CODING4GIRLS VALIDATION REPORT

Elaborated by

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Disclaimer

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SUMMARY

This document presents the results of the validation of the Coding4Girls (C4G) methodology and results and it is the final stage of the process as defined by the Validation Guidelines document.

In general, the validation process followed the established procedures, integrating multiple quantitative and qualitative data collections tools (interviews, surveys, observation, etc.) and involving different participants like teachers, students and external experts, with staff from the project members acting as observers. This allowed to have a holistic view of the whole process and answer criteria like the accomplishment of learning objectives, the analysis of materials and support tools, the interaction between teacher and student, student-student, student-materials and tools, the student's attitude, satisfaction, achievement, persistence, etc. As such, the validation process allowed to trace a detailed picture of the advantages and disadvantages of the C4G methodology and results and, therefore, contribute to improve the designed curriculum and the provided contents and tools.

As a general conclusion from the validation results, it is possible to consider that all the objectives of the process were achieved with success with a great involvement of students and teachers in spite of the COVID 19 pandemic that restricted many events to an online form. The C4G flexible and modular methodology was able to cope with those requirements and, as a result, teachers and students now have available a set of contents and tools for developing coding abilities. And, although primarily meant to foster girls' interest in coding and computer science, the validation showed that the methodology is equally effective for boys.

VALIDATION METHODOLOGY

In CODING4GIRLS the validation activities aim to ensure that the proposed pedagogical framework meets the needs of the identified target groups in terms of relevance, acceptance, usability, and effectiveness. These needs were originally translated in the following educational objectives:

- **Ob1.** To prepare young learners to enter computer science careers by building programming skills;
- **Ob2.** To enable learners to apply the newly developed programming knowledge in wider learning contexts;
- **Ob3.** To build transversal competencies related to programming, such as analytical and critical thinking;
- **Ob4.** To foster positive attitudes towards computer science among girls and boys with the objective of promoting the uptake of related educational and career paths;
- **Ob5.** To raise awareness on the links between ICT and the real-world through learning scenarios that demonstrate how ICT solutions can enhance quality of life and address common needs;
- **Ob6.** To empower learners to think entrepreneurially for introducing solutions to real-world problems through design thinking mind sets.

The educational objectives address the challenges faced by learners leading them to not choose careers in computer science, namely preparedness in terms of skills and perceptions in relation to the benefits and suitability of computer science careers for all, including girls and boys. More specifically:

1. Objectives (1) and (2) are directly related to employability of learners through the development at school age of competencies related to work thus address ET2020[1] objectives and the objectives of the New Skills for New Jobs initiative[2];

[1] https://ec.europa.eu/education/policies/european-policy-cooperation/et2020-framework_en
[2] https://ec.europa.eu/social/BlobServlet?docId=4508&langId=en

2. Objective (3) is directly linked to PISA[3] and ET2020 objectives in relation to building transversal competencies that help learners excel in academics and at work independently of subject area;
3. Objectives (4), (5), and (6) promote links between education, research, and the real world and address the New Skills for New Jobs initiative objectives which highlights the gap between available skills sets to those in demand by industry and points to the need to exploit all talented human capital, including girls and boys, in innovation related careers that are expected to drive sustainable economic growth in the coming years and, as a result, employability and social cohesion.

Procedure

The assessment of the accomplishment of these high-level objectives was done through an on-going internal and external validation that engaged representatives of project stakeholders throughout the implementation period. The proposed CODING4GIRLS evaluation methodology was based on a descriptive case study research[4], taking place at three levels:

1. Internally, engaging project partners;
2. Externally, engaging external groups of users that are representative of stakeholders, and specifically learners and teachers;
3. Through external experts who provided a professional opinion on the completion, quality, and effectiveness of project outputs.

Specific indicators in terms of effectiveness, quality, and completion included:

(i) the accomplishment of learning objectives by the students;

(ii) the perception of end users, namely learners and teachers, on the relevance and effectiveness of game-based learning for building programming skills;

(iii) the perception of end users, namely learners and teachers, on the relevance and effectiveness of the specific CODING4GIRLS learning approach;

[3] http://www.oecd.org/pisa/
[4] Yin, R., Case Study Research: Design and Methods, 2nd Edition, Sage Publications, 1994

(iv) the acceptance of the proposed methodologies by teachers;

(v) the perception of teachers on the relevance and effectiveness of instructional process support tools;

(vi) the perception of usability and acceptance of the proof-of-concept serious game approach in connection with the wider CODING4GIRLS game-based, design thinking educational framework.

Due to the COVID-19 pandemic, the validation process was extended in time and finally took place along the following tasks and timeline:

1. **O2/A4 - Evaluation through groups of learners and teachers (M13-M28)**
2. **O2/A5 - Evaluation through external experts (M13-M28)**

O2/A4 - Evaluation through groups of learners and teachers

Each partner was responsible for engaging user groups (learners and teachers) through learning activities built upon the CODING4GIRLS methodologies and tools. Each local/national implementation was scheduled by each partner according to the local conditions, particularly in relation to the COVID 19 pandemic.

In most countries, this task started with a training workshop for teachers presenting the C4G project, the proposed learning methodology and tools so that t hey were comfortable with the C4G approach and GBL in general. In several countries future teachers of informatics (students of master's degree programmes) were included in the implementation activities as well.

The format and duration of each local/national implementation was established by the responsible project partner (details are described in national reports) as there were differences namely in terms of availability of the target group, of the local conditions (for instance, it may be implemented in the scope of a school's curricular activities or as a free standalone course), situation with the COVID 19 pandemic, etc.

In terms of validation, a set of procedures and tools was established:

- Before the implementation students answered a preliminary questionnaire where their profile is identified.
- During the implementation sessions, teachers:

  - Used observational assessment methods and document the reaction of learners and their progress in building coding skills
  - Documented their findings in short texts
- After the implementation, in the last session, students answered the follow-up questionnaire with their perception and views on the C4G learning approach. Teachers then collected the students' verbal qualitative opinions and comments through a group interview and transcribed their opinions.
- Teachers also reported back their own views related to:
  - Their perception on the accomplishment of learning objectives by the students;
  - Their perception on the relevance and effectiveness of game-based learning for building programming skills and of the specific CODING4GIRLS learning approach;
  - Their acceptance of the proposed methodologies;
  - Their perception on the achieved fun by the students;
  - The overall organization of the implementation;
  - Their perception on the usability and acceptance of the proof-of-concept serious game approach in connection with the wider CODING4GIRLS game-based, design thinking educational framework.

The following tools (annexed) were available:

- S1_Preliminary_questionnaire_for_students
- S2_Follow-up_questionnaire_for_students
- S3_Students_comments
- T1_Teachers_observations
- T2_Teachers_comments

O2/A5 - Evaluation through external experts

Validation through external experts was pursued in the area of learning design aiming to further improve project outputs and to ensure that they met the needs of learners and teachers. Each partner identified 1 or 2 external experts (university professors related to teacher training, education, computer science, etc. Researchers in the field, teachers with experience in teaching coding to this target group, etc.), met with them and provided them with the C4G methodology, content and tools. They were able to test these materials and when possible, they were asked to follow the implementation with the teachers and students. In the end, their qualitative opinions and comments were collected verbally through a structured interview. Their opinions covered…:

a. The overall organization of the implementation
b. Their perception on the accomplishment of learning objectives by the students;
c. Their perception on the relevance and effectiveness of game-based learning for building programming skills and of the specific CODING4GIRLS learning approach;
d. Their perception on the acceptance of the proposed methodologies by teachers;
e. Their perception on the usability and acceptance of the proof-of-concept serious game approach in connection with the wider CODING4GIRLS game-based, design thinking educational framework.

A tool (annexed) was available to complete these reports:

- E_Experts_comments

National Reports

National report was provided by each partner presenting the format and duration of local/national implementation activities and results. National reports include the following sections:

- EXECUTIVE SUMMARY with a brief overview of the implementation and the main results
- IMPLEMENTATION with a description of the used methodology (how many teachers involved, how many students, how many sessions and when, concepts approached, exercises, etc.).
- RESULTS from all the data collection tools, namely teachers' observation, teachers' comments, students' comments, experts' comments, students' questionnaires

- DISCUSSION AND CONCLUSIONS with an analysis of the achieved results namely in terms of improvements to be included in the next versions of the C4G methodology

All national reports are included in this document as annexes. Based on the national reports and respective data, a global report (this document) that presents the summarized results was produced.

Participants

The project team members from partner institutions were actively involved in the implementation and validation activities. They are all researchers in the field of game-based learning, programming, didactics of informatics, and e-learning.

Direct participant of the implementation and validation activities were teachers of informatics and future teachers (N_T=225) from primary and secondary schools in partner countries and their students (N_s=1236) aged from 10 to 15 years. External experts (N_E=37) from partner countries were also included to validate the approach based on their expertise. Table 1 shows number of students – participants of the study by age. As shown in Figure 1, the most students were 12 years old. Depending on the country, these students are from 6th or 7th grade of primary school or from 1st grade of secondary school.

Table 1 - Number of students by age

Years of age	Number of students
10	35
11	256
12	347
13	264
14	327
15	7
Total	**1236**

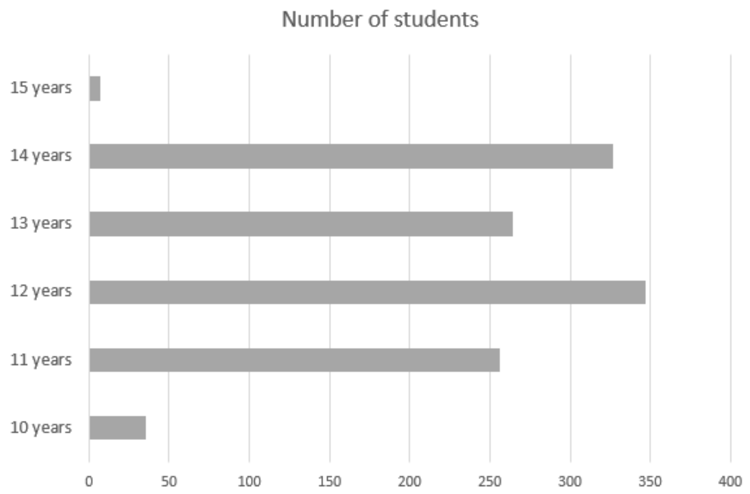

Figure 1 – Number of students by age

RESULTS

Results of questionnaires for students

Two questionnaires for students were used: preliminary questionnaire about the use of digital devices and perceived level of programming and the follow-up questionnaire about satisfaction with programming and coding activities, satisfaction with the organization of the implementation, and perception on the acquired coding skills.

In both questionnaires students were asked to self-assess their current level of programming skill. Based on this question, the difference between students' self-assessed initial and final level of programming skill was calculated (the answers from the questionnaires were paired based on the code that students have entered).

A total of 862 students (70% of students who participated in C4G activities) solved the preliminary questionnaire. A total of 709 students (57%) solved the follow-up questionnaire. Self-assessment results were compared only for students who solved both questionnaires - 633 students (51%).

S1 - Preliminary questionnaire

A total of 862 students solved the preliminary questionnaire about the use of digital devices and perceived level of programming. The mean age of students was 12.5 years (SD=1,106). Table 15 shows number of students who solved S1 by gender and grade. Figure 2 shows the distribution of number students by gender and age who solved S1 (44% of boys and 56% of girls).

Table 2 - Number of students who solved S1 - Preliminary questionnaire by gender and grade

Years of age	**10**	**11**	**12**	**13**	**14**	**15**	**Total**
Boys	8	77	119	89	85	0	378
Girls	1	98	142	123	114	6	484
Total	**9**	**175**	**261**	**212**	**199**	**6**	**862**
Response rate	26%	68%	75%	80%	61%	86%	70%

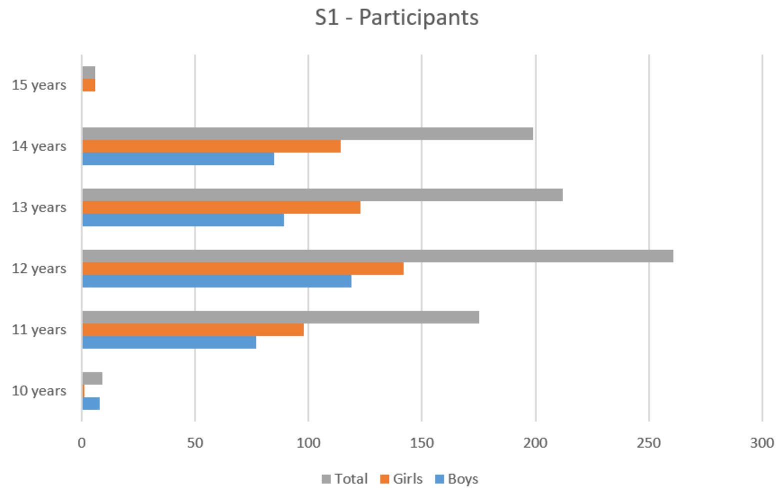

Figure 2 - Distribution of students who solved S1 - Preliminary questionnaire by gender and age

Table 3 shows descriptive statistical analysis of participants' responses to the questions related to the use of digital devices, the internet and video-games. It is worth noting the values of the standard deviation, which for some questions indicates larger deviances from the average values. The comparison of the overall average results by gender (Figure 3) shows that, on a weekly basis, boys use digital devices and the Internet more and spend significantly more time playing games.

Table 3 - The use of digital devices, the internet and video-games by gender

Question		**N**	**Min**	**Max**	**Mean**	**SD**
1. For how long have you been using computers, tablets or other digital devices (in years)?	Boys	378	1	12	6.00	2.11
	Girls	484	0	14	5.25	2.03
	Total	**862**	**0**	**14**	**5.58**	**2.10**
2. How many hours per week do you use a computer, tablet or other digital device?	Boys	378	0.5	168	18.33	19.48
	Girls	479	0	190	16.76	21.01
	Total	**857**	**0**	**190**	**17.45**	**20.35**
3. How many hours per week do you use the Internet?	Boys	376	0	140	19.02	20.52
	Girls	476	0	168	16.88	19.86
	Total	**852**	**0**	**168**	**17.80**	**20.16**
4. How many hours per week do you play video games?	Boys	376	0	84	10.82	11.95
	Girls	481	0	70	3.23	6.05
	Total	**857**	**0**	**84**	**6.56**	**9.86**

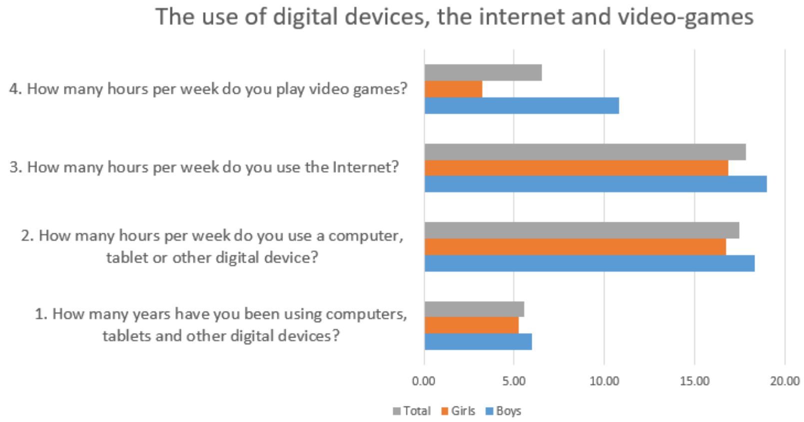

Figure 3 - The use of digital devices, the internet and video-games – comparison by gender

The average values show that students spend a little more time on the Internet than using digital devices. It can be assumed that such numbers are results of misconceptions. For example, some students may think that using their smartphone to access the Internet does not count.

The participants (N=859, 375 boys, 484 girls) self-assessed the level of their programming skills on the scale from *0 - I have never coded or programmed before* to *4 - I can design a solution of a problem in the form of a program*. Results are shown in the Table 4. Most of the students stated for themselves that they are at level *1 - novice programmers* (28.41%) or on level *2 – can code simple programs* (35.51%). If we compare these results by gender (Figure 4), it can be seen that the boys prevail among the students that self-assess their level of programming with the levels 3 and 4.

Table 4 - Self-assessment of programming skills by gender

Level of programming skills	**Boys**	**Girls**	**Total**
0 - I have never coded or programmed before	13.33%	21.49%	**17.93%**
1 - I am a novice programmer (just have basic ideas)	29.07%	27.89%	**28.41%**
2 - I can code simple programs	33.87%	36.78%	**35.51%**
3 - I am fluent in programming (can create a full program)	19.20%	11.16%	**14.67%**
4 - I can design a solution of a problem in the form of a program	4.53%	2.69%	**3.49%**

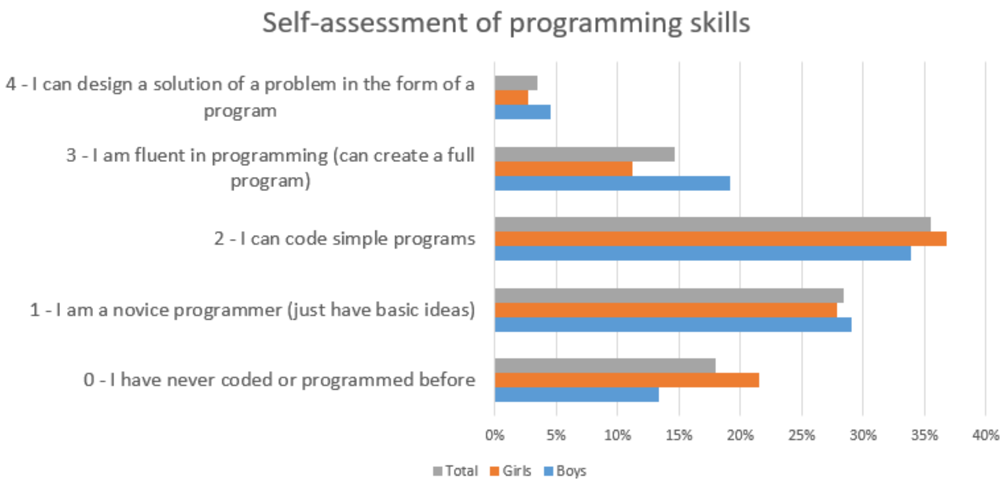

Figure 4 - Self-assessment of programming skills – comparison by gender

In the preliminary questionnaire the participants also stated which programming concepts are they familiar with. The results (Table 5) show that students are mostly familiar with the *statements* (53.94%), *variables* (47.80%) and *loops* (46.40%) while they are the least familiar with the *operators* (11.72%) and *parallelism* (3.25%). According to the results, boys are in a certain percentage more familiar with all the concepts except *parallelism* (Figure 5). The largest difference in percentages can be observed for the concept *operators*.

Table 5 - Familiarity with the programming concepts

Concept	**Boys**	**Girls**	**Total**
Loops	50.79%	42.98%	**46.40%**
Conditionals	40.21%	33.68%	**36.54%**
Variables	50.53%	45.66%	**47.80%**
Statements (sounds, movement, looks, drawing)	57.14%	51.45%	**53.94%**
Operators	13.76%	10.12%	**11.72%**
Events	34.66%	28.10%	**30.97%**
Parallelism	3.17%	3.31%	**3.25%**

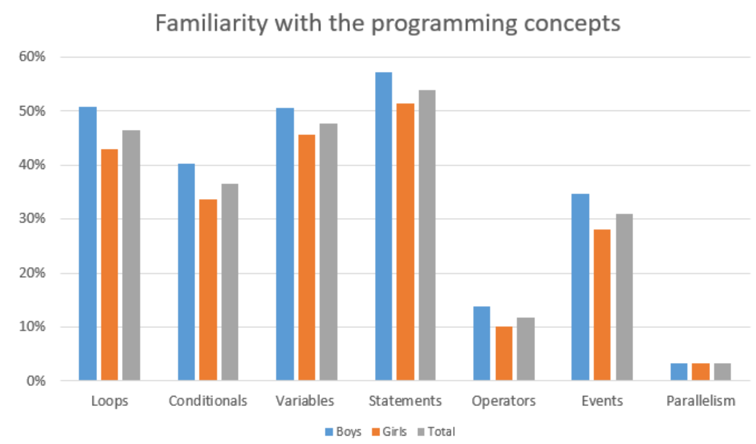

Figure 5 - Familiarity with the programming concepts – comparison by gender

Table 6 shows students' responses about what motivates them to learn to program (students could choose one or more responses). The most of the students are motivated by a success in the programming class (49.88%). Comparison by gender (Figure 6) shows that this factor motivates girls (54.87%) to a greater extent than boys (43.65%). Also, remarkably more boys want to follow career in programming.

