board. The code controls the main character's movements. With the use of the app, player scan the written code by capturing a photo or video. Once the program is scanned, Scottie will perform, on the device screen, the instructions placed on the game board, and give possibility to the player to see whether the task has been performed correctly. The application gives feedback to the player: if the command is correct, Scottie will carry out the task and go to the next level; otherwise players will be asked to rewrite the program. If the program is too long, or not efficient, players will be encouraged to optimize it (i.e. to shorten it). This is done by a gamification technique that assign stars to the created code (from one to three stars) once the code is scanned.

A unique coding interface, in the form of cardboard tiles, makes the game child-friendly and, allows children to collaborate by creating code in teams. Furthermore, children do not need to know the basics of coding to play the game. Scottie Go! gameplay improves the ability to think analytically and logically, develops algorithmic intuition, and teaches how to solve complex problems [16]. The game involves all basic concepts of coding, ranging from basic instructions, loops, conditionals to variables and functions. It can be used as a basic tool to introduce and teaching coding, or as a supplement of other tools that are used to teach coding.

2.2 Method

120 students from six different primary schools from Macedonia have used Scottie Go! as a code learning tool for two months. The main aim of the course during this period was to develop students' knowledge and skills for creating code with linear structure.

At the beginning of the course, students were introduced with the game. They have downloaded application on their mobile devices and the learning started. Students were working in groups (Fig. 2). Students had a central role in the classroom, due to their familiarity with the mobile and board games before. Their previous knowledge and skills in playing games were used in order to established a good base for further development on the subject, by learning from each other. The primary role of the teacher was just to facilitate the process, and to share the solutions of the problems noted by students. In addition, a teacher observed the learning process and lead discussions with the students.

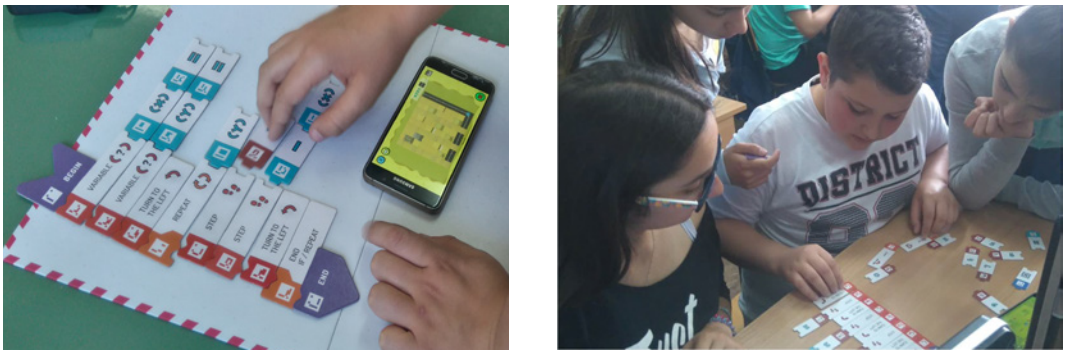

Figure 2. Learning how to code using Scottie Go!.

The game offers different levels of complexity which corresponds to different levels of students' knowledge and skills that should be acquired. Assessment of acquired knowledge and skills in the classroom was performed according to the defined criteria based on the Blooms' taxonomy [17]. According to the first level of this taxonomy - knowledge, students should only remember and recall information that they have learned (e.g. they should know that each program starts with instruction “Begin” and ends with instruction “End”). On the second level of understanding, students should be able to explain why concrete activity is performed (e.g. explain what will the following program perform). When applying knowledge, they should create their own sequences of codes (e.g. create a concrete program that is a solution of the given situation). Higher order thinking skills (analysis, synthesis and evaluation) are presented when students analyse given task, search for correct instructions, produce their own programs according to the new situations, test, are able to find and correct mistakes and reach desired solutions (e.g. analyze the given programs and decide which of them is a solution of the given situation). In accordance to this, the game starts with creating a very simple linear structure of code and each level is more complex than previous.

After coding with for two months, a survey regarding students' overall experience in using the game for development of computational skills was carried out. Information concerning students’ interest in the game, ease of use, students' quality of experience and correspondence to educational goals were obtained.

The first part of the survey was used for gathering demographic information about the participants (gender and type of school) and their experience in playing games. The second part was designed to measure students' attitudes toward using games as a tool for learning to code. Their attitudes were measured using a five-point Likert scale, with answer choices ranging from “strongly disagree” (1) to “strongly agree” (5). Attitudes toward: tool's ease to use, students' interest in the game, correspondence to educational goals, and students’ subjective attitudes for using the corresponding tool in the educational process, were investigated.

