Project Based Teaching with Digital Tools in Primary Education

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***Abstract* - The aim of the project based teaching as a form of integrated classroom teaching is to direct students to research a particular topic so that they can gain new insights through interactive learning. It implies a constructivist approach by which the process of learning is based on the student's activity, interaction, sharing previous knowledge and taking responsibility for research work. The contemporary approach to project based teaching involves the use of various digital tools in the research process. Within the GLAT project, a focus group of primary school teachers used some digital tools to carry out a project activity with their students. This paper analyses project activities and teachers' views on the use of digital tools, methods and forms of work in the preparation and implementation of project activities, as well as their students' assessments of the level of fun and learning using these tools in classroom.**

Keywords – project activities, digital tools, teachers, primary school students

I. INTRODUCTION

Project teaching is based on interesting content or a problem that requires the student to set up a research, investigate, and solve previously appointed problem. It is characterized by interaction between students and teachers, but also between students themselves who actively use their previous knowledge and skills in order to construct new knowledge with meaningful training operation. In search of the most effective ways of achieving student-centered project-based learning goals, Creitaru [3] points out that the project method is flexible and easily correlated with other didactic methods. The connection with problem-oriented teaching should be emphasized. Problem solving as a teaching method has the intention to enable students to explore, understand and evaluate the content they are learning [10]. Problem solving competency implies that the student will perceive the problem from different perspectives, practice different problem solving strategies and use different digital tools [11]. The use of technology, or digital tools, in the educational process has become indispensable in order to be able to carry out certain activities more successfully and more quickly and thus to support active learning in students. Project teaching can also be perceived as a form of Inquiry Based Learning, an active approach to learning that requests students' investigations and finding answers for assigned questions. This paper presents the results of the Erasmus+ GLAT project with the aim of involving algorithmic thinking in teaching different subjects in primary school in a fun and attractive way. One of the important activities of the project was the professional development of teachers in primary schools through different innovative teaching methods using digital tools and technology.

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II. STUDENTS' ORIENTED PROJECT TEACHING

Čudina-Obradović [4] explains the project as one of the basic forms of integrated teaching, which she defines as planning and organizing teaching in which different areas are interconnected in order to achieve a deep understanding of certain content and at the same time mastering critical and creative thinking skills. The implementation of the project particularly emphasizes the student's activity. As emphasized by Vujičić et al. [13], project teaching means the use of different methods, procedures, forms of learning and techniques and its overall aim is not only to improve teaching, but for students to work independently and learn. Project-based teaching can be motivating for students, if the teacher organizes it well and allows the student the freedom to self-organize learning. Project-based learning is important for realizing complex learning goals, so Cindrić et al. [1] emphasize that project teaching is "a well-planned, well-designed teaching designed to gain insight by exploring a particular situation through interactive learning". Interactive learning is the process of constructing knowledge.

The constructivist approach to teaching "rests on the premise that the learning process takes place on the basis of the personal construction and reconstruction of knowledge that results from students' interactions with the natural world in a particular sociocultural context, with the dynamic mediation of their prior knowledge" [8]. The project encourages teamwork and enhances the development of students' research, communication, organizational and critical skills. This form of learning encourages curiosity and learning with understanding and correction of misconceptions [5]. Barron and Darling-Hammond [1] define project learning as: central to the curriculum, organized around questions that guide students toward the central concepts or principles of a course, and focused on study that involves research and knowledge building. The student must be directed to find

information from multiple sources independently, as well as to use digital technology both as a source of information and as a means of learning through prepared digital materials. Structured and guided approaches are recommended for young learners in collaborative project learning. Song [12] also emphasizes 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". This kind of instructional design first involves students in an independent activity of finding solutions based on prior knowledge, which often leads to failure to solve problems. However, students will also use this information later to identify and gain new knowledge after the teacher helps them deal with misconceptions. Such approach can be useful for young learners to foster their active learning process. Furthermore, collaboration as a form of teaching is another important factor in project teaching in younger students, as different critical thinking and individual differences in prior knowledge can encourage better achievement [10].