Table 6 - Motivation for learning programming

Response	**Boys**	**Girls**	**Total**
I'm not motivated	15.34%	13.56%	**14.35%**
I want to succeed in the programming class	43.65%	54.87%	**49.88%**
I want to show other students I can program	15.61%	16.74%	**16.24%**
I want to follow a career in programming.	21.69%	6.36%	**13.18%**
I enjoy solving logic problems and puzzles	26.19%	21.40%	**23.53%**

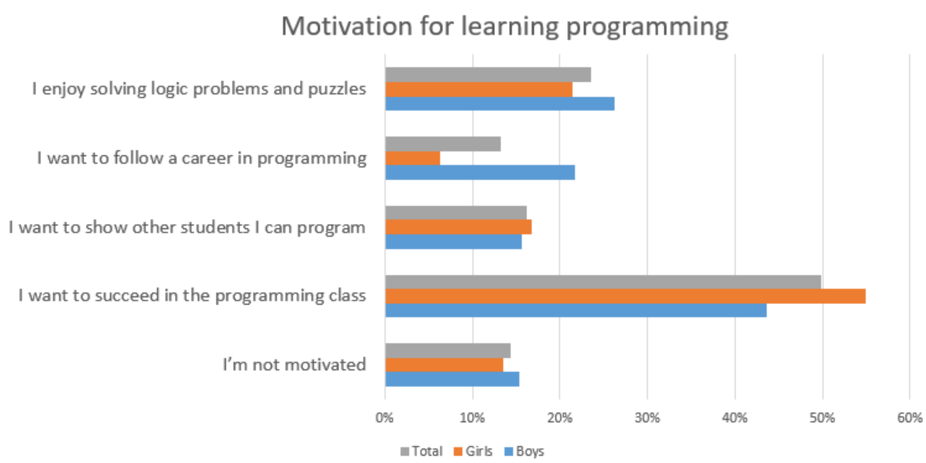

Figure 6 - Motivation for learning programming – Comparison by gender

Besides choosing among the offered responses, students had the opportunity to write everything else that motivates them to learn to program. Among the answers, they stated: *"It's fun"*, *"I'm interested in making programs or games"*, *"I want to learn how to make my own game"*, *"I want to learn something new"*, *"I want to acquire new skills"*, *"I want to see if this profession is right for me."*, *"I'm motivated by my uncle who also programs"*, *"I'm motivated by my father."*.

S2 – Follow-up questionnaire

A total of 710 students solved the follow-up questionnaire about satisfaction with programming and coding activities, satisfaction with the organization of the implementation, and perception on the acquired coding skills. The mean age of students was 12.48 years (SD=1.15). Table 7 shows number of students who solved S2 by gender and age. Figure 7 shows distribution of students who solved S2 - Follow-up questionnaire by gender and age (45% of boys and 55% of girls).

Table 7 - Number of students who solved S2 - Follow-up questionnaire by gender and age

Years of age	**10**	**11**	**12**	**13**	**14**	**15**	**Total**
Boys	7	80	95	62	73	0	317
Girls	1	88	99	102	97	6	393
Total	**8**	**168**	**194**	**164**	**170**	**6**	**710**
Response rate	23%	66%	56%	62%	52%	86%	57%

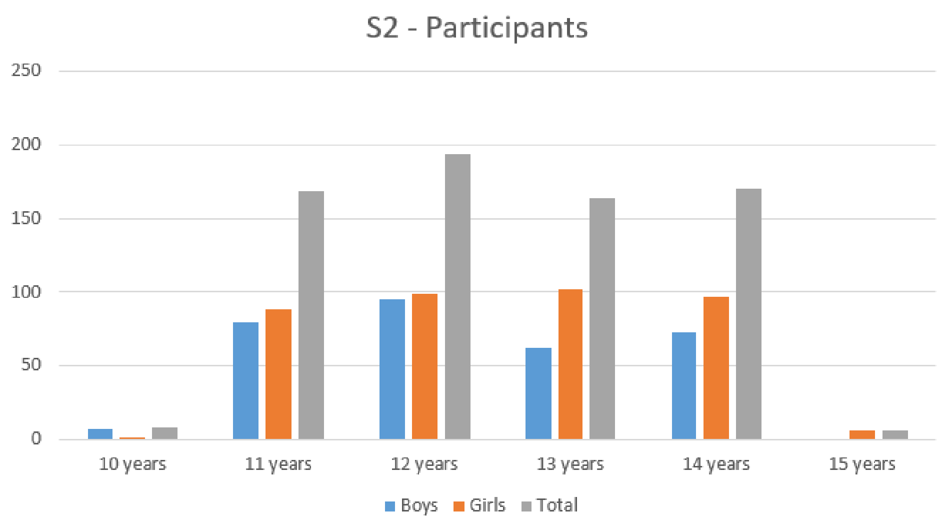

Figure 7 - Distribution of students who solved S2 - Follow-up questionnaire by gender and age

In the follow-up questionnaire, students expressed their attitudes regarding the C4G learning methodology and the implementation of activities using the 5-point Likert scale (1 – strongly disagree, 2 – disagree, 3 – neutral, 4 – agree, 5 – strongly agree). According to the results (Table 8), both boys and girls felt engaged with this way of learning and think that conducted activities were relevant for learning programming. They understood presented concepts and had fun during conducted activities and think that things they have learned will be relevant for their future. I their opinion programming is not easy. However, they found C4G activities relevant to learn programming.

Table 8 – Satisfaction with C4G learning methodology

Statement		1	2	3	4	5	AVG	SD
1. I found programming challenging.	Boys	8.52%	22.40%	27.44%	31.86%	9.78%	3.11	1.12
	Girls	4.58%	21.12%	31.04%	34.61%	8.65%	3.11	1.02
	Total	**6.35%**	**21.72%**	**29.48%**	**33.43%**	**9.03%**	**3.17**	**1.07**
2. I found programming motivating.	Boys	3.47%	7.89%	15.77%	51.74%	21.14%	3.72	1.02
	Girls	3.31%	9.92%	20.36%	51.15%	15.27%	3.73	0.95
	Total	**3.39%**	**9.03%**	**18.34%**	**51.34%**	**17.91%**	**3.69**	**0.98**
3. I found programming easy.	Boys	9.46%	24.92%	29.34%	27.44%	8.83%	2.93	1.13
	Girls	8.14%	24.94%	35.11%	26.97%	4.83%	2.93	1.02
	Total	**8.74%**	**24.96%**	**32.58%**	**27.08%**	**6.63%**	**2.96**	**1.07**
4. I enjoyed programming.	Boys	3.15%	6.31%	15.77%	36.28%	38.49%	3.93	1.05
	Girls	3.05%	7.12%	17.56%	47.84%	24.43%	3.94	0.98
	Total	**3.10%**	**6.77%**	**16.78%**	**42.74%**	**30.61%**	**3.89**	**1.01**
5. I understood most of programming concepts.	Boys	3.47%	8.52%	12.93%	50.79%	24.29%	3.79	1.01
	Girls	3.82%	10.18%	20.87%	44.53%	20.61%	3.78	1.03
	Total	**3.67%**	**9.45%**	**17.35%**	**47.25%**	**22.28%**	**3.74**	**1.02**
6. Learning this way is fun.	Boys	4.10%	6.31%	11.99%	42.90%	34.70%	3.95	1.06
	Girls	2.80%	5.85%	16.54%	41.48%	33.33%	3.96	0.99
	Total	**3.39%**	**6.06%**	**14.53%**	**42.17%**	**33.85%**	**3.96**	**1.02**
7. I felt engaged with this way of learning.	Boys	2.52%	6.62%	8.20%	41.32%	41.32%	4.12	0.99
	Girls	2.29%	4.58%	11.20%	42.24%	39.69%	4.13	0.95
	Total	**2.40%**	**5.50%**	**9.87%**	**41.75%**	**40.48%**	**4.12**	**0.97**
8. The activities were relevant to learn.	Boys	1.26%	3.79%	9.78%	43.22%	41.96%	4.19	0.88
	Girls	1.53%	2.80%	12.72%	49.87%	33.08%	4.20	0.83
	Total	**1.41%**	**3.24%**	**11.42%**	**46.83%**	**37.09%**	**4.14**	**0.85**
9. At any time, it was clear what I had to do.	Boys	2.52%	10.41%	21.14%	42.27%	23.66%	3.70	1.05
	Girls	2.80%	11.20%	34.10%	38.17%	13.74%	3.71	0.94
	Total	**2.68%**	**10.86%**	**28.21%**	**40.06%**	**18.19%**	**3.60**	**1.00**
10. What I learned will be relevant for my future.	Boys	2.21%	4.10%	16.40%	39.43%	37.85%	4.02	0.96
	Girls	3.56%	6.36%	22.39%	41.98%	25.70%	4.02	1.02
	Total	**2.96%**	**5.36%**	**19.75%**	**40.76%**	**31.17%**	**3.90**	**1.00**

In the follow-up questionnaire, students (N=226, 31% of boys and 61% of girls) expressed their attitudes regarding the usability of the C4G 3D game environment and game experience using the 5-point Likert scale (1 – strongly disagree, 2 – disagree, 3 – neutral, 4 – agree, 5 – strongly agree).

Regarding the usability of the game environment, the results show (Table 9) that students, both boys and girls, would like to use the game frequently and that they felt very confident using the game. Student found the game easy to use but with support of a technical person.

Table 9 – Satisfaction with the usability of the C4G 3D game environment

Statement		1	2	3	4	5	AVG	SD
1. I would like to use this game frequently.	Boys	2.82%	8.45%	9.86%	50.70%	28.17%	3.93	0.99
	Girls	4.52%	6.45%	25.81%	36.77%	26.45%	3.80	1.04
	Total	**3.98%**	**7.08%**	**20.80%**	**41.15%**	**26.99%**	**3.93**	**0.99**
2. I found the game complex.	Boys	7.04%	46.48%	22.54%	15.49%	8.45%	2.72	1.08
	Girls	7.10%	37.42%	21.94%	31.61%	1.94%	2.80	1.04
	Total	**7.08%**	**40.27%**	**22.12%**	**26.55%**	**3.98%**	**2.72**	**1.08**
3 .The game was easy to use.	Boys	1.41%	11.27%	21.13%	57.75%	8.45%	3.61	0.85
	Girls	1.94%	19.35%	28.39%	46.45%	3.87%	3.40	0.89
	Total	**1.77%**	**16.81%**	**26.11%**	**50.00%**	**5.31%**	**3.61**	**0.85**
4. I need the support of a technical person to be able to use this game.	Boys	8.45%	18.31%	18.31%	47.89%	7.04%	3.27	1.11
	Girls	6.45%	14.84%	15.48%	58.71%	4.52%	3.36	1.04
	Total	**7.08%**	**15.93%**	**16.37%**	**55.31%**	**5.31%**	**3.27**	**1.11**
5. The various functions in this game were well integrated.	Boys	4.23%	2.82%	25.35%	61.97%	5.63%	3.62	0.82
	Girls	1.29%	1.94%	27.74%	60.65%	8.39%	3.69	0.74
	Total	**2.21%**	**2.21%**	**26.99%**	**61.06%**	**7.52%**	**3.62**	**0.82**
6. There was too much inconsistency in this game.	Boys	19.72%	36.62%	35.21%	5.63%	2.82%	2.35	0.96
	Girls	27.10%	50.97%	19.35%	2.58%	0.00%	2.09	0.84
	Total	**24.78%**	**46.46%**	**24.34%**	**3.54%**	**0.88%**	**2.35**	**0.96**
7. Most people would learn to use this game very quickly.	Boys	2.82%	18.31%	28.17%	43.66%	7.04%	3.34	0.96
	Girls	3.23%	30.32%	21.94%	40.00%	4.52%	3.19	0.99
	Total	**3.10%**	**26.55%**	**23.89%**	**41.15%**	**5.31%**	**3.34**	**0.96**
8. The game was very cumbersome to use.	Boys	12.68%	36.62%	25.35%	18.31%	7.04%	2.70	1.13
	Girls	7.74%	54.84%	23.23%	14.19%	0.00%	2.52	0.94
	Total	**9.29%**	**49.12%**	**23.89%**	**15.49%**	**2.21%**	**2.70**	**1.13**
9. I felt very confident using the game.	Boys	1.41%	5.63%	25.35%	50.70%	16.90%	3.76	0.85
	Girls	1.94%	7.74%	25.81%	57.42%	7.10%	3.65	0.83
	Total	**1.77%**	**7.08%**	**25.66%**	**55.31%**	**10.18%**	**3.76**	**0.85**
10. I needed to learn many things before I could get going with this game.	Boys	5.63%	19.72%	25.35%	45.07%	4.23%	3.23	1.00
	Girls	5.16%	13.55%	18.06%	50.97%	12.26%	3.42	1.04
	Total	**5.31%**	**15.49%**	**20.35%**	**49.12%**	**9.73%**	**3.23**	**1.00**

As shown in the Table 10, both boys and girls expressed positive attitudes regarding the game experience. In their opinion the game is fun and they were fully occupied with it. While playing, students felt content, happy as well as rich experience. They were not bored nor did they feel (time) pressure.

Table 10 – Satisfaction with the usability of the C4G 3D game environment

Statement		1	2	3	4	5	AVG	SD
1. I felt content.	Boys	4.23%	4.23%	15.49%	25.35%	50.70%	4.14	1.10
	Girls	1.94%	1.94%	15.48%	47.10%	33.55%	4.08	0.86
	Total	**2.65%**	**2.65%**	**15.49%**	**40.27%**	**38.94%**	**4.10**	**0.94**
2. I felt skilful.	Boys	1.41%	9.86%	15.49%	47.89%	25.35%	3.86	0.96
	Girls	0.65%	9.68%	25.16%	50.97%	13.55%	3.67	0.85
	Total	**0.88%**	**9.73%**	**22.12%**	**50.00%**	**17.26%**	**3.73**	**0.89**
3. I was interested in the game's story.	Boys	2.82%	15.49%	25.35%	35.21%	21.13%	3.56	1.08
	Girls	0.00%	9.68%	30.32%	45.81%	14.19%	3.65	0.84
	Total	**0.88%**	**11.50%**	**28.76%**	**42.48%**	**16.37%**	**3.62**	**0.92**
4. I thought it was fun.	Boys	2.82%	8.45%	9.86%	43.66%	35.21%	4.00	1.03
	Girls	0.00%	3.23%	14.84%	63.87%	18.06%	3.97	0.68
	Total	**0.88%**	**4.87%**	**13.27%**	**57.52%**	**23.45%**	**3.98**	**0.80**
5. I was fully occupied with the game.	Boys	1.41%	15.49%	12.68%	53.52%	16.90%	3.69	0.98
	Girls	1.94%	10.32%	14.19%	62.58%	10.97%	3.70	0.87
	Total	**1.77%**	**11.95%**	**13.72%**	**59.73%**	**12.83%**	**3.70**	**0.90**
6. I felt happy.	Boys	1.41%	12.68%	9.86%	49.30%	26.76%	3.87	1.00
	Girls	0.65%	3.87%	15.48%	65.16%	14.84%	3.90	0.71
	Total	**0.88%**	**6.64%**	**13.72%**	**60.18%**	**18.58%**	**3.89**	**0.81**
7. It gave me a bad mood.	Boys	57.75%	23.94%	11.27%	1.41%	5.63%	1.73	1.09
	Girls	58.06%	32.26%	9.03%	0.65%	0.00%	1.52	0.69
	Total	**57.96%**	**29.65%**	**9.73%**	**0.88%**	**1.77%**	**1.59**	**0.84**
8. I thought about other things.	Boys	22.54%	43.66%	9.86%	19.72%	4.23%	2.39	1.16
	Girls	24.52%	49.03%	15.48%	9.68%	1.29%	2.14	0.94
	Total	**23.89%**	**47.35%**	**13.72%**	**12.83%**	**2.21%**	**2.22**	**1.02**
9. I found it tiresome.	Boys	60.56%	23.94%	7.04%	5.63%	2.82%	1.66	1.03
	Girls	53.55%	28.39%	14.84%	2.58%	0.65%	1.68	0.87
	Total	**55.75%**	**26.99%**	**12.39%**	**3.54%**	**1.33%**	**1.68**	**0.92**
10. I felt competent.	Boys	5.63%	14.08%	30.99%	43.66%	5.63%	3.30	0.98
	Girls	3.87%	15.48%	40.00%	38.71%	1.94%	3.19	0.86
	Total	**4.42%**	**15.04%**	**37.17%**	**40.27%**	**3.10%**	**3.23**	**0.90**
11. I thought it was hard.	Boys	14.08%	56.34%	16.90%	12.68%	0.00%	2.28	0.86
	Girls	13.55%	50.32%	20.65%	14.84%	0.65%	2.39	0.92
	Total	**13.72%**	**52.21%**	**19.47%**	**14.16%**	**0.44%**	**2.35**	**0.90**
12. It was aesthetically pleasing.	Boys	14.08%	49.30%	21.13%	12.68%	2.82%	2.41	0.98
	Girls	10.97%	42.58%	20.65%	23.23%	2.58%	2.64	1.04
	Total	**11.95%**	**44.69%**	**20.80%**	**19.91%**	**2.65%**	**2.57**	**1.02**
	Boys	7.04%	15.49%	19.72%	40.85%	16.90%	3.45	1.16

13. I forgot everything around me.	Girls	9.68%	19.35%	21.29%	41.94%	7.74%	3.19	1.13
	Total	**8.85%**	**18.14%**	**20.80%**	**41.59%**	**10.62%**	**3.27**	**1.14**
14. I felt good.	Boys	2.82%	8.45%	11.27%	57.75%	19.72%	3.83	0.94
	Girls	0.65%	4.52%	21.29%	65.81%	7.74%	3.75	0.69
	Total	**1.33%**	**5.75%**	**18.14%**	**63.27%**	**11.50%**	**3.78**	**0.77**
15. I was good at it.	Boys	0.00%	9.86%	11.27%	63.38%	15.49%	3.85	0.80
	Girls	0.65%	8.39%	27.74%	60.65%	2.58%	3.56	0.71
	Total	**0.44%**	**8.85%**	**22.57%**	**61.50%**	**6.64%**	**3.65**	**0.75**
16. I felt bored.	Boys	43.66%	28.17%	15.49%	8.45%	4.23%	2.01	1.15
	Girls	41.29%	38.06%	16.13%	4.52%	0.00%	1.84	0.86
	Total	**42.04%**	**34.96%**	**15.93%**	**5.75%**	**1.33%**	**1.89**	**0.96**
17. I felt successful.	Boys	0.00%	12.68%	22.54%	47.89%	16.90%	3.69	0.90
	Girls	1.94%	8.39%	25.16%	60.65%	3.87%	3.56	0.78
	Total	**1.33%**	**9.73%**	**24.34%**	**56.64%**	**7.96%**	**3.60**	**0.82**
18. I felt imaginative.	Boys	9.86%	8.45%	25.35%	50.70%	5.63%	3.34	1.05
	Girls	3.87%	12.26%	21.29%	57.42%	5.16%	3.48	0.91
	Total	**5.75%**	**11.06%**	**22.57%**	**55.31%**	**5.31%**	**3.43**	**0.96**
19. I felt that I could explore things.	Boys	0.00%	8.45%	21.13%	57.75%	12.68%	3.75	0.79
	Girls	1.94%	4.52%	21.29%	63.87%	8.39%	3.72	0.76
	Total	**1.33%**	**5.75%**	**21.24%**	**61.95%**	**9.73%**	**3.73**	**0.77**
20. I enjoyed it.	Boys	2.82%	15.49%	9.86%	42.25%	29.58%	3.80	1.12
	Girls	2.58%	7.10%	11.61%	61.29%	17.42%	3.84	0.89
	Total	**2.65%**	**9.73%**	**11.06%**	**55.31%**	**21.24%**	**3.83**	**0.96**
21. I was fast at reaching the game's targets.	Boys	2.82%	16.90%	28.17%	45.07%	7.04%	3.37	0.94
	Girls	2.58%	18.71%	40.65%	36.13%	1.94%	3.16	0.84
	Total	**2.65%**	**18.14%**	**36.73%**	**38.94%**	**3.54%**	**3.23**	**0.88**
22. I felt annoyed.	Boys	50.70%	19.72%	22.54%	5.63%	1.41%	1.87	1.04
	Girls	52.26%	36.13%	10.32%	1.29%	0.00%	1.61	0.73
	Total	**51.77%**	**30.97%**	**14.16%**	**2.65%**	**0.44%**	**1.69**	**0.84**
23. I felt pressured.	Boys	50.70%	25.35%	15.49%	4.23%	4.23%	1.86	1.10
	Girls	54.84%	38.06%	6.45%	0.65%	0.00%	1.53	0.65
	Total	**53.54%**	**34.07%**	**9.29%**	**1.77%**	**1.33%**	**1.63**	**0.83**
24. I felt irritable.	Boys	66.20%	11.27%	16.90%	1.41%	4.23%	1.66	1.08
	Girls	63.87%	30.32%	3.23%	1.94%	0.65%	1.45	0.71
	Total	**64.60%**	**24.34%**	**7.52%**	**1.77%**	**1.77%**	**1.52**	**0.85**
25. I lost track of time.	Boys	8.45%	12.68%	19.72%	46.48%	12.68%	3.42	1.13
	Girls	5.16%	19.35%	26.45%	43.23%	5.16%	3.24	1.00
	Total	**6.19%**	**17.26%**	**24.34%**	**44.25%**	**7.52%**	**3.30**	**1.04**
26. I felt challenged.	Boys	7.04%	11.27%	28.17%	47.89%	5.63%	3.34	1.00
	Girls	4.52%	16.13%	25.16%	49.68%	3.23%	3.31	0.94
	Total	**5.31%**	**14.60%**	**26.11%**	**49.12%**	**3.98%**	**3.32**	**0.96**
27. I found it impressive.	Boys	7.04%	8.45%	35.21%	38.03%	11.27%	3.38	1.03
	Girls	3.23%	8.39%	27.10%	56.13%	5.16%	3.52	0.85
	Total	**4.42%**	**8.41%**	**29.65%**	**50.44%**	**7.08%**	**3.47**	**0.91**
	Boys	5.63%	8.45%	23.94%	56.34%	5.63%	3.48	0.94
	Girls	7.10%	14.19%	20.65%	55.48%	2.58%	3.32	0.99