In addition to the survey, and in order to assess the possibility to use game as a tool for achieving learning outcomes concerning computational thinking, a short test was carried out with students. The test consisted of 10 multiple choice questions concerning linear structure in coding. According to the expected learning outcomes students should: know the elements of a program; create short and simple programs with linear structure; through logical thinking determine the result of created program; detect and correct errors. The test covered different levels of achieved educational goals (according to Bloom's taxonomy). The idea was to see did the students achieved the learning outcomes using the game and to measure the level of retention of students' learning with this playful approach.

3 RESULTS AND DISCUSSION

During the two months, students progress with their own pace, learning from each other, helping each other and without knowing it, taking control over their learning. Collaborative learning environment was established very naturally because in order for students to successfully play the game, they had to communicate, collaborate, and help each other. This collaborative game based approach helped in involving less interested (talented) students in achieving learning outcomes in a very natural way. Students from vulnerable categories (with less learning, social or economic abilities) were involved in the learning process, too. By playing the game students had both fun and possibility to learn from the other in the flipped classroom manner.

The survey was conducted among students in urban and rural school (with different technological equipment). There was a good distribution among participating students concerning their gender (52,07% of students were male and 47,93% were female).

More than 70% of the students play games on regular bases and even 69,17% of them do that on mobile phones or tablet. This was expected since today's students spend a lot of time on their mobile phones. This contributed to students' positive attitude towards using games in the learning process.

The results concerning students' attitudes towards: ease to use of Scottie Go!, students' interest in the game, subjective attitude toward the game, and its use in educational context are presented in Table 1.

Table 1. Students' attitudes toward using Scottie Go! as a tool for learning to code.

Item concerning students' attitudes/ N=121	Strongly agree	Agree	Neutral	Disagree	Strongly disagree	Mean
Interface of the game is easy to use	103	18	/	/	/	4,85
It was easy to learn how to play the game	109	11	1	/	/	4,89
I have fun while playing Scottie Go!	104	16	1	/	/	4,85
The game attracts my attention	102	18	1	/	/	4,83
I can play together with my friends	111	8	2	/	/	4,90
It is interesting to learn with Scottie Go!	107	14	/	/	/	4,88
It is exciting to learn on this way	99	21	1	/	/	4,81
I like this way of learning	103	14	4	/	/	4,82
I like the overall experience	100	20	1	/	/	4,82

Results showed that students think that Scottie Go! is easy for installing and has easy interface with clear instructions and requirements. This is confirmed with finding that the gameplay is easy to learn. Since the beginning of the course and the first introduction of Scottie Go!, students were excited and delighted that they are going to use mobile phones in the learning process. They like the interactivity of the game, the possibility to work in teams and to collaborate with other students.

All these lead to increased motivation and interest from the students. Almost all students (99% of them), agree of strongly agree with the facts that the game attracted their attention and that they had fun while playing the game. Students have positive attitudes regarding using Scottie Go! for learning to code. They find this way of learning very exciting for the achieving learning outcomes. The overall quality of students' experience is very high and they find learning with Scottie Go! very interesting, motivational and excited.

It is interesting that students have very high level of accordance with the statements of the survey. The fact that they can play the game together with their friends is the most appreciated characteristic of this game based approach. More than 90% of the students strongly agree with this statement. If we want to highlight the characteristic that they like at least it will be the one that it is exciting to learn by game. But there is no need for the further analysis in this direction since the results are satisfactory. Namely, only one of the students does not have his opinion about this and 17,35% agree and 81,82% of the students strongly agree with their satisfaction from game based learning.

Concerning other aspect of game integration - educational value and the possibility to achieve learning outcomes, results are presented in Table 2.

Table 2. Students' achievement of educational goals.

Educational goal complexity	Percentage of correct answers
Knowledge	100,00%
Understanding	95,83%
Applying	96,83%
Higher order thinking skills	90,28%

The results show that all students have correct answers of the questions concerning knowing facts. More than 95% of students don't have problem answering questions that need understanding of the concepts or applying of the knowledge and skills in new situation. Results from evaluation of higher order thinking skills, show that 90,28% of students using Scottie Go! have correct answers. Result are satisfactory and show that students achieve learning outcomes easily, even when the more complex situations are in front of them.

It is interesting that students have better results concerning applying the knowledge in new situation than in understanding of some coding concepts. According to the Bloom's taxonomy understanding is easier than applying the knowledge, but in our case students have better results in this higher level of cognitive knowledge. So. the question that should be discussed is whether cognitive dimension of Bloom's taxonomy is the most suitable method for assessing students' learning in computational thinking course. Experts in this area find it difficult to agree on an interpretation of the Bloom's taxonomy for computational thinking tasks [18]. For example, according to this taxonomy, creating is considered to be much more complex than understanding, but can we really say that creating a simple project – whose goal is to move a sprite from one point to another – is cognitively more complex than fully understanding the concept of concurrency? [19] One possible explanation of our results is the level of complexity of the given tasks. For getting more reliable results further research should be done.