III. THE GLAT PROJECT

The Erasmus+ project GLAT - Games for Learning Algorithmic Thinking, which ended in October 2019, included, as one of the goals, the professional development of primary school teachers with various innovative teaching methods using digital tools and technology. Primary school teachers were participating in the education through three workshops and the online part with the Moodle based e-learning system. After each workshop, teachers-education participants created learning scenarios according to the current national curriculum, using teaching methods and digital tools that were pointed out in the workshop. Subsequently, teachers applied such learning scenario in classroom with their students. A scenario consists of a subject and lesson, level of complexity, key concepts, learning outcomes and all activities description supplemented by teacher and student materials and resources [6], [9].

The second and the third workshop included Project-based teaching activities with digital tools. The topic of the second workshop, held on August 2018, was Problem Based Learning (PBL), online quizzes and logical tasks. As the name of the workshop points out, the focus was on examples of learning scenarios and supporting materials for the implementation of problem based activities and logical tasks. The topic of the third workshop, held on January 2019, was Games and Tools for Programming. The emphasis was on the learning scenarios that will include educational games and algorithmic thinking for the implementation of inquiry based learning activities for different school subjects.

When explaining a problem as algorithm, it is broken down in smaller parts that can be more familiar and thus solved using a set of rules (algorithms). Abstractions can be also used to generalize those solutions to similar problems [14]. For example, in early grades, teachers can explain the algorithm by highlighting the steps involved in solving any problem. Algorithmic thinking can be developed through any school subject with the appropriate teaching methods, with or without technology. For example students can play educational digital games to learn some new concepts as well as board games without technology. Younger students can understand and use the concept of the algorithm by writing a sequence of commands that solve a particular everyday situation they encounter (such as preparing breakfast, preparing for school, the way from home to school, etc.). In project teaching that includes problem solving and group work in lower grades, different tasks without technology can be assigned to individual groups: one group can design a gymnastic exercise and present it with pictures, while the other group than perform the exercise according to the presented algorithm. Any learning situation can be improved by incorporating such methods into the appropriate learning scenario from the first grade of primary school, and this can only be carried out by teachers who are qualified. [9].

A. Learning scenarios for Project Based Learning

A learning scenario is a document by which teachers plan or structure a learning situation. It can be made for one or more teaching units. It should have a strong connection with other subjects, that is, thoughtful activities that will emphasize and stimulate connection with other subjects. For example, one of the scenarios, created at the second workshop, aimed to understand the importance and value of cultural landmarks in the coastal area. The activities were designed in such a way that teacher created a quiz and a memory game on a computer /tablet for the introductory part of the lesson, to help students memorize key terms and define a problem question for group work. Through project-based learning and group work on a computer, students will explore cultural landmarks, present the gathered information, and replicate the learning unit by solving an interactive computer worksheet. The applications used for carrying out online quizzes and logical tasks were Kahoot! quiz, Match the Memory game, Wizer.me and LearningApps interactive worksheets [10].

The other example is one of the scenarios developed on the third workshop for the first grade students. The goal was to recognize and distinguish the characteristics of the seasons, specific to our climate. Project assignment included group work with the specific part of a project assignment (season). The specificities of the seasons and their seasonal fruits were explored partly at school, with the supervision of the teacher, and mostly at home with the supervision of the family members. Each group makes their own poster with the theme of the given season and present it. For remembering specifics of each season students design a storyboard for a digital story that includes a game: design a scene, main character, define the moves of the main character, what he/she is doing, saying, determine the ultimate goal of the game, describe the main character's tasks, define the way the points are collected in the game and determine when the game is over. Besides the learning scenario, the teachers, in collaboration with the students, created a "Game/story scenario" (Figure 1.) according to which the game in Scratch was programmed. Since the lower grades elementary school students who had not encountered

programming so far were involved in the design of the game/story, the program was created according to their instructions by the students of Informatics from University of Rijeka.