28. I was deeply concentrated in the game.	**Total**	**6.64%**	**12.39%**	**21.68%**	**55.75%**	**3.54%**	**3.37**	**0.98**
29. I felt frustrated.	Boys	49.30%	26.76%	16.90%	4.23%	2.82%	1.85	1.04
	Girls	48.39%	36.77%	10.97%	1.94%	1.94%	1.72	0.88
	Total	**48.67%**	**33.63%**	**12.83%**	**2.65%**	**2.21%**	**1.76**	**0.93**
30. It felt like a rich experience.	Boys	2.82%	8.45%	18.31%	46.48%	23.94%	3.80	0.99
	Girls	1.29%	7.74%	18.06%	61.94%	10.97%	3.74	0.81
	Total	**1.77%**	**7.96%**	**18.14%**	**57.08%**	**15.04%**	**3.76**	**0.87**
31. I lost connection with the outside world.	Boys	9.86%	26.76%	28.17%	29.58%	5.63%	2.94	1.09
	Girls	21.94%	30.97%	24.52%	21.29%	0.65%	2.47	1.08
	Total	**18.14%**	**29.65%**	**25.66%**	**23.89%**	**2.21%**	**2.62**	**1.10**
32. I felt time pressure.	Boys	42.25%	23.94%	22.54%	8.45%	2.82%	2.06	1.12
	Girls	45.81%	34.19%	14.84%	3.87%	1.29%	1.81	0.92
	Total	**44.69%**	**30.97%**	**17.26%**	**5.31%**	**1.77%**	**1.88**	**0.99**
33. I had to put a lot of effort into it.	Boys	5.63%	14.08%	22.54%	42.25%	14.08%	3.46	1.09
	Girls	6.45%	20.65%	25.81%	39.35%	7.74%	3.21	1.06
	Total	**6.19%**	**18.58%**	**24.78%**	**40.27%**	**9.73%**	**3.29**	**1.07**

In the S2, the students again self-assessed the level of their programming skills on the scale from *0 - I have never coded or programmed before* to *4 - I can design a solution of a problem in the form of a program*. A total of 633 students (273 boys, 360 girls) solved the preliminary and the follow-up questionnaire so their self-assessment results were compared. Table 11 shows data on the difference between the self-assessed initial level and the self-assessed final level of programming skill. Over 40% of students stated that they have progressed, the most of them for 1 level (29.07%). About 6% of students self-assessed their programming skill level higher before participating in C4G activities. It can be assumed that these students were not able to self-assess their programming skill realistically before the C4G activities. Comparison by gender shows that slightly fewer girls remained at the same level of programming skill than boys (difference is 0). Also, slightly more girls progressed by one level than boys (difference is 1).

Table 11 - The difference between the self-assessed levels of programming skill

	Difference						
	-2	**-1**	**0**	**1**	**2**	**3**	**4**
Boys	0.37%	4.76%	55.31%	25.64%	10.99%	2.56%	0.37%
Girls	0.56%	6.67%	47.22%	31.67%	11.94%	1.94%	0.00%
Total	0.47%	5.85%	50.71%	29.07%	11.53%	2.21%	0.16%

A Wilcoxon's signed rank test for paired samples showed that students self-assessed their programming skill significantly higher after the C4G activities compared to self-assessment before the C4G activities (Table 12). The results of rank-biserial correlation (rB), which are considered as an effect size, show large effect size, overall and by gender.

Table 12 - Comparison of self-assessment of programming skill

		Descriptive statistics					Wilcoxon's signed rank test results		
		N	**MIN**	**MAX**	**MEAN**	**SD**	**W**	**p**	**Effect size (rB)**
Boys	S1	273	0	4	1.670	1.063	6858	< .001	0.8
	S2	273	0	4	2.183	1.038			
Girls	S1	360	0	4	1.383	1.044	16155	< .001	0.8
	S2	360	0	4	1.919	1.019			
Total	**S1**	**633**	**0**	**4**	**1.507**	**1.063**	**43942.5**	**< .001**	**0.8**
	S2	**633**	**0**	**4**	**2.033**	**1.038**			

Students' comments

In their comments after the implementation activities, the students stated that they are very happy with this way of learning, think that they have learned a lot, and feel like real developers because they created their games. During the implementation of C4G approach, they could hardly wait for every new task and new project. Learning by designing games was for students interesting and "*much more fun than traditional learning*". Some students said it would be fun if they could choose a theme for the game by themselves.

Students were satisfied with the received materials. This way of learning was very fun and they can't wait for more tasks like these. In some countries, these activities motivated students to enrol in extracurricular course in programming.

Students who participated in the activities online mentioned that they liked doing the tasks at home but that they would like to try this approach in the classroom, too.

Students also liked 3D game. The experience of using the games in the Students Game Environment was both fun and interesting for boys and girls because it enabled them to see actually what kind of product is attainable through the coding. Some of the students criticised the high technical requirements for playing the 3D game since they would like to play the game via smartphones or tablets at home.

Teachers' observations and comments

After the implementation activities, teachers and future teachers (N_T=225) were asked to express their qualitative opinions about the C4G methodology and the implementation process using the forms T1 and T2.

Teachers' observations

Using the form T1, teachers and future teachers reported on students' participation and engagement as well as learning difficulties and problems.

All teachers stated that students were actively involved in the activities. They were motivated for work, discuss, collaborate, brainstorm, and help each other while participating in the activities. Students had a lot of fun developing games and were motivated to learn new functionalities to implement them in the game. They also enjoyed playing their games as well as seeing the other participants playing the games they had created. Most of the students successfully completed all the tasks with the help of prepared materials. Students with some previous experience in programming were more independent and often did even more than excepted. Novice programmers with no previous experience needed more support in the beginning, but with some assistance and hints from teachers and other students were able to create projects in Snap!. In some countries, students continued doing challenges and asking teachers and project members for support and comments even after the testing. Some teachers suggested development of additional challenges as well as more complex scenarios for students of secondary schools.

Due to technical limitations, some students were slower in completing assignments. Students working on tablets had some problems with the Snap! but students who were creating projects on desktop computers or laptops had no problems. Some teachers pointed out that Snap!, in comparison with Scratch, have less features.

Regarding the C4G 3D game, teachers stated that the use of the game supported the learning and teaching process effectively because in this way students were more interested and motivated to learn even more complex scenarios. Teachers pointed out that one of the key advantages of the C4G game is that entices students to engage with building programming skills but also that it takes into account the needs of girls, aiming to bring them closer to computing. Some students needed more time to become familiar with the Students' Game Environment but once they get used to it the motivation and interest were greater than before. Some technical issues were notices due to the weak technological infrastructure in the schools or the devices that students have at home.

In general, no particular differences in the learning process and involvement levels between girls and boys were observed. There were no visible differences between girls and boys regarding the perceived fun either. However, the motivation seemed to be a little different: boys were very much interested in the coding itself and finding out about what they could do with the instructions. Girls were more reflective, liked to understand very well every aspect of a certain challenge so that they could be more creative in the solution. Boys were a bit competitive and always tried to be the first to finish an activity while typically girls were more reflective and more perfectionist in terms of the final result (for example, they always tried to customize the background and objects in the scenes). Girls liked very much the stories in most of the challenges and tried to contribute also to that aspect. But they also collaborated between themselves in the process of finding bugs and problems in the challenges.

Teachers noticed that students, while using the game, asked both practical questions related to the execution of the game in diverse environments and devices as well as more high-level issues related to the importance of programming in the digital age. The experience with the C4G game enabled student to understand that the evolution of technology, and more specifically of network speeds, is a driver for demand for ever evolving digital applications which in turn drives the need for qualified programming professionals. During the implementation activities students also reflected on how girls and boys have equal opportunities in engineering careers and more specifically the software industry and that it is important for society to put all innovative minds to work for addressing emerging challenges.

Teachers’ comments

Using the form T2, teachers reported on accomplishment of learning objectives, relevance, effectiveness and acceptance of the proposed methodology by the students, and the overall organization of the implementation.

The opinion of the teachers is that game-based learning is fun for students. They are motivated to solve tasks (problems) which makes this way of learning effective for learning programming. All teachers stated that the learning objectives were fully achieved by the students during the C4G activities. Teachers liked that learning objectives are stated in all the prepared learning scenarios (projects). The developed materials and tolls facilitate the understanding of the contents, students learn by doing in an interdisciplinary perspective, mixing creativity with imagination. Students can achieve learning objectives by developing digital skills, with particular regard to computational thinking.

According to teachers, this learning approach had a great influence on the motivation of the students and therefore on the competences achieved. Some students were motivated to improve the original game by adding functionalities that went beyond the expected skill level simply because they wanted to make their game better and have more fun playing it. Relatively complex concepts were no longer difficult to understand, and that is the biggest benefit of this approach. Additionally, teachers think that this approach challenges students and helps them see the big picture before designing a detailed solution. In particular, the use of these digital tools and games makes the activity captivating, increasing the pupil's motivation and commitment, thus promoting learning.

Teachers agreed that the students fully accepted the C4G methodology. The topics of the projects were very interesting to them and most of students enjoyed using newly acquired programming knowledge to create games. They love playing games and this approach gave them the opportunity to design their own simple game. C4G projects had a positive effect on their desire and motivation to eliminate all mistakes. Students persisted until they reached the set goal - a game they could play. The relatively complex learning content of programming, which is often perceived as difficult and boring, was presented in a fun and meaningful way that the students enjoyed.

According to teachers, the C4G approach is suitable for a different kind of learning styles for the students, thanks to the use of challenges and the learning scenarios designed on several levels of difficulty. Additional benefit is ability to discuss challenges in the brainstorming section.

The teachers reported that the 3D game was attractive to students, enticing learning to want to explore it further. Part of the attractiveness is the 3D graphics of the application that are very similar to what students are used to when playing digital games for entertainment. The graphical environment and the user movement in the digital world is comparable to popular commercial games in terms of quality and fidelity and this is one of significantly positive aspects of the application.

In case C4G activities were conducted online, the insight regarding achieved fun by the students could not be complete, but teachers stated that it is evident from the communication with the students that the students had fun and were looking forward to gaining new knowledge using the C4G methodology.

Teachers share opinion that the proposed learning methodology is captivating for both girls and boys, develops a greater interest in the discipline, enhances computer skills, keeps curiosity high, educates for innovation, invites for collaboration with others, while maintaining and promoting one's individuality. The complexity of the learning content and programming tasks in the course gradually increases so that students can effectively progress in the learning process. The games they program become more and more interesting and present a real challenge.

Teachers also agree that the C4G game-based, design thinking educational framework is applicable in their future work. Learning scenarios with projects that need to be developed in Snap! are appropriate to the age of students and plan to use them in future. Some teachers suggested that the challenges should be more complex for secondary school pupils (14-16 years old).

Teachers also believe that a design thinking approach in combination with game-based learning can be used not only for development of programming skills but also to enhance students’ creative potential which can result in some new ideas and solutions. The approach can be used to increase both male and female participation in computer science and for future involvement in related professions.

Teachers perceived the C4G game to be of great value for introducing programming to wider audiences and for attracting all children, including both girls and boys, to information technology studies and careers. The game can help students demystify technology and to understand is not only a choice for boys but also for girls, and that they can participate equally in the field of information technology. The Teachers' Game Environment allows the design of educational activities through an easy interface. As added value, the teachers pointed out functionality that allows them to review and reproduce courses and activities produced by other teachers and made public for use. This is beneficial for individuals that have less experience with the deployment of serious games since it enables them to design activities for their students by being inspired and guided by activities and materials designed by others. Finally, the teachers found the link between programming and STEAM particularly useful as both fields help build critical and analytical thinking, and combined offer opportunities for positive multiplier effects on student transversal, soft skill development.

Regarding the overall organization of the implementation, teachers reported that it was fully aligned to the teaching needs (achievement of the outcomes related to programming). Created materials for implementation of C4G activities are comprehensive and clear. It was useful to have instructions for using Teachers' Game Environment. During the implementation, logistical support from project team members was efficient and available at any time. Teachers pointed out that they were involved in all phases and that these activities were a good opportunity for them to learn about new approaches.

Experts' comments

External validators (N_E=37) were also asked to give their qualitative opinions regarding the accomplishment of learning objectives by the students, relevance, effectiveness and acceptance of the proposed methodology by the students, and the overall organization of the implementation.

According to experts' opinion, C4G design thinking educational framework is effective and applicable for teaching programming to girls as well as boys. Experts agreed that for developing basic programming skills among students from 10-16 years, the C4G methodology is very suitable. Snap! programming interface allow students to create interactive stories and games which is fun and stimulating for them. The advantage of coding using blocks is that students of that age do not need to learn the programming syntax because this negatively affects students' motivation to learn programming (they usually forget the syntax very quickly). According to the experts, projects in C4G learning scenarios are well designed but some of them suggested the development of complex scenarios for older students.

Experts mentioned that the learning objectives for each learning scenario (challenge) are very clear and very well detailed which allows teachers to plan activities and assess whether students reached those learning objectives. Experts think that during C4G implementation activities students accomplished all the learning objectives and acquired basic programming skills. According to experts, the proposed methodology favours the achievement of learning objectives because they are suitable for all age groups and represent an interactive and alternative way to acquire skills by stimulating curiosity and motivation. The activities within the platform are well structured. The challenges structure guides and stimulates the students to move on to the next level - from simple problems to more complex so students, both girls and boys, who have difficulty to master programming concept during traditional teaching can achieve good results through the C4G approach. The graphics design in the Students' Game Environment is captivating and the challenge modalities at different levels are suitable for the age of the target group of students.

According to experts, designed tools are good support to teachers. The integration of the teacher and student platforms facilitates building programming skills by creating customized learning scenarios. Therefore, the C4G approach can be very effective.

Experts stressed out that the C4G approach assumes solving real-life problems which is interesting to students, especially girls. The projects stimulate students to be creative and enable them to learn in a fun way by creating games. Topics included in the projects are interesting to the girls and motivate them to solve the given problem using newly acquired programming knowledge. At the same time, topics are interesting to boys as well.

Experts noted that the proposed methodology helped students feel engaged. Moreover, students were actively participating in activities and collaborating with each other since the approach involves design thinking. Using design thinking issues and problems can be observed, discussed and reflected upon in terms of the impact of the solutions created on their users and society.

Experts assessed the overall organization of the implementation successful. They think it was very important to verify the proposed methodology with teachers. The experts think that the flexibility of the C4G validation methodology was fundamental to ensure results in the situation with the COVID-19 pandemic. For teachers, it was a good opportunity to improve knowledge and get familiar with the developed resources and tools available. The number of resources and tools for the teachers is a very positive aspect of this approach as it gave the teachers confidence to guide the students in the process of learning to code.

DISCUSSION AND CONCLUSIONS

The results of the preliminary questionnaire (S1) showed that students of both genders use the Internet and digital devices, on average a couple of hours a day, and have 5 to 6 years of experience in their use. This shows that the students had the appropriate digital skills necessary for the implementation of the C4G approach. The large number of hours that some students spend per week using digital devices and the Internet is partly conditioned by the online teaching that was conducted is schools at the time of the implementation activities. Results also showed that students play video games and that boys spend significantly more time playing them than girls. This indicates that game-based activities, such as those designed within the C4G approach, should be tailored to interests of the girls to keep the girls motivated.

Results of the preliminary questionnaire also indicated students are mostly motivated for learning programming by success in the programming class (girls to a greater extent that boys). Students are also motivated by the fact that they enjoy solving problems and puzzles and because creating their own games is fun for them. This confirms that the C4G methodology which includes creating games for solving real-life problems is appropriate for the target group of students. According to the results, boys are further motivated by the desire to become programmers while girls are very little motivated by this factor. This shows that girls are less interested to follow a career in programming so they need to be motivated by approaches like C4G.

In the initial self-assessment of their programming skills, the most of the students stated that they are novice programmer s (level 1) or that they can code simple programs (level 2). This is confirmed by the results regarding the familiarity with programming concepts which showed that most students are familiar only with basic concepts such as statements and loops. Some students attend the subject Informatics for several years but do not consider that they have developed programming skills. The reason for this may be that they find programming difficult and are not interested in learning.

Results of the comparison of self-assessment confirmed the effectiveness of implemented activities for learning programming. Students self-assessed their programming skill significantly higher after the C4G activities compared to self-assessment before the C4G activities (large effect size is present for overall results and results grouped by gender).

Students' attitudes regarding the C4G methodology, expressed in the follow-up questionnaire, shown that they consider the approach relevant for learning programming and that they had fun and enjoyed programming which also supports the validation of the C4G approach. Regarding the 3D game environment, both boys and girls found the game fun and would like to use it frequently. As stated before, students' qualitative feedback was also very positive.

After the implementation activities, teachers reported that conducted activities enable students to achieve learning outcomes and at the same time had fun. Teachers think that creating games is a very effective way for students to learn programing concepts and they plan to apply the C4G methodology in the future as well. They observed that C4G approach encouraged creativity and problem solving and students were motivated to complete the project (their own game) to the end. Regarding the C4G 3D game, teachers stated that the use of the game was effective because in this way students were more motivated to learn programming. Some of them stressed out that one of the main advantages of the C4G game is engaging students in programming and at the same time taking into account the needs of girls through the design of the 3D environment and inclusion of logical mini-games/puzzles.

The external experts who participated in the validation activities agreed with these observations and support the application of game-based learning approach using visual programming tools for learning programming. They emphasized the good choice of topics of the projects included in the learning scenarios which are interesting to girls and encouraged them to apply their programming knowledge. Experts stressed out that the C4G approach assumes solving real-life problems which is interesting and motivating especially for girls.

Regarding the possible improvements, one of the challenges for teachers in schools was the size of the Coding4Girls 3D game application, which made it difficult to download to the computers due to their limited capacity and the low bandwidth of the network. To overcome this, the recommendation is to provide the teachers with USB sticks with the software installation. The other problem was related to technical difficulties encountered by students who used Snap! on tablets, so the next version of the C4G methodology could include the possibility of using another visual programming tool beside or instead of Snap! (e.g. Scratch).

In conclusion, all goals related to the implementation of C4G methodology were achieved successfully with the large participation of students and teachers despite the COVID 19 pandemic which limited many events to an online form. The flexibility of C4G methodology has proven to be successful and appropriate for students, both girls and boys, and has made it possible to achieve learning outcomes in an effective and fun way in both f2f and online environments. Although it is primarily intended to encourage girls' interest in coding and computer science, validation has shown that the methodology is equally effective for all students.

ANNEXES

S1. PRELIMINARY QUESTIONNAIRE FOR STUDENTS

Code: _______

Age: _______

Sex: _______

Country: _______

1. For how long have you been using computers, tablets or other digital devices? _____ years
2. How many hours per week do you use a computer, tablet or other digital device? _______ hours
3. How many hours per week do you use the Internet? _______ hours
4. How many hours per week do you play video games? _______ hours
5. a) What is your level of programming, now?
   i. Never did any coding or programming
   ii. Starting (just have basic ideas)
   iii. Coding (can create parts of a program)
   iv. Programming (can create a full program)
   v. Problem solving (can pick a problem and design a solution for it in the form of a program)

   b) If you already did some coding, which of the following concepts are familiar to you?
   i. Loops ☐
   ii. Conditionals ☐
   iii. Variables ☐
   iv. Statements (sounds, movement, looks, drawing) ☐
   v. Parallelism ☐
   vi. Operators ☐
   vii. Events ☐
2. What motivates you to learn to program?

i. I'm not motivated ☐

ii. I want to succeed in the programming class ☐

iii. ii) I want to show other students I can program ☐

iv. iii) I want to follow a career in programming ☐

v. iv) I enjoy solving logic problems and puzzles ☐

vi. v) Other ______________________________

S2. FOLLOW-UP QUESTIONNAIRE FOR STUDENTS

Code: ________

1. Classify the following statements:

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
a) I found programming challenging					
b) I found programming motivating					
c) I found programming easy					
d) I enjoyed programming					
e) I understood most of programming concepts					
f) Learning this way is fun					
g) I felt engaged with this way of learning					
h) The activities were relevant to learn					
i) At any time it was clear what I had to do					
j) What I learned will be relevant for my future					

2. What is your perceived level of programming, now?
   a) Starting (just have basic ideas)
   b) Coding (can create parts of a program)
   c) Programming (can create a full program)
   d) Problem solving (can pick a problem and design a solution for it in the form of a program)

3. Usability of the game environment[5] (optional)

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
a) I would like to use this game frequently.					
b) I found the game complex.					
c) The game was easy to use.					
d) I need the support of a technical person to be able to use this game.					
e) The various functions in this game were well integrated.					
f) There was too much inconsistency in this game.					