4 CONCLUSION

The study presented in this paper shows that game based learning with the elements of flipped classroom can be used for establishing a student centered learning environment. Such learning environment is open and entertaining, students are playing games, and their interests and motivation levels for achieving educational goals are increased. The learning can take place without space and time limitation. Students take responsibility for their own learning and progress with own pace. Collaboration and learning from each other is another benefit from this game based approach. All students take active participation in the learning process, regardless their background and previous knowledge and experience.

By using this game based approach students can develop different digital competences and master basic coding concept on natural and interesting way. Students develop computational thinking skills during the play, demonstrating decomposition of the problem, logical thinking, abstraction, finding pattern, creating algorithm and evaluation of the created program. The results from the test confirmed that students were learning during the play, achieving learning outcomes and getting long-lasting knowledge.

The results from the survey and test indicate that Scottie Go! can be use as a game based learning tool for computational thinking course. This approach is a good opportunity for increasing positive attitudes about coding, and learning abstract coding concepts at an early age.

The findings presented in this paper can be used as a base for further research concerning game based learning approaches in developing students' computational thinking skills in primary schools. Using of different taxonomies as assessment method of students' learning should be further investigated taking into account specific character of computer science education.

ACKNOWLEDGEMENTS

This paper is supported by Erasmus+ project “GLAT – Games for learning algorithmic thinking”, 2017-1-HR01-KA201-035362 and partially by the Faculty of Computer Science and Engineering, Ss. Cyril and Methodius University, Skopje, Republic of Macedonia.

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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).

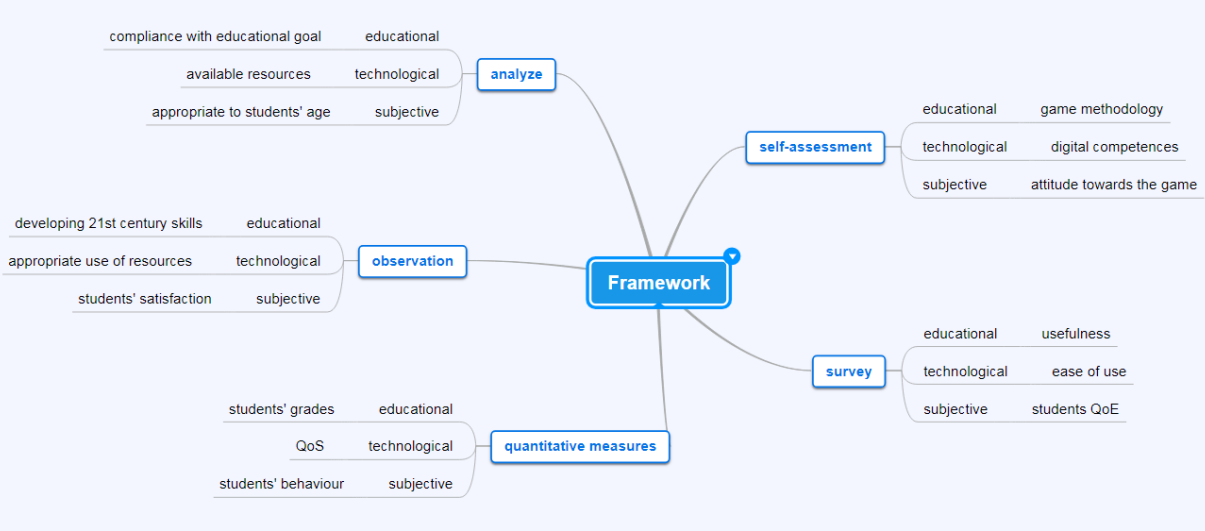

Figure 1. MEDGE evaluation framework - mind map.

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**

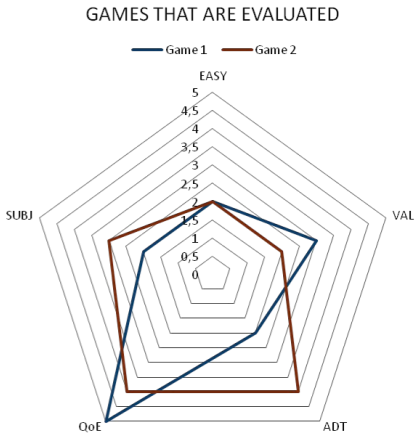

Figure 2. Example of MEDGE comparison between two games' evaluation.

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.

ACKNOWLEDGEMENTS

This paper is supported by Erasmus+ project "GLAT – Games for learning algorithmic thinking", 2017-1-HR01-KA201-035362.

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