Games for Learning Algorithmic Thinking

Game/story scenario

Title of the game	Seasons
Type *(Scratch or micro:bit)*	Scratch story with game elements
Course/Grade	Science: Seasons / Health - 1st grade
Learning outcomes	Learning outcomes focused on general subjects • Recognize the seasonal fruits of particular seasons • Associate appropriate clothes with specific seasons Learning outcomes focused on algorithmic thinking • Search, find, and extract relevant information
Goal of the game	Dress the main character in season-appropriate clothing to eventually harvest the fruits characteristic of that season.
Characters and their role	Mia – the main character Family (mom, dad, 2 sisters, 1 brother) - supporting characters
Description of the game flow	The main character introduces the player into the story. Little girl Mia comes from Africa to Croatia in search of a better life. The goal is to teach Mia all about the seasons specific to the Croatian climate. For each season, it is necessary to first dress appropriately Mia, which is also a condition for continuing the game. Successful dressing is followed by the second part of the game, in which fruits specific to a particular season are collected. In that way the main character goes through all four seasons. By collecting the correct fruit, the player wins 1 point, while by making the wrong choice, he loses 1 point. Accordingly, by collecting seasonal fruits in all seasons, the player can collect a total of 36 points, out of which a minimum of 20 points is required for successful completion of the game.
List of scenes/backgrounds	1. Park - an introduction to the game 2. Africa 3. Summer - Dubrovnik, beach, sea 4. Laundry rope - choose summer clothes 5. Sailboat 6. Summer - beach - selection of summer fruits 7. Tree (displaying 4 seasons) - entry of the season following the summer 8. Autumn – forest 9. Laundry rope - choose autumn clothes 10. Autumn - forest - selection of autumn fruits 11. Tree (displaying 4 seasons) - entry of the season following the autumn 12. Winter - mountains, snow, cottage 13. Laundry rope - choose winter clothes 14. Winter – selection of winter fruits 15. Tree (displaying 4 seasons) - entry of the season following the winter 16. Spring – Meadow 17. Laundry rope - choose spring clothes 18. Spring – selection of spring fruits 19. Promenade - end, display of points won, arrival of Mia's family
Logical mini-games within the story *(Note: select games that are aligned with your learning outcomes)*	Recognizing the characteristics of the seasons. The first part of the game for each season: Choosing the right clothes for the main character according to the current season. Condition to continue the game - collecting points. Minimum required for each season: • Summer: 4 points • Autumn: 3 points • Winter: 4 points • Spring: 3 points The second part of the game for each season: Collecting fruits specific for specified season. By collecting fruits, a maximum of 9 points can be collected in each season.
End of the game	If all four levels are successfully played and the minimum number of points (20 points) is collected, we get to know the whole family of the main character. If the player does not collect enough points, Mia instructs him/her to repeat the game from the beginning.

Figure 1. Example of Game/story scenario developed by the teacher participant at GLAT education

IV. TEACHERS' AND STUDENTS' ATTITUDES ON THE USE OF DIGITAL TOOLS IN PROJECT TEACHING

The activities designed by the teachers who participated in the GLAT project were evaluated by examining the attitudes of their students and through the insight of their impressions of the performed activities. The evaluation in whole is presented in document "GLAT Project Dissemination" [6] of project web site. This paper describes only the part considering teachers' and students' attitudes on the project based teaching.

Assessment of the effectiveness of teacher education in the GLAT project was conducted using the initial and final questionnaires. A total of 27 teachers (only one male teacher) participated in the evaluation study. The main objective of the initial questionnaire was to identify the extent to which teachers are familiar with the terminology, methods and tools relevant to the use of ICT in teaching. In the final questionnaire, teachers indicated changes in relation to the same questions in the initial questionnaire.

The questionnaires consisted of four parts. For the purposes of this paper, the results of second part: "Familiarity with the possibilities of adapting, creating and using methods, contents and tools" consisting of six questions, were analyzed. Teachers expressed their progress in answering a series of the same six questions in the initial and final questionnaires for their ability to create teaching materials and apply various digital tools and teaching principles related to the GLAT project. Progress is evident by comparing the Likert-type responses in both questionnaires. Teachers reported progress in response format from 0 = "not at all" to 4 = "to a great extent".

Figure 2 shows the results regarding initial knowledge of the possibilities for adapting, creating and using digital teaching content and self-assessment of progress in the final questionnaire for the same terms. Three questions were identified relevant to the topic of this paper. It can be seen that the highest indicator of progress is related precisely to the area in which the participants showed a relatively high score in the initial questionnaire: creating online quizzes and logical tasks. However, it is more important to highlight an item with a relatively lower initial score that has a relatively high self-assessment of progress, such as "creating digital content using Web 2.0." Generalizing the progress from the initial situation, it can be said that the capability of the "digital teaching content creation" has doubled.