[5] Adapted System Usability Scale (SUS): https://www.usability.gov/how-to-and-tools/methods/system-usability-scale.html

g) Most people would learn to use this game very quickly.					
h) The game was very cumbersome to use.					
i) I felt very confident using the game.					
j) I needed to learn a lot of things before I could get going with this game.					

4. Game experience [6] (optional)

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
a) I felt content					
b) I felt skilful					
c) I was interested in the game's story					
d) I thought it was fun					
e) I was fully occupied with the game					
f) I felt happy					
g) It gave me a bad mood					
h) I thought about other things					
i) I found it tiresome					
j) I felt competent					
k) I thought it was hard					
l) It was aesthetically pleasing					
m) I forgot everything around me					
n) I felt good					
o) I was good at it					
p) I felt bored					
q) I felt successful					
r) I felt imaginative					
s) I felt that I could explore things					
t) I enjoyed it					
u) I was fast at reaching the game's targets					
v) I felt annoyed					
w) I felt pressured					
x) I felt irritable					
y) I lost track of time					
z) I felt challenged					
aa) I found it impressive					
bb) I was deeply concentrated in the game					
cc) I felt frustrated					
dd) It felt like a rich experience					
ee) I lost connection with the outside world					
ff) I felt time pressure					
gg) I had to put a lot of effort into it					

[6] Adapted from the Game Experience Questionnaire (GEQ): https://pure.tue.nl/ws/portalfiles/portal/21666907/Game_Experience_Questionnaire_English.pdf

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S3. STUDENTS' COMMENTS

Country:

Teacher:

Date:

In the end of the implementation group all the students and collect their verbal qualitative opinions and comments. You can ask students about the overall organization of the implementation, their perception on the acquired knowledge, their perception on the relevance and effectiveness of game-based learning and their perception on the achieved fun. You can also ask them for other information that you find relevant. Students can also report on any learning difficulties or problems during the course and what they did when they found those problems. Students can also express their views on how to improve the C4G methodology, tools and contents. Transcribe here their opinions.

T1. TEACHERS' OBSERVATIONS

Country:

Teacher:

Dates: **to**

During the implementation sessions, observe and document the reaction of your students and their progress in building coding skills. Report here the mains aspects of that observation (are they having fun, are they struggling with the content, exercises, are they collaborating, asking for support, etc.)

T2. TEACHERS' COMMENTS

Country:

Teacher:

Date:

Please report your views on:

a. Your perception on the accomplishment of learning objectives by the students;
b. Your perception on the relevance and effectiveness of game-based learning for building programming skills and of the specific CODING4GIRLS learning approach;
c. The acceptance of students of the proposed methodologies;
d. Your perception on the achieved fun by the students;
e. Your analysis of the overall organization of the implementation;
f. Your perception on the usability and acceptance of the proof-of-concept serious game approach in connection with the wider CODING4GIRLS game-based, design thinking educational framework.

E. EXPERTS COMMENTS

Country:

Expert names:

Date:

Please report the expert views on:

a. Their perception on the accomplishment of learning objectives by the students;
b. Their perception on the relevance and effectiveness of game-based learning for building programming skills and of the specific CODING4GIRLS learning approach;
c. The acceptance of students of the proposed methodologies;
d. Their perception on the achieved fun by the students;
e. Their analysis of the overall organization of the implementation;
f. Their perception on the usability and acceptance of the proof-of-concept serious game approach in connection with the wider CODING4GIRLS game-based, design thinking educational framework.

NATIONAL REPORT: BULGARIA

TABLE OF CONTENTS

EXECUTIVE SUMMARY

Implementation and validation of the C4G approach in Bulgaria held from February to December 2020 with experts, teachers in Information technology, Informatics and Computer modelling and students age 13-14 from Vocational school of Geodesy, Construction and Architecture, Blagoevgrad. Due to the COVID-19 pandemic, Bulgarian schools were in most of the time closed and face-to-face training activities with the teachers were forbidden. There were some periods for face-to-face activities in September and October 2020 and we use these periods for some of validation activities. The approach was adapted for implementation and use in online environment.

The validation activities were focussed mainly to the teachers and prospective teachers. Students from Master degree program "Technology for education in mathematics and informatics" (Nmst= 15) were involved in the course "Computer games in teaching mathematics and informatics" the course was implemented in blended mode – combination of face-to-face and online activities. Also, after multiplayer event we organised in December 2020 online qualification course for teachers in ICT, Informatics and Computer modelling (Nt=25). The course syllabus was approved by the Faculty council of the Faculty of mathematics and natural sciences at SWU "Neofit Rilski" and gives teachers 2 qualification credits for 16 hours online videoconference meetings and 16 hours for self-preparation and working in on-line environment according to national requirements for teachers' qualification improvement. One teacher together with member of project team organised validation activities with school students (Ns=39) in Vocational school of Geodesy, Construction and Architecture, Blagoevgrad. In addition, two experts (Ne=2) were invited to validate the approach.

The all activities with teachers and students were based on the C4G methodology and game-based environment developed in the frame of the project.

Results showed that students accepted the game based C4G methodology, participated actively in short workshop and part of them decided to continue with extracurricular activities in programming. Teachers and experts have positive attitude to the proposed methodology and game-based environment.

IMPLEMENTATION

Validation activities

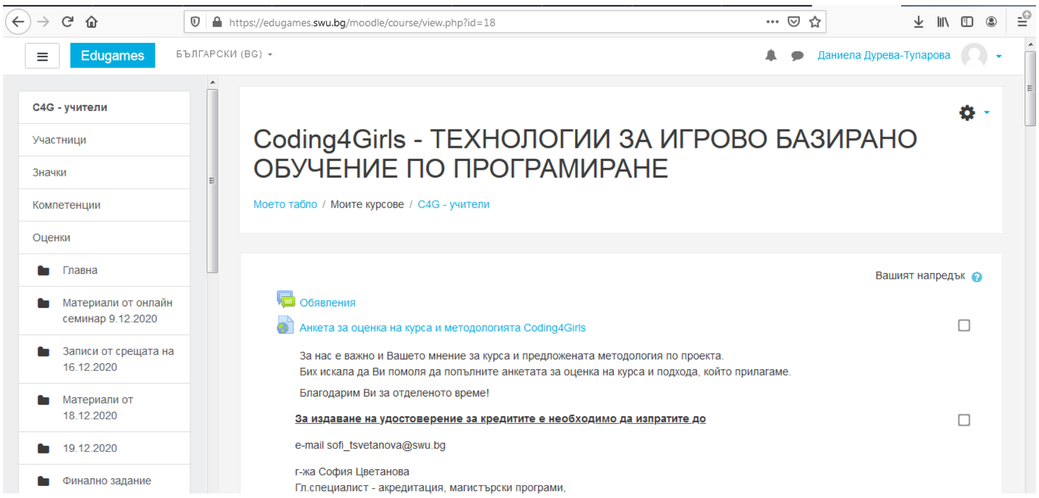
The validation activities in Bulgaria were implemented with:

- personal communication with experts and one teacher, who in the next stage applied the C4G approach with school students. During these personal meetings first were presented ideas of the C4G methodology and after that the game - based environment was introduced;
- blended learning course in area of educational computer games with master degree students (N=15) "Technologies for teaching of mathematics and informatics". The course was organized in face-to-face classes, on-line videoconference meetings and self-learning in online environment. As a result of this course master students prepared learning scenarios and some of them implemented scenarios in C4G game-based platform.

Fig. 1. Moments from face-to-face workshop with prospective teachers - students in Master degree

- Face-to-face activities with students from one vocational school. In frame of these activities teacher and member of our project team presented and trained the students to use the C4G game based environment for introducing students in programming concepts and engaged them for participation in extracurricular course in digital competences and programming. Information about these presentations were published on the web site of the school - https://www.pgsag-blg.com/?page_id=7

- Online course with teachers from different parts of the country. In this online course participated high motivated teachers in ICT, Informatics and Computer Modelling from Capital city – Sofia, Towns in South-East, Nord-East, South-West and Central parts of Bulgaria (Sofia, Blagoevgrad, Kardzhali, Provadia, Yablanica etc.). Information about this course was announced during multiplayer event at 9.12.2020 and in the Facebook group of teachers in informatics. We organized 16 hours in videoconference environments of MS Teams (this is requirement of the Ministry of Education) and LMS Moodle. All sessions were recorded and published in the LMS Moodle and MS Teams. The course is available in Bulgarian language at https://edugames.swu.bg/moodle/course/view.php?id=18



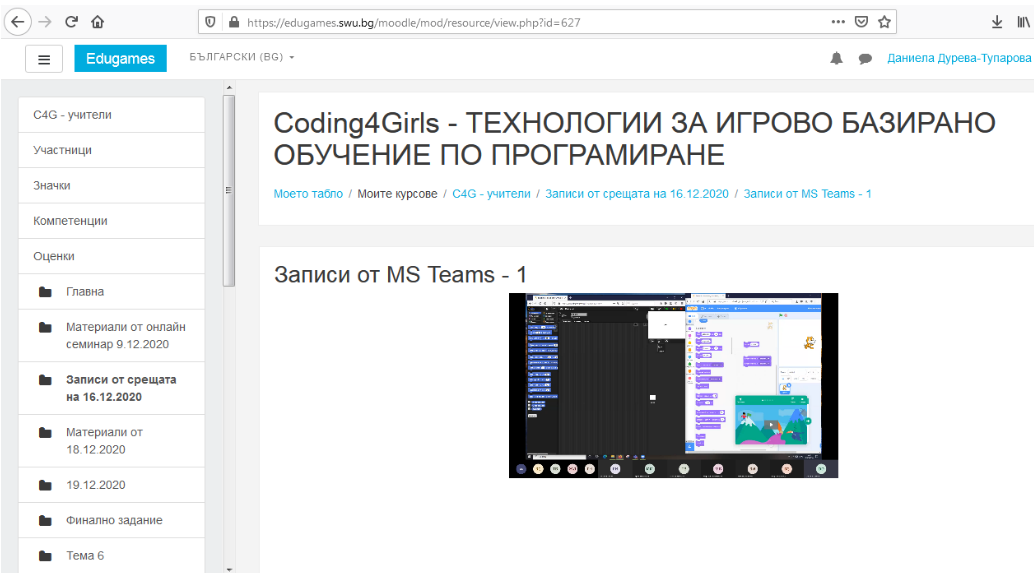


Fig.2. Screenshots from the online course in Moodle environment

Data collection tools

During the validation of C4G approach, all the data collection tools provided in the C4G validation strategy were used:

- S1 – Preliminary questionnaire (for students)
- S2 – Follow-up questionnaire (for students)
- T1 – Teacher's observations (one teacher)
- T2 – Teacher's comments
- T2A – Teacher's comments for online course
- E – Expert's comments

The data collection tools were before validation activities translated into the Bulgarian language.

Questionnaires S1 and S2 were paper based, while data collection tools S3, T1, T2, and E for teachers and experts were prepared as Word documents in which they could write observations and comments. Also, for the online course for teachers was developed Google form with extended number of questions.

Materials

During the implementation, learning scenarios and 3D game environment that were developed by the project partners were used, also additional materials have been developed to support activities. All resources were translated in Bulgarian.

Because most of the students have had a low motivation for programming and no previous experience in programming some of topics were presented with aim to increase their motivation. Additional game-course was prepared by teacher and member of project team. The course includes all minigames and initial step in programming with Snap!

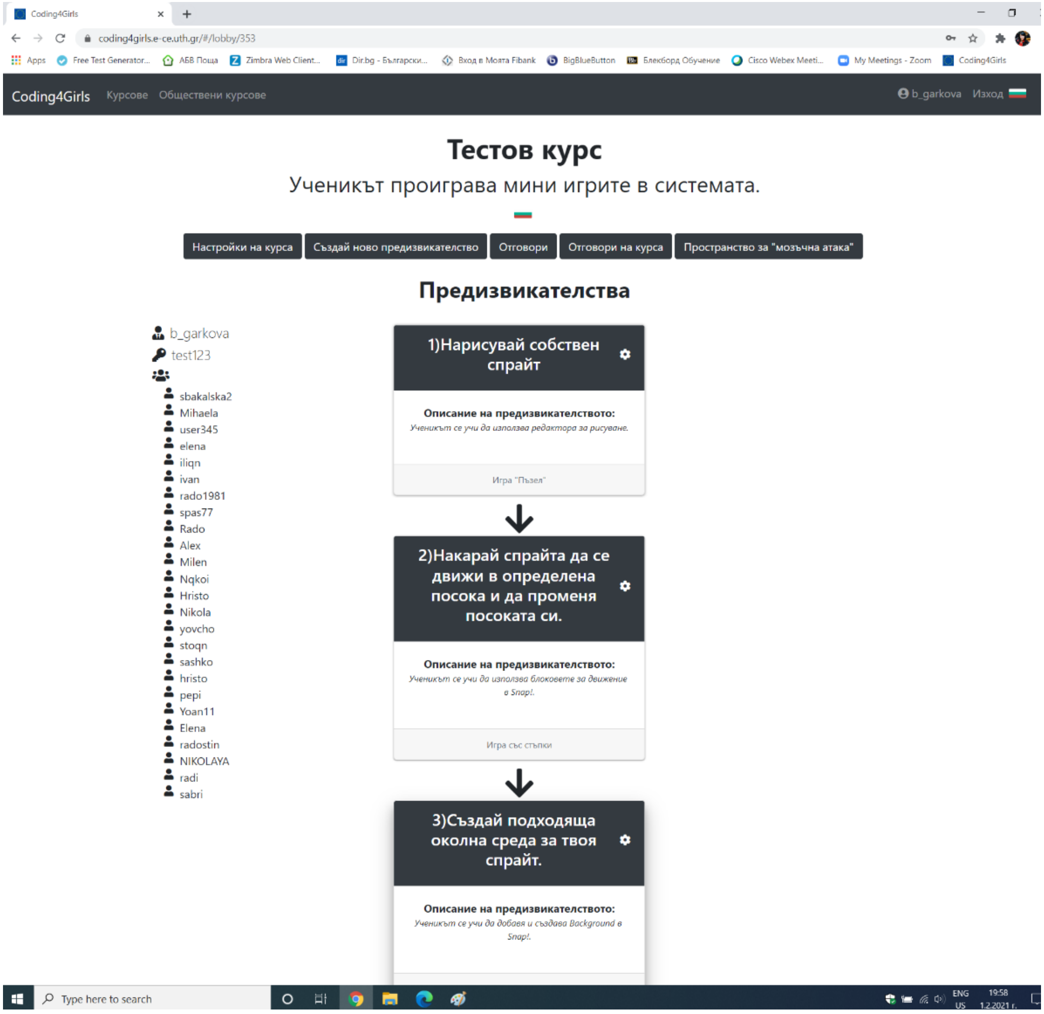


Fig. 3. Screenshot – Teacher's side of the C4G platform with additional course for students

Fig. 4. Screenshot with players of the Test game and results from students' achievements

For the training of the master degree students in face to face mode we used next games and learning scenarios:

- Introduction to Snap!
- Discover Snap! : move a sprite
- Moving around the stage
- Changing costumes and turning
- Sounds of the farm
- Chameleon's summer vacation

In online workshops with teachers we demonstrated process of development of learning scenario and implementation of the scenarios in the C4G game platform with scenario Allice in the Wonderland and additional scenario Traffic Light.

(The whole activity in Snap! is available at https://snap.berkeley.edu/snap/snap.html#present:Username=ddureva&ProjectName=Svetofar)

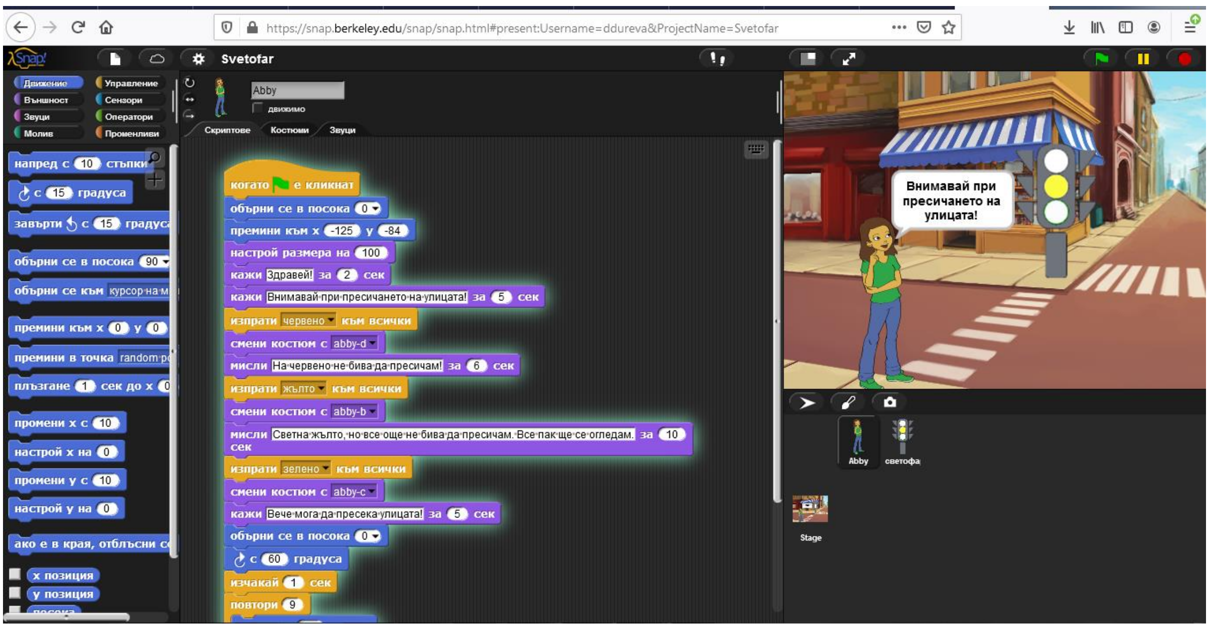


Fig. 5. Traffic Light – story telling

Setup model and procedure

Sessions with students in school were relatively short (about 3 school hours) therefore to engage and motivate students we developed additional game with all minigames. The teacher was involved in the C4G approach and had previous experience and research activities in area of design thinking methodology.

Before the workshop with the students, teacher conducted survey S1, after the workshop students filled the survey S2. The students were required to write the anonymised code received from the teacher to ensure comparison of results regarding the self-assessment of their programming skill.

Teacher reported the reaction of students and their progress in building coding skills using the game-based C4G approach (T1) and her own views related to the relevance and effectiveness of the CODING4GIRLS game-based learning approach for building programming skills (T2). The teacher participated in the online National Multiplication event and shared her experience and observation during these short workshops with the students.

The first validation workshop with teachers and prospective teachers was implemented in blended mode with Master students. They expressed their opinion regarding C4G approach in T2 in MS Word files. First in face to face mode we presented them the main principles of programming in Snap! All of them had already an experience with Scratch and we compared main futures of both programming environments. After that we involved the teachers in the C4G approach with game – they were in role of students. They played the selected game. During the next face to face session, master students worked together with the project member on development of example game in C4G game-based environment. In the frame of the virtual classrooms and self-learning activities they developed own learning scenarios and games.

After the National multiplier event (December 2020) an online course was implemented with teachers from different part of the country. Some of teachers had experience in block programming environment, some of them were without any experience in block programming environment. In the course teachers were involved in the game-based approach, design thinking ideas and learning framework. Due to different initial programming skills of the teachers, we presented main concepts and blocks in Snap! programming environment. Also because another environments is most used in the schools – Scratch, we compared functionalities of both environments Snap! and Scratch. Teachers were involved in the C4G game-based environment first as a students and after that as a teachers. The next step in the course was to present structure of learning sheets. We used as an example learning scenario 14. Allice in wonderland. In the last virtual session we prepared together new learning scenario „Traffic light“ which is based on the story telling and broadcasting events. The syllabus of the course and screenshots from the online course are presented in Annexes.

External experts expressed their point of view regarding proposed C4G approach.

Participants

The project team at SWU includes researchers and teachers (N_{PT}=3) in the field of game-based learning, programming, didactics of informatics, multimedia and e-learning. All actively involved in the preparation of the implementation and validation activities, including collaborative work with teacher and students and preparing of additional on-line learning materials and virtual workshops.

Direct participant of the study were one teacher in informatics (N_T=1), 39 students at 8th grade (14 years old), 18 Master students in program “Technology of education in mathematics and informatics”, 25 teachers – participants in online qualification course and two experts.

The teacher that conducted training with the students has more than 15 years of teaching experience in informatics and research interest to the design thinking and game-based education in informatics. The first expert is senior teacher in informatics at mathematical high school, has more than 20 years of experience in teaching in informatics, participated in group at Ministry of education for development of new curricula in ICT and computer modelling for 5-7th grades. She holds PhD degree (from 2019) and her PhD thesis is related to development of integrative model (based on game development and game-based learning) for teaching programming in secondary school. The second expert has more than 15 years of experience in teaching ICT and is currently part time PhD student at University of Plovdiv with research interests in methodology of game-based education in ICT.

RESULTS

Results of questionnaires for students

According to the accepted validation strategy two questionnaires for students were used: preliminary questionnaire about the use of digital devices and perceived level of programming and the follow-up questionnaire about satisfaction with programming and coding activities, satisfaction with the organization of the implementation, and perception on the acquired coding skills.

In both questionnaires students were asked to self-assess their current level of programming skill. Based on this question, the difference between students' self-assessed initial and final level of programming skill was calculated (the answers from the questionnaires were paired based on the code that students have entered).

A total of 26 students (66,67% of students who participated in C4G activities) solved both questionnaires. We processed data for students participated in both questionnaires - 26 students (66.67%).

S1 - Preliminary questionnaire

The mean age of students was 13.96 years (SD=0.2041). The number of girls is 5 (19%)

Table 31 shows descriptive statistical analysis of participants' responses to the questions related to the use of digital devices, the internet and video-games. The comparison of the overall average results by gender (Figure 3) shows that boys and girls have been using digital devices for the same length of time. On a weekly basis, girls use digital devices and the Internet more, but boys spend significantly more time playing games.

Table 1 - The use of digital devices, the internet and video-games by gender

Question		N	Min	Max	Mean	SD
5. For how long have you been using computers, tablets or other digital devices (in years)?	Boys	21	2	11	6,67	2,517
	Girls	5	5	8	6,60	1,140
	Total	**26**	**2**	**11**	**6,65**	**2,297**
6. How many hours per week do you use a computer, tablet or other digital device?	Boys	21	5	84	30,43	20,889
	Girls	5	10	105	60,60	43,552
	Total	**26**	**5**	**105**	**36,23**	**28,278**
7. How many hours per week do you use the Internet?	Boys	20	3	56	17,85	16,576
	Girls	5	9	95	55,40	41,016
	Total	**25**	**3**	**95**	**25,36**	**27,072**
8. How many hours per week do you play video games?	Boys	20	0	74	19,00	19,791

	Girls	5	0	10	2,60	4,219
	Total	**25**	**0**	**74**	**15.72**	**18.918**

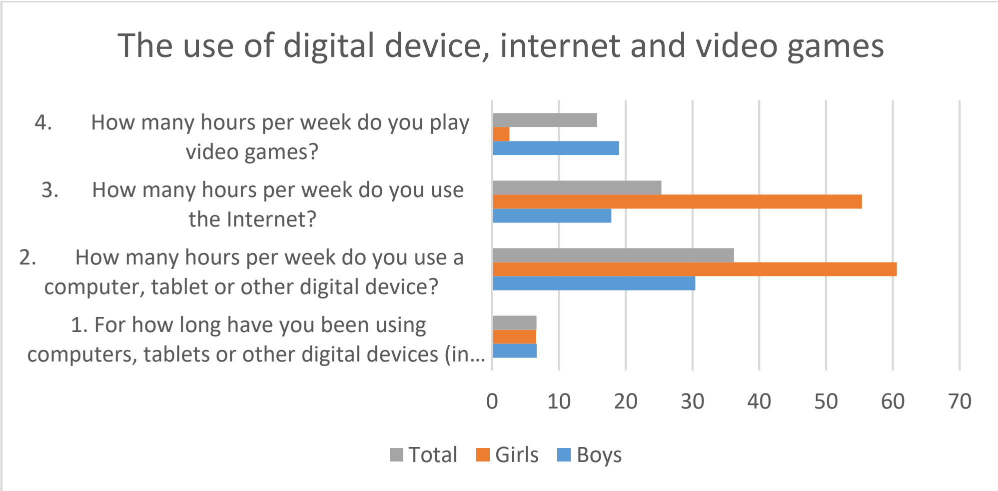


Figure 8 - The use of digital devices, the internet and video-games – comparison by gender

The participants self-assessed the level of their programming skills on the scale from *0 - I have never coded or programmed before* to *4 - I can design a solution of a problem in the form of a program*. Results are shown in the Table 2. Most of the students stated for themselves that they are at level 0 – novice in programming (50%) and level *1 - novice programmers* (38.5%). If we compare these results by gender (Figure 4), it can be seen that the boys prevail among the students that self-assess their level of programming with the levels 0 and 1. About 80% of the girls stated that their previous knowledge are at level 1.

Table 2 - Self-assessment of programming skills by gender

Level of programming skills	**Boys**	**Girls**	**Total**
0 - I have never coded or programmed before	61,9%	0	50,0%
1 - I am a novice programmer (just have basic ideas)	28,6%	80%	38,5%
2 - I can code simple programs	0%	0%	0%
3 - I am fluent in programming (can create a full program)	9,5%	20%	11.5%
4 - I can design a solution of a problem in the form of a program	0%	0%	0%

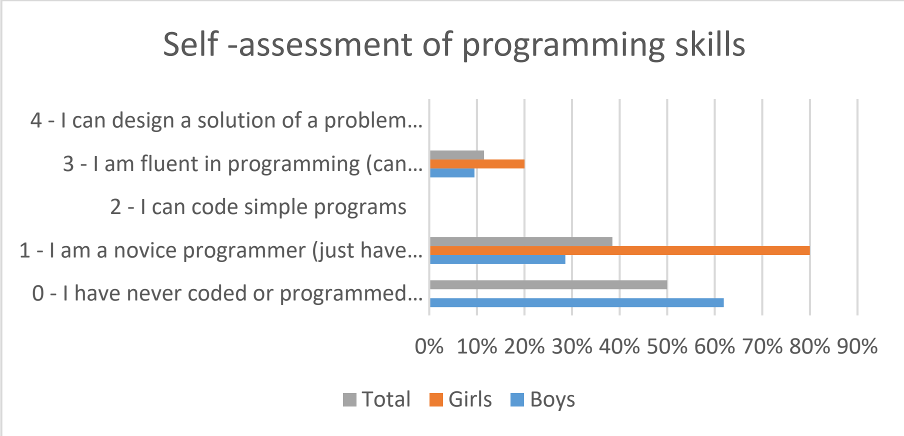


Figure 9 - Self-assessment of programming skills – comparison by gender

In the preliminary questionnaire the participants also stated which programming concepts are they familiar with. The results (Table 53) show that students are mostly familiar with the *events* (26,9%) and operators (19,2%) while they are the least familiar with the *loops* (3,8%) and *parallelism* (7,7%). According to the results, there is difference in familiarity of programming concepts between the genders (Figure 5). The largest difference in percentages can be observed for the concept *operators*. But due to small numbers of girls it is possible that there is no statistically significant difference in ratios for girls and boys. Additional analysis is needed.

Table 3 - Familiarity with the programming concepts

Concept	Boys	Girls	Total
Loops	4,8%	0%	3,8%
Conditionals	9,5%	40%	15,4%
Variables	14,3%	20%	15,4%
Statements (sounds, movement, looks, drawing)	4,3%	40%	11,5%
Operators	14,3%	40%	19,2%
Events	19%	60%	26,9%
Parallelism	4,8%	20%	7,7%

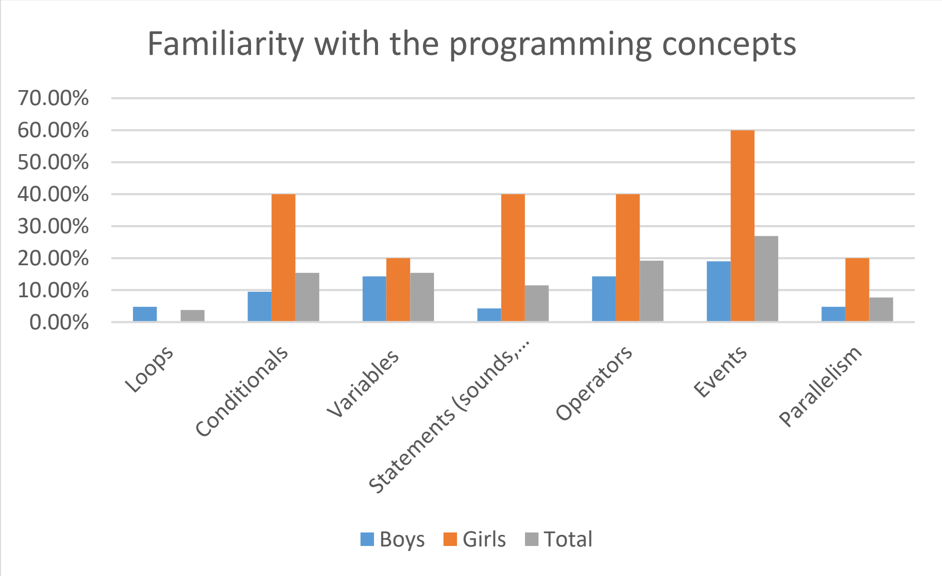


Figure 10 - Familiarity with the programming concepts – comparison by gender

Comparison of motivations by gender (Table 4) shows that about 40% of boys and girls are low motivated. Girls are not impressed to have carrier in programming, but they wish to show to others that they can program. We have to take into account that girls are only 5.

Table 4 - Motivation for learning programming by grade and gender

Statement	Boys	Girls	**Total**
I'm not motivated	38,1%	40%	38,5%
I want to succeed in the programming class	28,6%	0%	23,1%
I want to show other students I can program	**9,5%**	**40%**	15,4%
I want to follow a career in programming	14,3	0%	11,5%
I enjoy solving logic problems and puzzles	19%	0%	15,4%

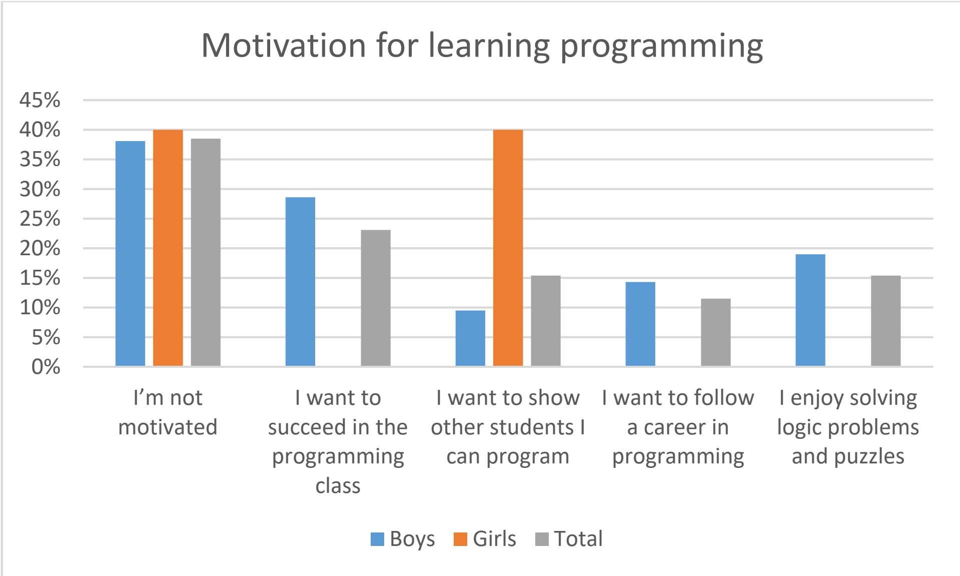


Figure 11 - Motivation for learning programming – Comparison by gender

S2 – Follow-up questionnaire

A total of 26 students solved the follow-up questionnaire about satisfaction with programming and coding activities, satisfaction with the organization of the implementation, and perception on the acquired coding skills. The students are the same that filled S1 questionnaire.

In the follow-up questionnaire, students expressed their attitudes regarding the C4G learning methodology and the implementation of activities using the 5-point Likert scale (1 – strongly disagree, 2 – disagree, 3 – neutral, 4 – agree, 5 – strongly agree). According to the results (Table 5.), both boys and girls felt engaged with this way of learning and think that conducted activities were relevant for learning programming. The short time of workshop did not give them to understand all concepts in programming. But they find that learning programming in this way is fun. Girls find that programming is easy. Both groups boys and girls confirm that learned material will be helpful for their future.

Table 513 – Satisfaction with C4G learning methodology

Statement		1	2	3	4	5	Mean	Median	SD
11. I found programming challenging.	Boys	9,5	14,3	19,0	42,9	14,3	3,38	4	1,203
	Girls	0	20	40	40	0	3,2	3	0,837
	Total	**7,7**	**15,4**	**23,1**	**42,3**	**11,5**	**3,35**	**4**	**1,129**
12. I found programming motivating.	Boys	23,8	14,3	28,6	28,6	4,8	2,7	3	1,153
	Girls	0	40	20	40	0	3	3	1,000

	Total	**19,2**	**19,2**	**26,9**	**30,8**	**3,8**	**2,81**	**3**	**1,201**
13. I found programming easy.	Boys	9,5	33,3	28,6	19,0	9,5	2,86	3	1,153
	Girls	0	20	20	60	0	3,40	4	0,894
	Total	**7,7**	**30,8**	**26,9**	**26,9**	**7,7**	**2,96**	**3**	**1,13**
14. I enjoyed programming.	Boys	9,5	14,3	19,0	38,1	19,0	3,43	4	1,248
	Girls	0	0	40	60	0	3,60	4	0,548
	Total	**7,7**	**11,5**	**23.1**	**42,3**	**15,4**	**3,46**	**4**	**1,140**
15. I understood most of programming concepts.	Boys	19,0	38,1	19,0	19,0	4,8	2,52	2	1,167
	Girls	0	80	0	20	0	2,40	2	0,894
	Total	**15,4**	**46,2**	**15,4**	**19,2**	**3,8**	**2,50**	**2**	**1,105**
16. Learning this way is fun.	Boys	19,0	0,0	14,3	42,9	23,8	3,52	4	1,401
	Girls	0	0	40	40	20	3,80	4	0,837
	Total	**15,4**	**0**	**19,2**	**42,3**	**23,1**	**3,58**	**4**	**1,301**
17. I felt engaged with this way of learning.	Boys	23,8	23,8	23,8	23,8	4,8	2,62	3	1,244
	Girls	0	60	20	20	0	2,60	2	0,894
	Total	**19,2**	**30,8**	**23,1**	**23,1**	**3,8**	**2,62**	**2,50**	**1,169**
18. The activities were relevant to learn.	Boys	0	4,8	38,1	28,6	28,6	3,81	4	,928
	Girls	0	20	40	40	0	3,20	3,00	0,837
	Total	**0**	**7,7**	**38,5**	**30,9**	**23,1**	**3,69**	**4**	**,928**
19. At any time, it was clear what I had to do.	Boys	0	14,3	38,1	38,1	9,5	3,43	3	,870
	Girls	0	40	20	40	0	3	3	1
	Total	**0**	**19,2**	**34,6**	**38,5**	**7,7**	**3,35**	**3**	**0,892**
20. What I learned will be relevant for my future.	Boys	0	9,5	28,6	23,8	38,1	3,90	4	1,044
	Girls	20	0	0	60	20	3,60	4	1,517
	Total	**3,8**	**7,7**	**23,1**	**30,8**	**34,6**	**3,85**	**4**	**1,120**

The students again self-assessed the level of their programming skills on the scale from *0 - I have never coded or programmed before* to *4 - I can design a solution of a problem in the form of a program*. A total of 26 students (21 boys, 5 girls) solved the preliminary and the follow-up questionnaire so their self-assessment results were compared. Because the workshops with the students were too short, we can not to expect achievements of higher results and changes in self-assessment of programming skills. All girls do not state changes in their level of programming skills. Only two boys (9,5%) indicate changes in their programming skills with one level up.

A Wilcoxon's signed rank test for paired samples showed that students self-assessed their programming skill are the same as before short workshop activities. significantly higher after the C4G activities compared to self-assessment before the C4G activities (Table 126).

The effect size is calculated with formula r=$\frac{Z}{\sqrt{n}}$, where Z is z- statistics obtained from Wilcoxon signed rank test (SPSS), n is number of observations.

Table 6 - Comparison of self-assessment of programming skill

		Descriptive statistics					Wilcoxon's signed rank test results		
		N	**MIN**	**MAX**	**MEAN**	**SD**	**Z**	**p**	**Effect size**
Boys	S1	21	0	3	.57	.926	-1,414	0,500 (exact sig. 0,500)	.309
	S2	21	0	4	.67	1.065			
Girls	S1	5	1	3	1.4	.894	0	1.0 (exact sig. 2-tiled)	.0
	S2	5	1	3	2.4	.894			
Total	**S1**	**26**	**0**	**3**	**.73**	**.962**	**-1.414**	0,500 (exact sig. 0,500)	**.277**
	S2	**26**	**1**	**4**	**.81**	**1.059**			

Students' comments

Nevertheless, that there were no changes in self-assessment of programming skills students were impressed by the proposed approach and as a result of this short workshops half of them decide to start participation in extracurricular course in programming.

Teachers' observations and comments

After the implementation activities, teachers and students – future teachers were asked to express their qualitative opinions about the C4G methodology and the implementation process using the forms T1 and T2.

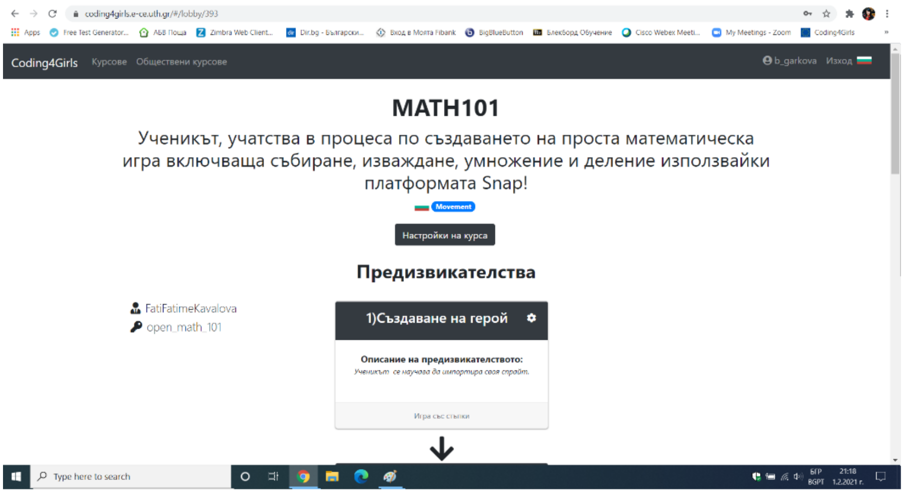
Teachers' observations

The teacher that implemented C4G approach reported: "The students quickly navigated the platform, it was fun and interesting, they helped each other and competed with each other. The students did not encounter any special difficulties in working with the platform, they sought help in performing some tasks set by the teacher. It is very useful to have a textbook for using the programming training platform, as well as a teacher's book with methodological guidance and tasks and scenarios." Also, in discussions with the teacher about positive and negative side of Snap! usage, she comment that less features of the Snap! in comparison with Scratch, regarding the integrated graphical editor, gives opportunities to the students to extend their skills in searching, finding and processing external images from internet space and take care about copyrights of the used pictures.

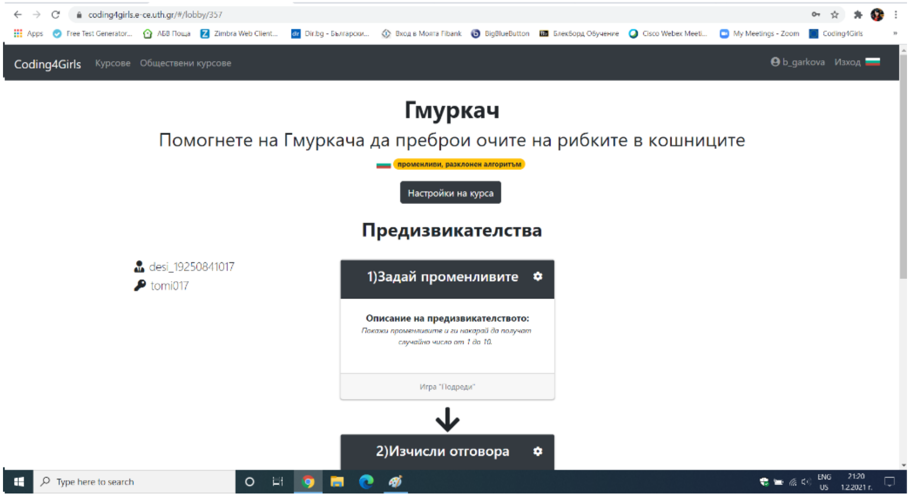
The future teachers from master's degree programme in their answers of the questions in form T2 (11 from 15) stated their attitude to the C4G method. Most of them mentioned that the use of games in education aims to make the learning content much more accessible and understandable for students and at the same time to strengthen children's interest in the discipline. Students will be engaged in the games and for them it will be fun. The approach is relevant to the new school curricula in ICT. They evaluate positively teachers' and students' materials published on the web site of the project – videos, learning sheets with scenarios. Tree of master's degree students (one of them is teacher in Informatics) commented that in the beginning it will be interesting for the students, but it will be difficult to confirm that this interest will be sustainable. They also comment that approach requires a lot of time to prepare games and to be implement in the class. The platform works slowly and requires high parameters of the used computer system.