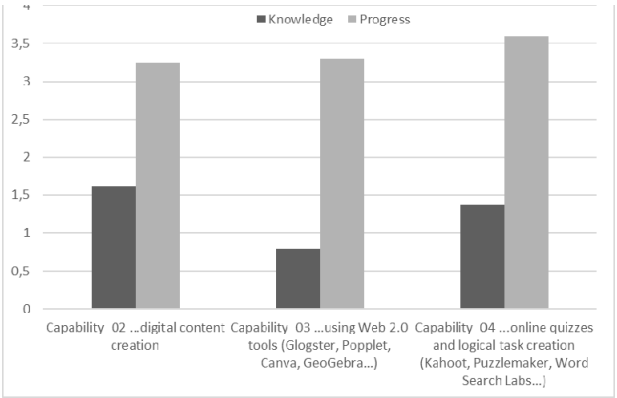

Figure 2. Comparison for initial status and progress in capabilities

To analyze the success of the implementation of GLAT activities with students, a questionnaire was designed for students in 3rd and 4th grades. Students evaluated the level of interest and the level of fun using digital learning tools. The questionnaire consisted of 5 statements about all the tools used in the class that

students evaluated with a 5-point Likert scale in which 1 indicated "I didn't have fun at all" and 5 indicated "I had a lot of fun". The respondents' sample consisted of 114 3rd and 4th grade students from six primary schools, of which 55.26% (N = 63) were girls and 44.74% (N = 51) were boys.

The Table I shows that Kahoot! is the best rated tool by level of entertainment, followed by Scratch. The tool with the lowest rating is LearningApps.

TABLE I. EVALUATION OF THE LEVEL OF ENTERTAINMENT WITH THE DIGITAL TOOLS

Tool	Match the Memory	Kahoot!	Wizer.me	Learning Apps	Scratch
N	111	113	114	98	114
Min	0	0	0	0	0
Max	5	5	5	5	5
Mean	3,26	4,67	2,86	1,97	4,3
Std. Dev.	1,818	0,881	1,886	1,976	1,212

A T-test was conducted to assess whether gender or age influences the level of entertainment in using digital tools. The results showed that there were no statistically significant differences between male and female respondents in assessing the level of entertainment with individual digital tools. A statistically significant difference in the estimate of the level of entertainment by gender (F = 8,885, p 0.023) was observed only with the Scratch tool, where the female examinees rated the Scratch tools higher (M = 4.54) than the male respondents (M = 4.00).

TABLE II. EVALUATION OF 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	0,386
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 analysis of the level of entertainment of computer tools in relation to the class that students attend shows that 3rd grade students statistically significantly rated the Match the Memory and Wizer.me tools from 4th grade students, while the results for Kahoot! quiz were opposite (Table II). When choosing the tool they learned the most from, students mostly specified Kahoot! quiz (73.42%), while tools LearningApps and Match Memory have the lowest rating of 1.26%.

V. CONLUSION

Today, more attention is being paid to modernize the teaching process with digital technology. As technology has become one of the most important didactic tools in all school subjects, their use is no longer restricted to Computer science teachers. Timely with the help of digital tools is possible to carry out new, more interesting activities that enhance the educational process and enable active learning for students who achieve better results. However, teachers will be able to lead effective teaching with technology once they have been sufficiently educated to apply it [10]. Therefore, the training of teachers in this regard is very important. On the other hand, it is very important to modify the educational process to the needs and interests of students. In order to do this, it is important to examine the interests and opinions of students with a purpose of improving the quality of educational practice. Certainly, further research on this topic will bring in results that will make contributions to changes and innovations in teaching practice.

With the GLAT project we tried to encourage teachers to apply contemporary methods and teaching strategies together with digital tools and to implement problem-solving skills, logic and creativity into the daily learning. Project based teaching method can contribute to the development of creativity and logical thinking in young students which may consequently enable them to carry out what they have learned in new situations.

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