The master's degree students developed additional scenarios according the C4G methodology and some of them were implemented in the C4G game platform. Some example of these games are given in Fig. 10. The games are:

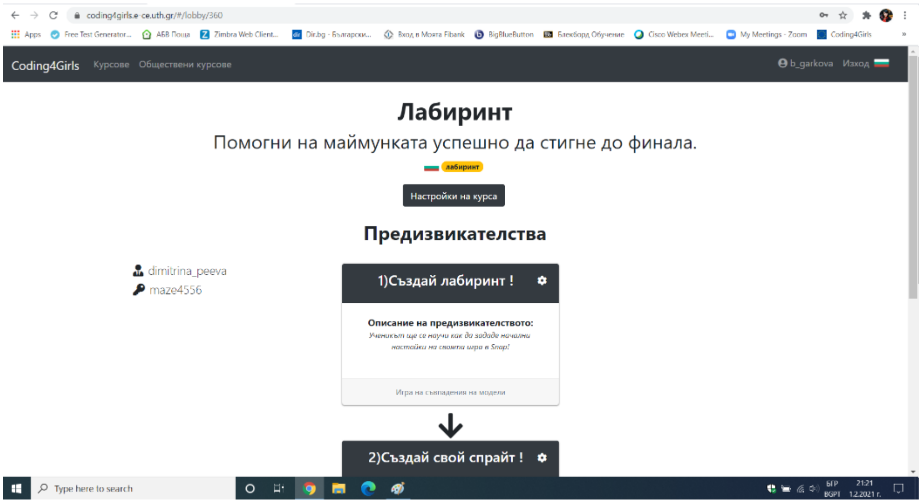
- Fun math – access code open_math_101;
- Diver with access code – tomi017;
- Maze – access code maze4556.



Course Math 101



Course Diver



Course Maze

Fig. 10 Games created by the master degree students in C4G platform – teacher side

Teaches from online qualification course developed 17 learning scenarios with possibilities for integration with different school subjects – physics, maths etc.

They filled online questionnaire based on the T2 with some changes in type of questions. Results from the questionnaire are presented in the Fig.11 ….Fig. The colours in the chart mean as follows: (Definitely yes – blue colour, Yes – red colour, Not – orange colour and Definitely not – green colour).

All teachers have positive perceptions about proposed C4G approach. They confirm that approach is effective to achievement of learning objectives, effective for building programming skills, easy of use learning material for the students. The teachers will apply the platform and methodology of the Coding4girls project in their teaching practice. Only one of them answered that will not use the game-based platform.

Fig. 11. The proposed approach for learning programming adds value to achieve learning objectives

Fig. 12. Answers of the statement: the game-based approach in Coding4Girls is effective for development of programming skills.

Fig. 13. Proposed methodology gives possibilities for easy understanding of learning material

Fig. 14. For the students it will be fun to use this approach

Fig.15. Would you like to apply this approach in your school practice

Fig. 16. Would you like to use the game platform developed in the frame of the project Coding4Girls?

We also asked teachers how many hours they spend for development of learning scenario and game in the platform in case they have developed the game. Average time for development of scenario – 11,5 hours (STD- 16,51) and 4,7 hours for development of the game (STD – 3,26). The process is estimated as high time consuming for development of scenarios and game in C4G game environment. Of course, it will depend from the experience and skills of the teacher.

The teachers gave high grade of the organisation of the online course, learning materials and the used teaching approaches.

Regarding usability teachers confirm that approach is useful and effective. Some of them mentioned that C4G game-based platform requires to high parameters of the computer system, that in some cases is till not available for some schools and the system works slowly. Some materials developed by the teachers are presented in Annex J.

Experts' comments

External validators - experts (N_E=2) were also asked to give their qualitative opinions regarding the accomplishment of learning objectives by the students, relevance, effectiveness and acceptance of the proposed methodology by the students, and the overall organization of the implementation.

They agree that for developing basic programming skills for students from 10-16 years, the C4G methodology is suitable. The methodology for learning scenarios is adaptable to different block programming environments and it is possible easy to transfer scenarios from Snap! to Scratch. (Scratch is most used programming environment in Bulgarian primary schools.) "Although very different from the traditional methodology for working in programming classes, the proposed methodology is very well precepted by the students and they quickly will orientate themselves in the new situation. Today's students are a generation that grew up with various computer games. The C4Girls platform for learners did not turn out to be something scary and difficult to work with, on the contrary - another game (challenge) to learn to play." The platform and the proposed methodology can be used both for the acquisition of new knowledge and for the consolidation of already studied material. Developed project platform requires the presence of computers with very good technical performance. This poses some barriers to the implementation of the approach in schools, where technology is often obsolete. Also, the platform will be more engaged for girls if in the beginning the rooms are decorated in suitable interior. The approach of combining game environment for engagement of the students and learning programming through game development is very appropriate for the students in age 10-16.

DISCUSSION AND CONCLUSIONS

The results from students' opinion and teacher observation show that students accept well an approach as fun environment for building programming skills. But to achieve results in programming they need more time for using of environment and more classes with collaboration with classmates and teacher.

After the training activities, teachers and prospective teachers stated that proposed conducted activities will enable students to achieve learning outcomes and at the same time had fun. Some of master students (3) are not so satisfied about sustainable effect of the proposed approach and platform. Teachers think that C4G approach is effective, fun and useful for development of programming skills. They intend to apply approach in their future work with the context of new school curricula in ICT and Computer modelling in 5-7th grade. This curriculum will start from 2021/2022 school year and contains topics related to programming. In 5th grade programming in bock based environment will continue with development of games and use of subprograms and lists. In 6th and 7th grades students will move from block-based programming to text-based programming in JavaScript or Python. Teachers will decide about used programming language and environment. The combination of design thinking and game-based approach for building programming skills is very suitable for the students. The approach is time consuming for the teachers if they decide to develop own scenarios and games according to needs and previous skill of the students. But the developed in the frame of the project learning materials will help them to apply proposed methodology and to attract the programming to the wide number of students.

Teachers and experts well evaluate fact that platform gives the teacher possibility to adapt existing games to curricula and students' needs. Teachers also and experts stated that platform requires high computer systems parameters and, in some schools, will be difficult to implement successfully the environment.

Experts suggest being improved the design of "interior" of the entrance room and lobby of the environment.

In conclusion the C4G methodology is appropriate for students who are 10 – 16 years old and enable the achievement of learning outcomes in an effective and fun way, it is adaptable according curricula, students' needs and interests. Most of schools use Scratch instead Snap! and in new Bulgarian curricula in ICT and programming will be introduced JavaScript or Python. Therefore, enlargement of the platform towards the Scratch, JavaScript and Python will be very useful.

Acknowledgments: we thanks to all participants in the validation study of the C4G methodology and game environment and colleagues from Croatia project team for the proposed report template. This report is based on the template of Croatian National validation report and in some paragraphs are used relevant texts from it.

ANNEXES

A. S1. PRELIMINARY QUESTIONNAIRE FOR STUDENTS (in Bulgarian)

S1. ПРЕДВАРИТЕЛЕН ВЪПРОСНИК ЗА УЧЕНИЦИ	
Тази анкета представлява предварително проучване за използването на цифрови устройства и опит в програмирането, проведено в рамките на проекта CODING4GIRLS, който има за цел да разработи игрови подход за изграждане на умения за програмиране. Вашите отговори ще бъдат анонимни и ще се използват само с изследователски цели. Благодарим Ви за отделеното време и съдействие! Моля напишете кода, получен от вашия учител по-долу.	
КОД И ОСНОВНА ИНФОРМАЦИЯ	
Код: ______________ Училище: ______________ Възраст: ______________ Клас: ______________ Пол: М Ж	
УПОТРЕБА НА ДИГИТАЛНИ УСТРОЙСТВА, ИНТЕРНЕТ И ВИДЕОИГРИ	
От колко време използвате компютри, таблети или други цифрови устройства?	_________ години
Колко часа на седмица използвате вашите компютри, таблети или други дигитални технологии?	_________ часа
Колко часа на седмица сърфирате в Интернет?	_________ часа
Колко часа на седмица играете видеоигри?	_________ часа
ОПИТ В ПРОГРАМИРАНЕТО	
Какво е вашето ниво на програмиране сега? *Закръглете най-подходящия отговор.* Никога преди не съм програмирал. Аз съм начинаещ програмист (имам основни познания). Мога да пиша леки програми. Владея свободно програмирането (мога да създам пълна програма). Мога да проектирам решение на даден проблем под формата на програма.	
Ако вече сте изучавали програмиране, коя от следните концепции ви е позната? *Отбележете един или повече отговори.* Цикли Променливи Събития	

Условия	Оператори	Паралелност
Представяне (звук, движение, изглед, рисуване)		

Какво Ви мотивира да се научите да програмирате? *Изберете едно или повече.*
Не съм мотивиран
Искам да успея в курса по програмиране
Искам да покажа на съучениците си, че се справям добре
Искам да работя, като програмист
Интересно ми е, да решавам логически задачи и пъзели
Друго ______________________________

B. S2. FOLLOW-UP QUESTIONNAIRE FOR STUDENTS (in Bulgarian)

S2. ПОСЛЕДВАЩО ПРОУЧВАНЕ ЗА УЧЕНИЦИ

Това е последващо проучване за удовлетвореността от C4G подхода за обучение и изпълнението на дейности за придобиване на умения за програмиране.

Вашите отговори ще бъдат анонимни и ще се използват само за изследователски цели. Благодарим ви за отделеното време и съдействие!

Моля, напишете по-долу кода получен от вашия учител (това е същият код, който сте използвали в предварителния въпросник).

КОД И ОСНОВНА ИНФОРМАЦИЯ

Код: _______________ Училище: _______________

Възраст: _______________ Клас: _______________

Пол: М Ж

C4G МЕТОДОЛОГИЯ ЗА ОБУЧЕНИЕ

Класифицирайте следните твърдения:	*Напълно несъгласен*	*Несъгласен*	*Нямам мнение*	*Съгласен*	*Напълно съгласен*
Програмирането за мен е предизвикателство.	1	2	3	4	5
Мотивиран съм да програмирам.	1	2	3	4	5
Считам програмирането за лесно.	1	2	3	4	5
Приятно ми е да програмирам.	1	2	3	4	5
Разбирам повечето от програмите концепции.	1	2	3	4	5
Обучението по този начин е забавно.	1	2	3	4	5
Почувствах се ангажиран с този начин на обучение.	1	2	3	4	5
Дейностите бяха добре подбрани.	1	2	3	4	5

По всяко време беше ясно какво трябва да направя.	1	2	3	4	5
Това, което научих, ще ми бъде полезно за в бъдеще.	1	2	3	4	5

ВЪЗПРИЕТО НИВО НА ПРОГРАМИРАНЕ

Какво е вашето ниво на програмиране? *Закръглете най-подходящия отговор.*

Никога преди не съм програмирал

Аз съм начинаещ в програмирането (имам основна представа)

Мога да пиша лесни програми

Владея свободно програмирането (мога да създам пълна програма)

Мога да проектирам решение на проблем под формата на програма

УДОБСТВО НА ИГРОВАТА СРЕДА

Класифицирайте следните твърдения:	*Напълно несъгласен*	*Несъгласен*	*Нямам мнение*	*Съгласен*	*Напълно съгласен*
Бих искал да използвам тази игра по-често.	1	2	3	4	5
Намирам играта за сложна.	1	2	3	4	5
Играта беше лесна.	1	2	3	4	5
Имам нужда от помощ за да използвам тази игра.	1	2	3	4	5
Различните функции в играта бяха добре интегрирани.	1	2	3	4	5
В тази игра имаше твърде много непоследователност.	1	2	3	4	5
Повечето хора много бързо биха се научили да използват тази игра.	1	2	3	4	5
Играта беше много тромава.	1	2	3	4	5

Чувствах се уверен, докато играя.	1	2	3	4	5
Трябваше да науча много неща, преди да мога да започна да играя тази игра.	1	2	3	4	5
ОПИТ В ИГРИТЕ					
Класифицирайте следните твърдения:	*Напълно несъгласен*	*Несъгласен*	*Нямам мнение*	*Съгласен*	*Напълно съгласен*
Чувствах се доволен.	1	2	3	4	5
Чувствах се сръчен.	1	2	3	4	5
Заинтересувах се от играта.	1	2	3	4	5
Мислех, че е забавно.	1	2	3	4	5
Бях напълно зает с играта.	1	2	3	4	5
Чувствах се щастлив.	1	2	3	4	5
Играта ми развали настроението.	1	2	3	4	5
Мислех за други неща.	1	2	3	4	5
Изморително е.	1	2	3	4	5
Чувствах се достатъчно компетентен.	1	2	3	4	5
Мислех, че е трудно.	1	2	3	4	5
Беше естетически приятно.	1	2	3	4	5
Забравих за всичко около мен.	1	2	3	4	5
Чувствах се добре.	1	2	3	4	5
Бях добър/а в това.	1	2	3	4	5
Бях отегчен.	1	2	3	4	5
Чувствах се успешен.	1	2	3	4	5
Проявих въображение.	1	2	3	4	5

Чувствах, че мога да изследвам нещата.	1	2	3	4	5
Забавлявах се.	1	2	3	4	5
Бързо постигнах целите на играта.	1	2	3	4	5
Чувствах се раздразнен.	1	2	3	4	5
Чувствах се притиснат.	1	2	3	4	5
Чувствах се раздразнително.	1	2	3	4	5
Изгубих представа за времето.	1	2	3	4	5
Беше едно предизвикателство.	1	2	3	4	5
Чувствах се предизвикан.	1	2	3	4	5
Бях дълбоко концентриран в играта.	1	2	3	4	5
Чувствах се разочарован.	1	2	3	4	5
Чувствах се с богат опит.	1	2	3	4	5
Загубих връзка с външния свят.	1	2	3	4	5
Усетих натиск във времето.	1	2	3	4	5
Трябваше да положа много усилия за това.	1	2	3	4	5

C. S3. STUDENT'S COMMENTS (in Bulgarian)

S3. МНЕНИЕ НА УЧЕНИЦИ
След прилагането на C4G подхода за изграждане на умения по програмиране, учителите събират мнения и коментари от учениците в групова анкета и ги обобщават. Моля, групирайте учениците и съберете техните мнения и коментари, като използвате този формуляр. Благодарим ви за отделеното време и съдействие!
ОСНОВНА ИНФОРМАЦИЯ
Учител: ______________________ Клас: _______________ Училище: ______________________ Дата: _______________
ОБЩА ОРГАНИЗАЦИЯ И ВЪЗПРИЯТИЕ ОТ УЧЕНИЦИТЕ
Бихте могли да попитате учениците за мнението им относно цялостната организация, придобитите знания, тяхното възприятие за уместността и ефективността на обучението, основано на игри и постигнатото забавление.
ТРУДНОСТИ ПРИ ОБУЧЕНИЕТО
Бихте могли да попитате учениците за всякакви затруднения или проблеми, с които са се сблъскали по време на курса и каква е била реакцията им, откривайки тези проблеми.
МНЕНИЕ НА УЧЕНИЦИТЕ ЗА ТОВА КАК ДА СЕ ПОДОБРЯТ МЕТОДОЛОГИЯТА, ИНСТРУМЕНТИТЕ И СЪДЪРЖАНИЕТО НА C4G.
ВСИЧКО, КОЕТО СЧИТАТЕ ЗА ПОЛЕЗНО

D. T1. TEACHER'S OBSERVATIONS (in Bulgarian)

T1. НАБЛЮДЕНИЯ НА УЧИТЕЛЯ
По време на изпълнение на задачите, учителите наблюдават и документират реакцията на учениците и техния напредък в изграждането на умения по програмиране, използвайки игрови-базирания C4G подход. Моля, използвайте този формуляр и посочете вашите наблюдения относно изброените по-долу аспекти. Благодарим ви за отделеното време и съдействие!
ОСНОВНА ИНФОРМАЦИЯ
Учител: ____________________ Клас: __________________ Училище: ____________________ Дати (от - до): __________________
УЧАСТИЕ И ЗАИНТЕРЕСОВАНОСТ НА УЧЕНИЦИТЕ
Вземат ли активно участие в обучението? Сътрудничат ли си? Забавляват ли се? и т.н.
ТРУДНОСТИ И ПРОБЛЕМИ ПРИ ОБУЧЕНИЕТО
Срещат ли трудности със съдържанието и/ или технологията? Имат ли нужда от помощ при работата в платформата? и т.н.
ВСИЧКО ДРУГО, КОЕТО СЧИТАТЕ ЗА ПОЛЕЗНО

E. T2. TEACHER'S COMMENTS (in Bulgarian)

T2.2 АНКЕТА ЗА УЧИТЕЛИ
Събират се мнения и коментари на учителите относно C4G подхода, основан на играта за изграждане на умения по програмиране. Моля, използвайте този формуляр и споделете вашето мнение по изброените по-долу аспекти. Благодарим ви за отделеното време и съдействие!
ОСНОВНА ИНФОРМАЦИЯ
Учител: ______________________ Дата: ____________ Училище: ______________________
ПРИНОС НА C4G ПОДХОДА ЗА ИЗПЪЛНЕНИЕ НА ПОТЕНЦИАЛНИТЕ ЦЕЛИ НА ОБУЧЕНИЕТО
ЕФЕКТИВНОСТ И АКТУАЛНОСТ НА ИГРОВИЯ ПОДХОД ПРЕДЛОЖЕН В ПРОЕКТА CODING4GIRLS ЗА ИЗГРАЖДАНЕ НА УМЕНИЯ ПО ПРОГРАМИРАНЕ

ВЪЗМОЖНОСТИ ЗА ВЪЗПРИЕМАНЕ НА ПРЕДЛОЖЕНАТА МЕТОДОЛОГИЯ ОТ УЧЕНИЦИТЕ
ЗАБАВНО ЛИ ЩЕ Е ЗА УЧЕНИЦИТЕ ДА ИЗПОЛЗВАТ ТОЗИ ПОДХОД?
ВАШЕТО МНЕНИЕ ЗА ОБЩАТА ОРГАНИЗАЦИЯ НА ОБУЧЕНИЕТО НА УЧИТЕЛИ

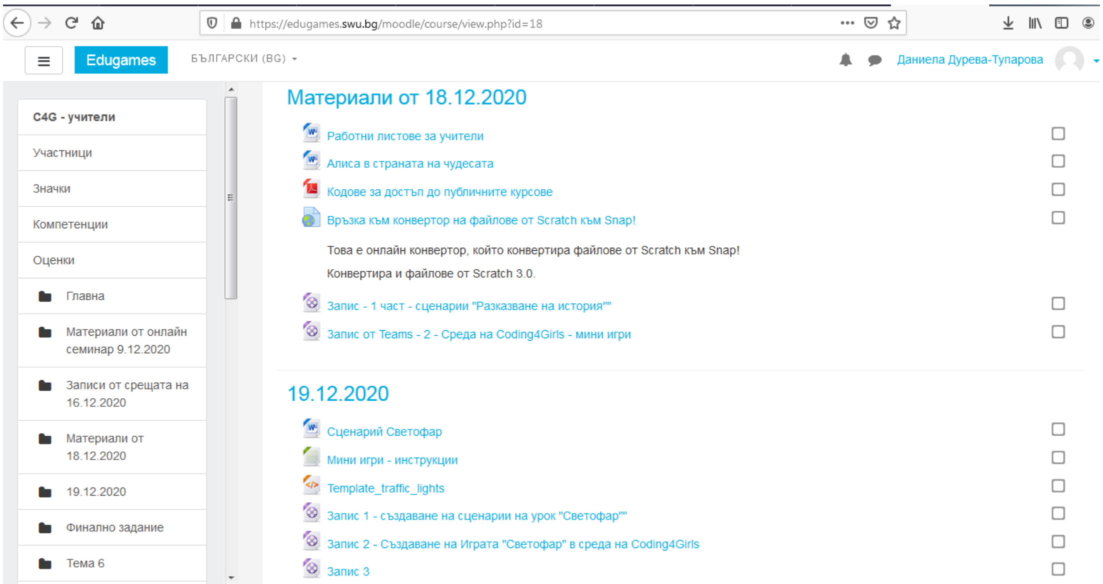
ПОЛЗВАЕМОСТ И ВЪЗПРИЕМАНЕ НА ПОДХОДА CODING4GIRLS ЗА ОБУЧЕНИЕ ЧРЕЗ СЕРИОЗНИ ИГРИ (комбинация на дизайн мислене, игрови подход, образователна рамка)
КОМЕНТАРИ, КОИТО СЧИТАТЕ ЗА ПОЛЕЗНИ

F. EXPERT'S COMMENTS (in Croatian)

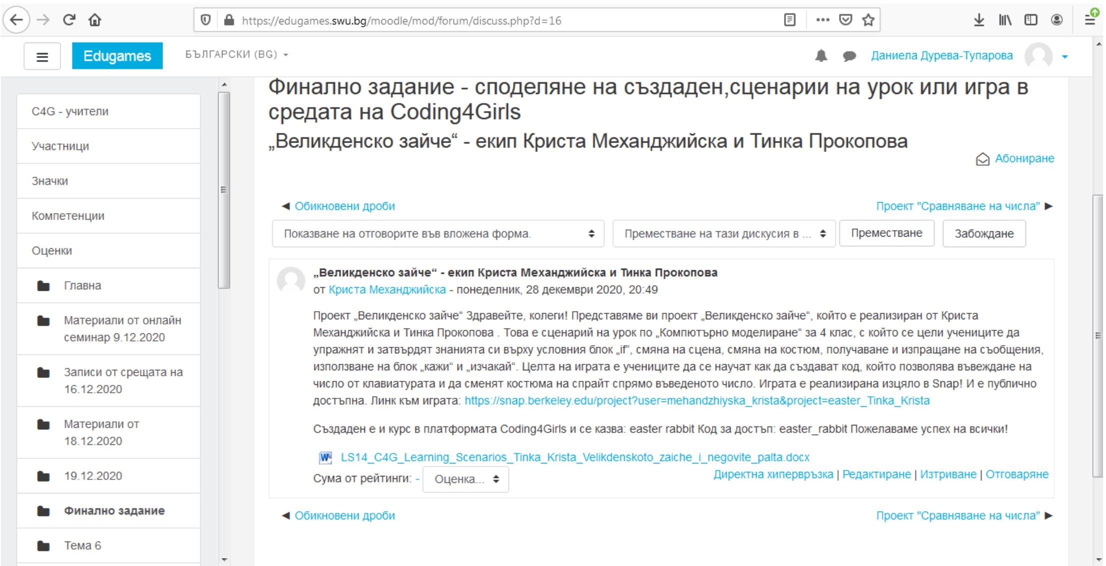
Е. Коментари на експерти	
След внедряване на игрово-базиран C4G за изграждане на умения за програмиране, вербалните качествени мнения и коментари на експертите се събират в структурирано интервю. Моля, използвайте този формуляр и посочете експертно мнение по изброените по-долу аспекти.	
GENERAL INFORMATION	
Име: ____________________	Позиция:__________
Институция: ____________________	Дата: __________
Изпълнение целите на обучение от учениците	
Съответствие и ефективност игрово базираното обучение за изграждане на умения за програмиране предложен в проекта Coding4Girls	
Възприемане на предложената методология от учениците	

Постигане забавление от учениците
Вашето общо мнение за цялостната организация при реализация на подхода
Ползваемост и възприемане на концепцията на подхода базиран на сериозни игри (свързан с CODING4GIRLS игрови подход, дизайн мислене и образователна рамка)
Всяко нещо, което смятате че е подходящо да коментирате.

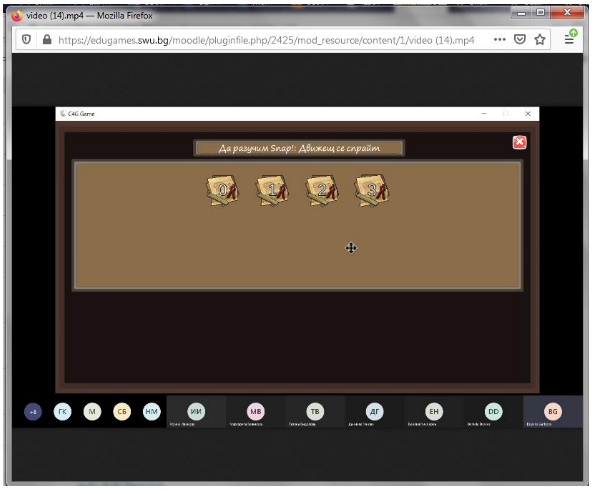
G. Screenshots from the online course with the teachers

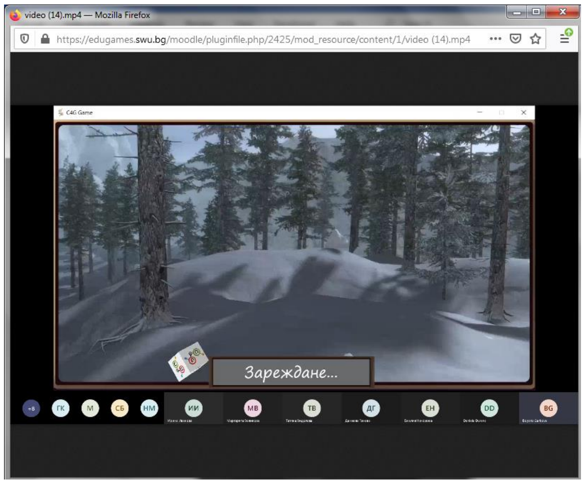


Part of the online course with all records of the meetings

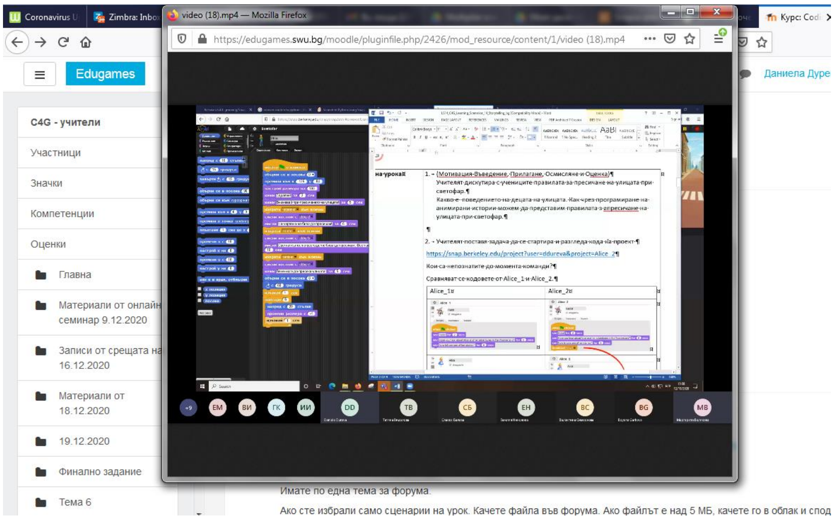


Some final assignments, developed by the teachers

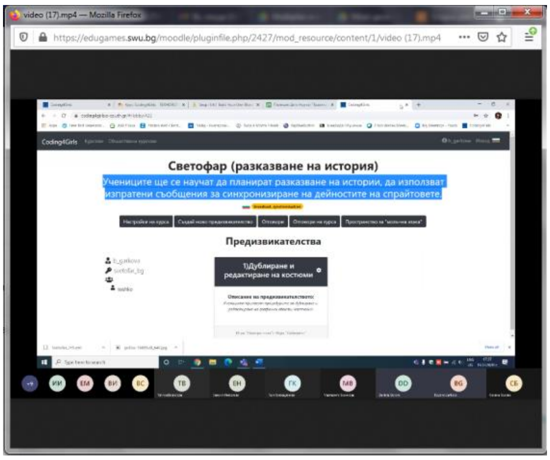


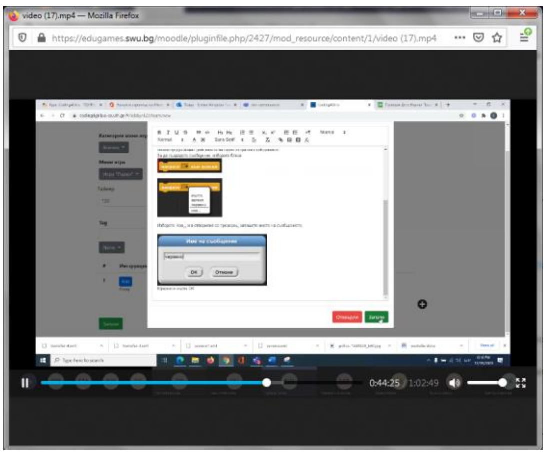


Presentations of mini games in the C4G platform



Development of scenario in learning sheet for the topic Traffic Light





Development of game Traffic Light in the C4G environment

H. Syllabus for teachers' qualification course

SOUTH-WEST UNIVERSITY "NEOFIT RILSKI"

BLAGOEVGRAD

Approved by:

Dean of FMNS: / Assoc. Prof. El. Каращранова, PhD /

S Y L L A B U S

for a qualification course for teachers

GAME-BASED PROGRAMMING TRAINING TECHNOLOGIES

CODING4GIRLS PROJECT

Period of Tuition:	32 hours
Form of Tuition:	Partial on-site attendance/distance
Tuition-Providing Faculty:	Faculty of Mathematics and Natural Sciences (FMNS)
Tuition-Providing Department:	Informatics (in FMNS)

BLAGOEVGRAD
2020 г.

Syllabus

The syllabus and the teaching and learning materials were designed within the Coding4Girls project, co-financed together with ERASMUS+, KA201

Name of Programme
GAME-BASED CODING INSTRUCTION TECHNOLOGIES

Programme Target: (*more than one type of educationalists can be chosen*)	
X	Teachers – primary school
X	Teachers – lower-secondary school
X	Teachers – upper-secondary school
	Head-teachers
	Deputy Head-teachers
X	Head of ICT Sector
	Pedagogical consultants, psychologists
	Pedagogical staff in dormitories
	Speech therapists, rehabilitators, resource teachers
	Répétiteur, choreographers, coaches
	Other (please specify)

Syllabus annotation
Brief description:
The course is designed to target teachers of computer modelling at primary level, IT teachers at lower-secondary level, and IT and Informatics teachers at upper-secondary level, as well as head of ICT sector. Course graduates will be able to organise successfully digital competences development classes within the framework of the *Education for Tomorrow* project and other extracurricular activities in the field of teaching programming. The syllabus includes the following key topics:

1. Fundamental concepts – serious games, game-based learning, design thinking, learning theories and their association with serious games.
2. Game environments for the teaching of programming. Overview.
3. Snap! block environment for programming. Major characteristics and blocks. Introducing basic structures through computer games design.
4. Game environment for programming, designed through the *Coding4girls* project. Teacher interface and student interface. Application of the environment in the process of acquiring new content and skills, digital competences evaluation, independent studies.
5. Creating learning scenarios for teaching coding to children through computer games.

The form of tuition is partial attendance – 16 classes of attendance is required, as well as 16 classes if distance education in the form of webinars and independent assignments. Practice sessions involve group work and production of resource materials. Should attendance at the university is impossible (in accordance with instructions of the Ministry of Education and Science /MES/), classes will be held in the form of synchronous learning through synchronous distance learning technologies: on-line videoconference platforms.

Aims and Objectives:

The tuition will result in improving the trainees' knowledge and skills in:

Academic competence:

- Knowledge in the sphere of the teaching and learning in computer modeling and coding, as well as coding teaching methodology. (1.1.)
- Evaluation of digital competencies through contemporary means and technologies (1.2.)
- Development of communicative skills, critical and design thinking for the purpose of efficient search, deduction and selection of information from a variety of sources. (1.7)

Pedagogical competence:

- Planning of activities, in the sphere of extracurricular education in coding (1.1)
- Realization of disciplinary and interdisciplinary connections, forecasting of the expected learning outcomes. (1.2)
- Application of innovative methods for teaching and evaluating students' results. (1.5)
- Supporting and motivating students in the formation of digital skills (2.4)
- Implementing the requirements for safe learning, education and work conditions and providing students with a safe and secure environment, including work on the Internet (2.10)
- Using innovative methods and tools to promote student progress. (3.2)

Administrative competence   • Organization of coding training in a game environment.

Methods of teaching:
The following training methods will be applied: Lecture, discussion, group work, independent assignment.

Material, technical and information resources specific to the program:
Laptop, video projector, screen, internet access, computer room with internet access for students, e-learning platform Moodle, online video conferencing environment, study materials: user guides, videos, sample lesson scenarios, developed within the Coding4Girsl project.

Relationship between the theoretical and practical parts:
Theoretical part - 30%, practical part - 70%

Competencies to be acquired: **(one may choose one or more types of competencies)**	
X	Academic
X	Pedagogical
	Organisational
	Communicative
X	Administrative

Forms of tuition:	
	On-site attendance
X	Distance
X	Partial on-site attendance

Duration of tuition: (*number of classes*)
32 (16 on-site attendance and 16 distance education)

Number of qualification credit points: (*number of points*)
2 credit points

Final evaluation (elective):	
X	Defending a lesson project
	Test
	Presentation
	Other(please, specify):
	Methodological case-study

Trainers included in the program: **(list the names and PIN of the trainers)**
Daniela Ivanova Tuparova **Boyana Garkova** **Rositsa Georgieva**

Contact person:	
Name:	**Daniela Ivanova Tuparova**
Current address (by ID card):	
Tel:	
E-mail:	ddureva@swu.bg

Blagoevgrad Lecturer:

2020 г. / Prof. Daniela Tuparova, PhD /

The syllabus was discussed and approved by the Department Council of the Department of Informatics on …………… ………….. protocol №

Head of Department:

/Assoc. Prof. Stefan Stefanov, PhD/

The syllabus was approved by the Faculty Council of the Faculty of Natural Sciences and Mathematics on ……..; protocol No….

I. Some materials developed by teachers – scenario and games

Project “Clean the Seabed” by Elena Garbacheva

“This is a lesson scenario in which students will learn to use variables. They will also consolidate their previous knowledge and skills.

I created a game that is now public and available in Snap !. The octopus moves with the help of arrows.

The link to the game is:

https://snap.berkeley.edu/project?user=elenagmg&project=Sea-floor-end

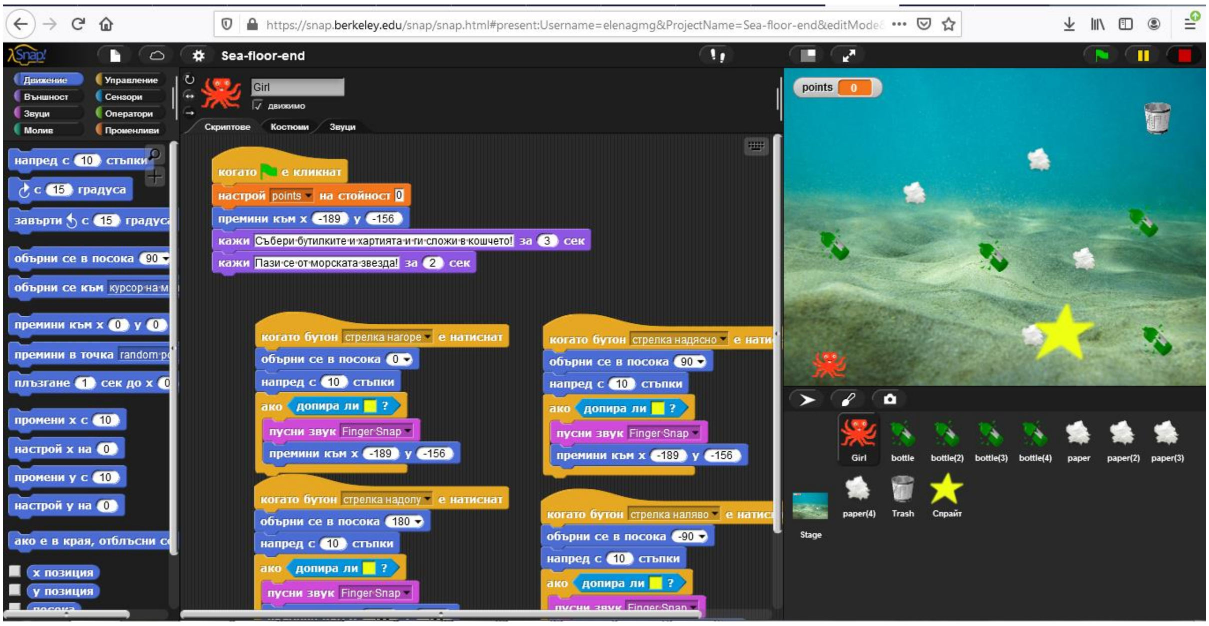
After collecting all the garbage, the octopus should go to the trash.

Of course, garbage collection is not an easy task, so there is a sprite - a star that returns the octopus to its starting position.

The collected garbage is counted and this number is stored in a variable.

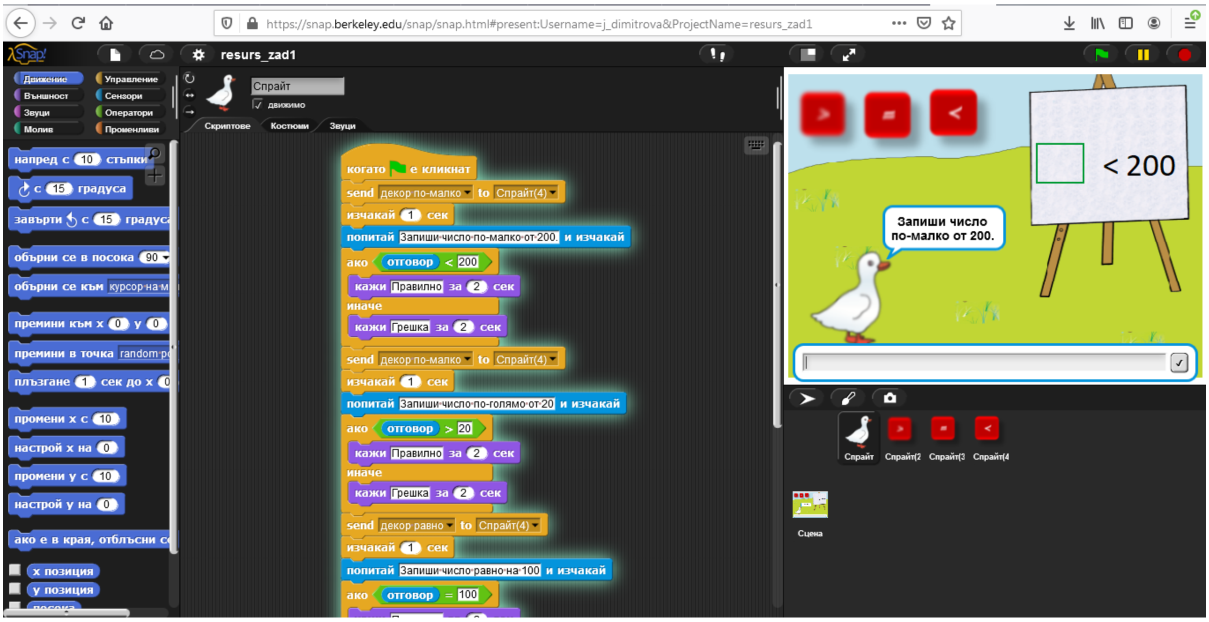
The course I created on the Coding4Girls platform is called **"Clean the Seabed."**

The code for it is: **sea_bed”**

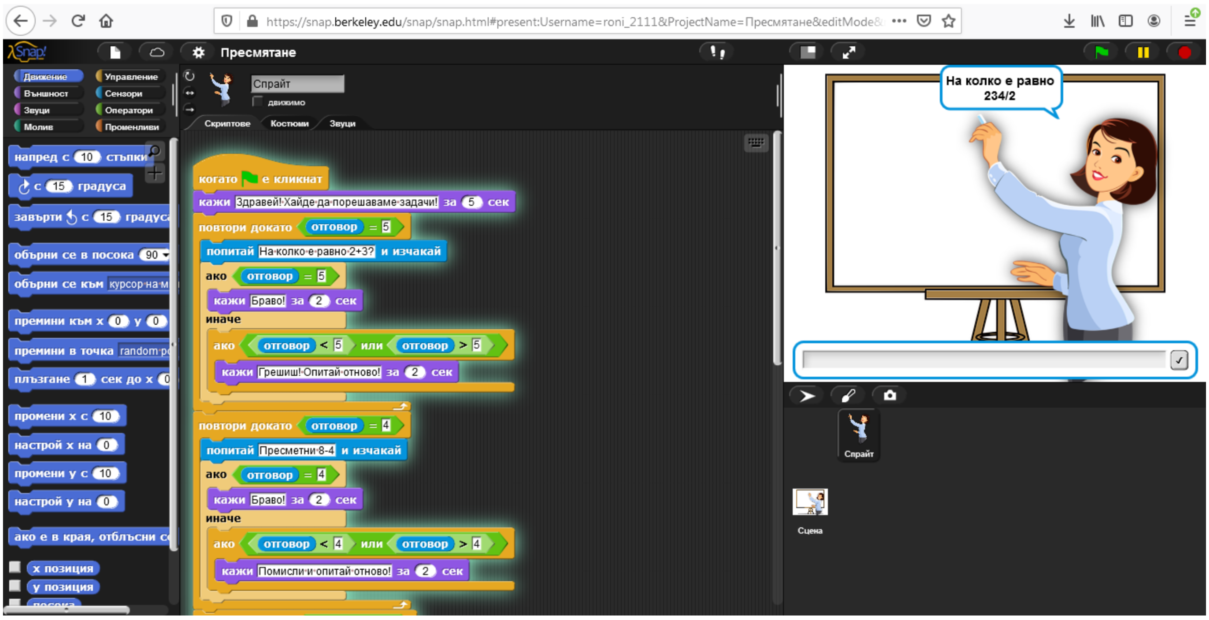


Compare numbers by Julietta Dimitrova

Game for checking knowledge about numbers.

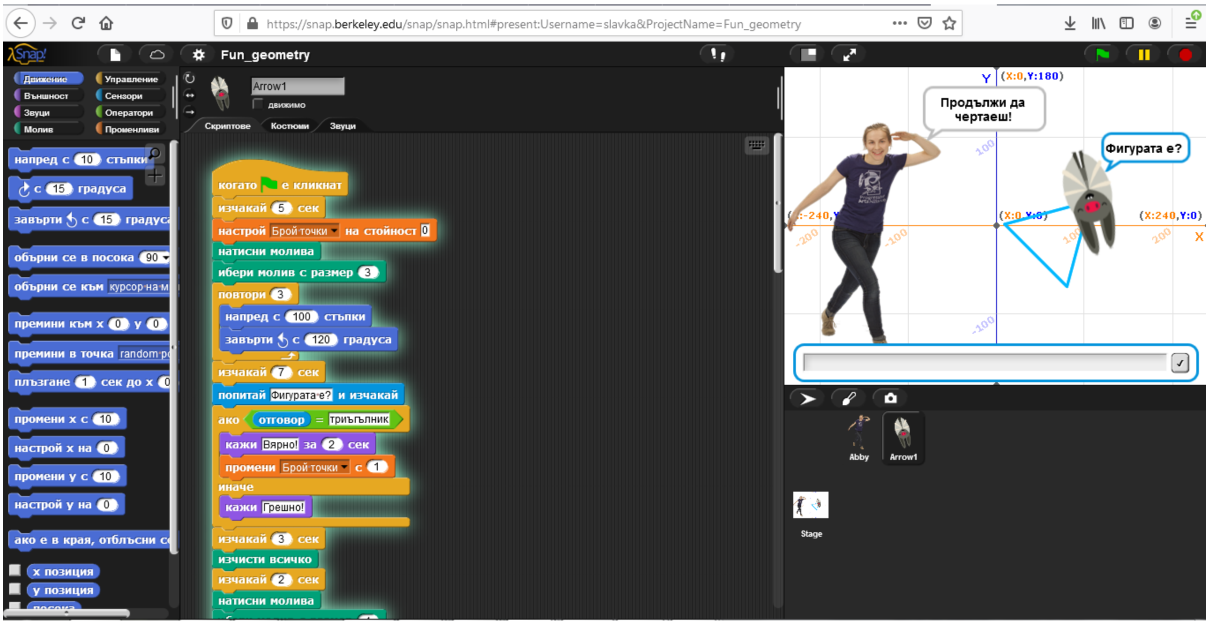


Let's calculate by Galia Kojumdzhieva



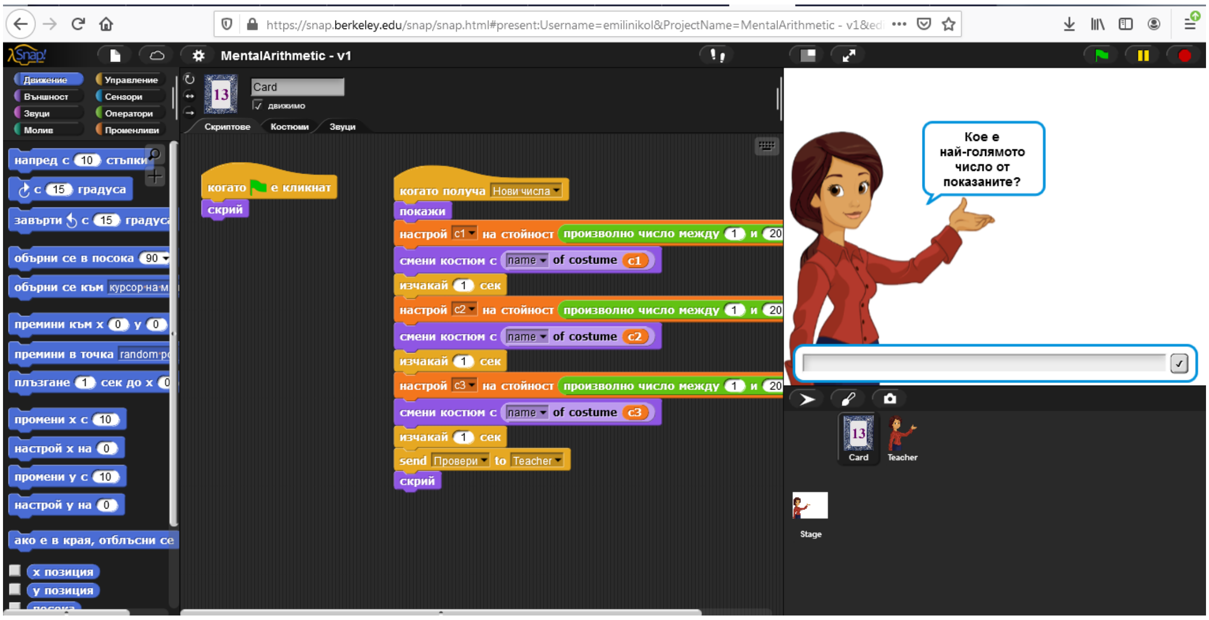
https://snap.berkeley.edu/snap/snap.html#present:Username=roni_2111&ProjectName=%D0%9F%D1%80%D0%B5%D1%81%D0%BC%D1%8F%D1%82%D0%B0%D0%BD%D0%B5&editMode&noRun

Fun geometry by Slavka Baleva



https://snap.berkeley.edu/snap/snap.html#present:Username=slavka&ProjectName=Fun_geometry

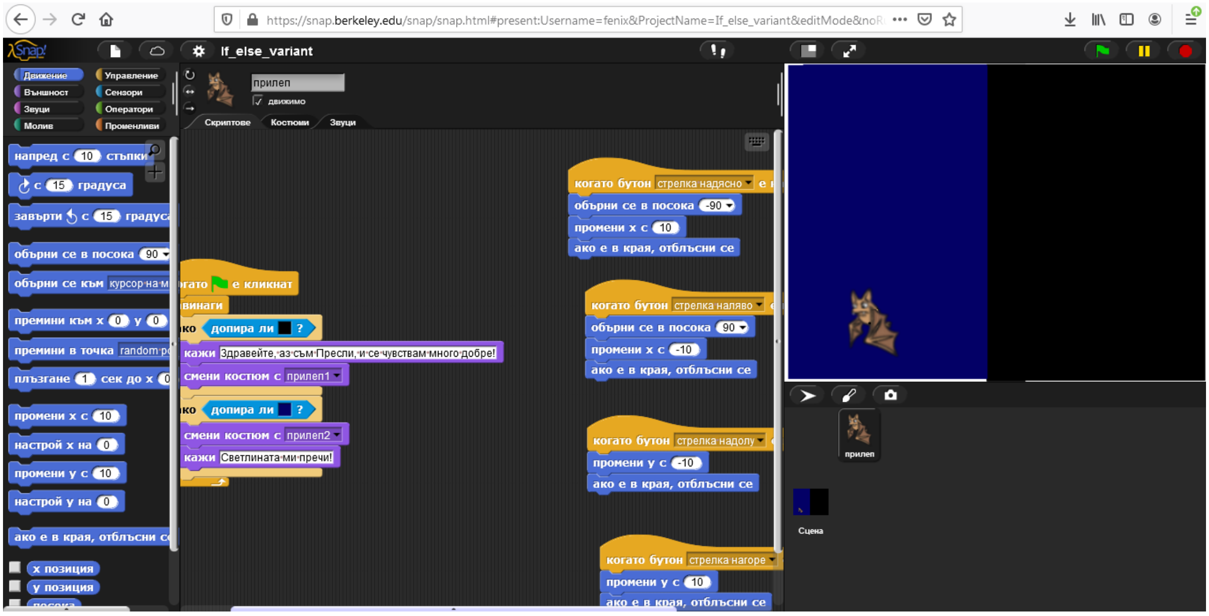
Mental arithmetic by Emilia Nikolova



https://snap.berkeley.edu/project?user=emilinikol&project=MentalArithmetic%20-%20v1

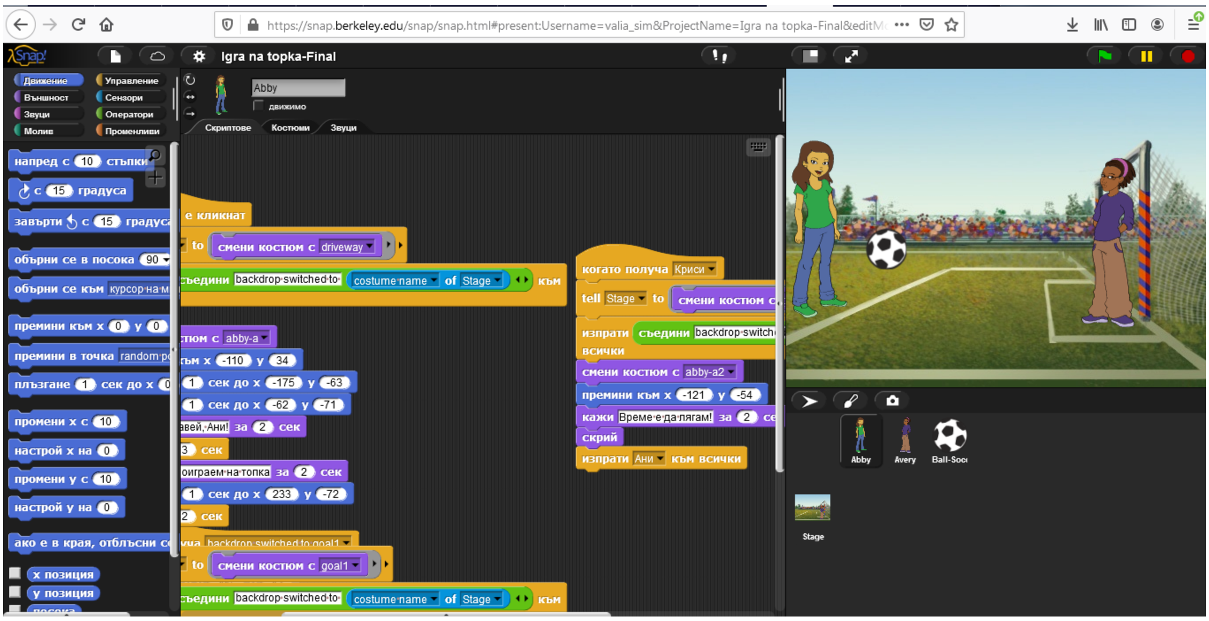
The live of the Bat – Margarita Velikova

The game is like the Live of Chameleon, but it is simple and involves if else constructions and sensors.



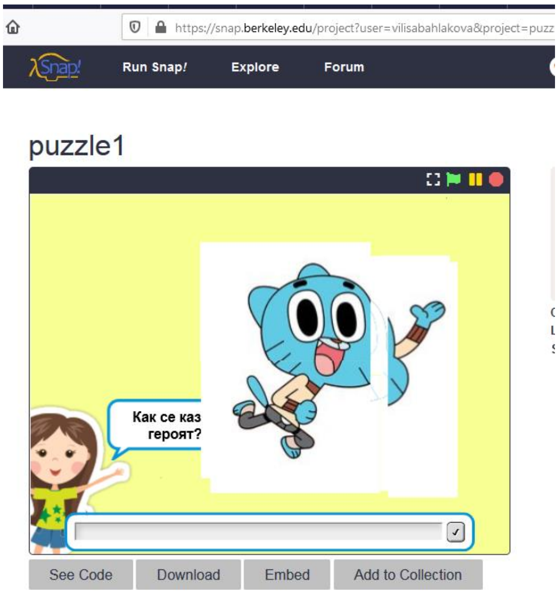
https://snap.berkeley.edu/project?user=fenix&project=If_else_variant

Game with ball by Valentina Simeonova, Ljuben Simeonov



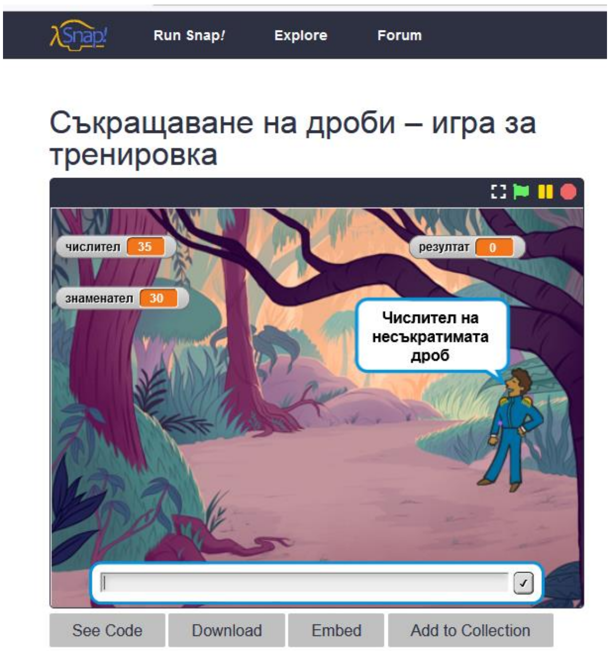
https://snap.berkeley.edu/snap/snap.html#present:Username=valia_sim&ProjectName=Igra%20na%20topka-Final&editMode&noRun

Order the jigsaw by Velichka Sabahlakova



https://snap.berkeley.edu/project?user=vilisabahlakova&project=puzzle1

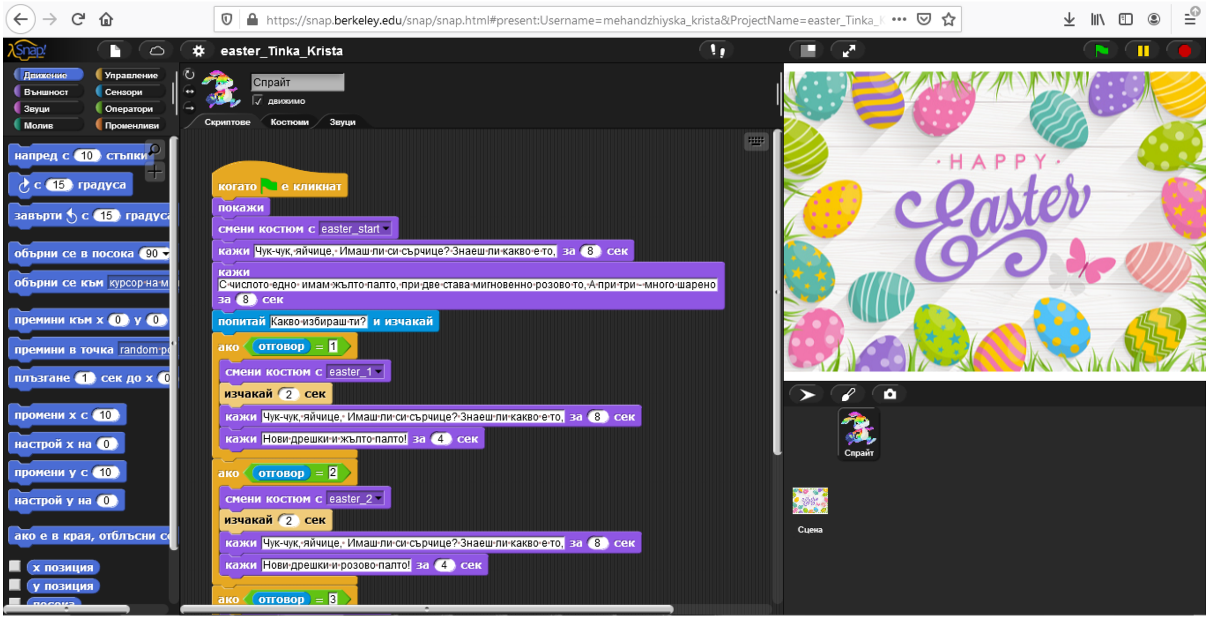
Fractions in mathematics by Muharem Mollov



https://snap.berkeley.edu/project?user=mohy-m&project=%D0%A1%D1%8A%D0%BA%D1%80%D0%B0%D1%89%D0%B0%D0%B2%D0%B0%D0%BD%D0%B5%20%D0%BD%D0%B0%20%D0%B4%D1%80%D0%BE%D0%B1%D0%B8%20%E2%80%93%20%D0%B8%D0%B3%D1%80%D0%B0%20%D0%B7%D0%B0%20%D1%82%D1%80%D0%B5%D0%BD%D0%B8%D1%80%D0%BE%D0%B2%D0%BA%D0%B0

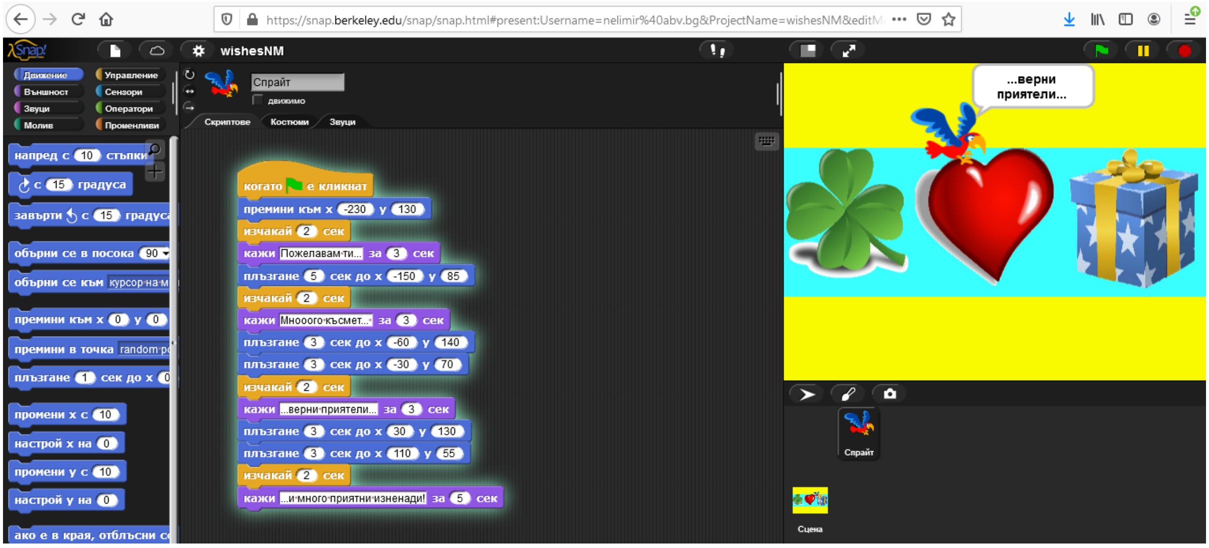
Co-funded by the
Erasmus+ Programme
of the European Union

Happy Easter – Story telling by Krista Mehandzhijska and Tinka Prokopova



Story – Happy Easter

Celebrations by Nely Mircheva

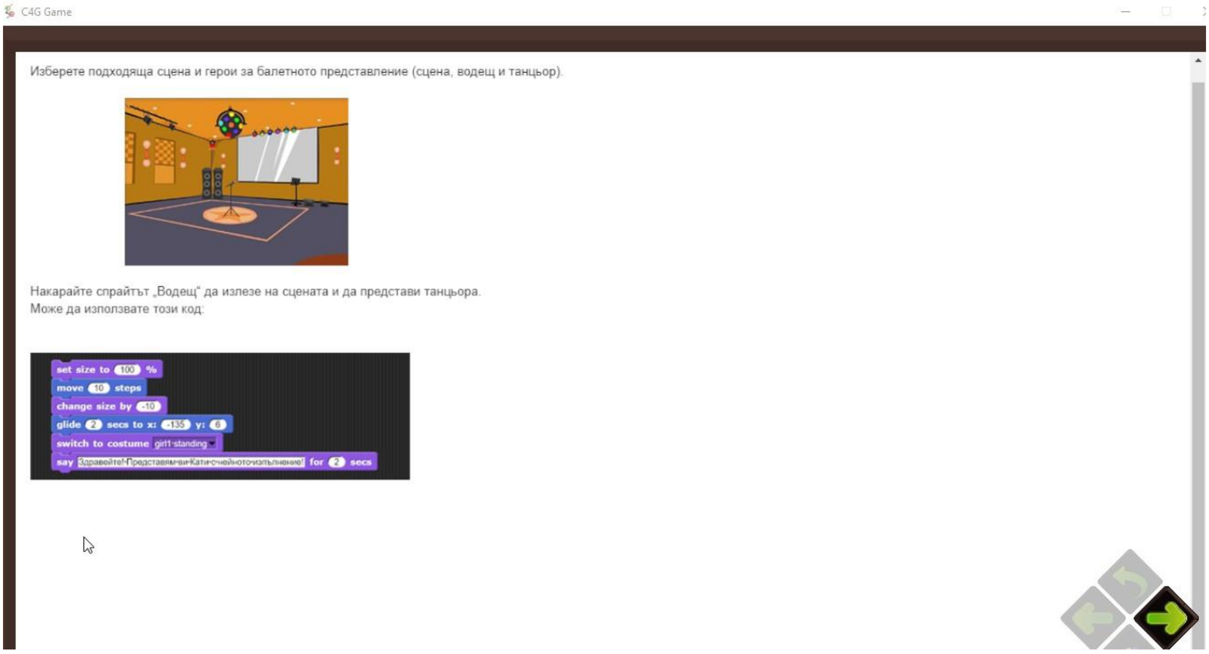


https://snap.berkeley.edu/project?user=nelimir%40abv.bg&project=wishesNM

Course in C4G game platform: „Празнични поздравления“

Access code: wishes_nm

Game Ballet by Rositsa Georgieva



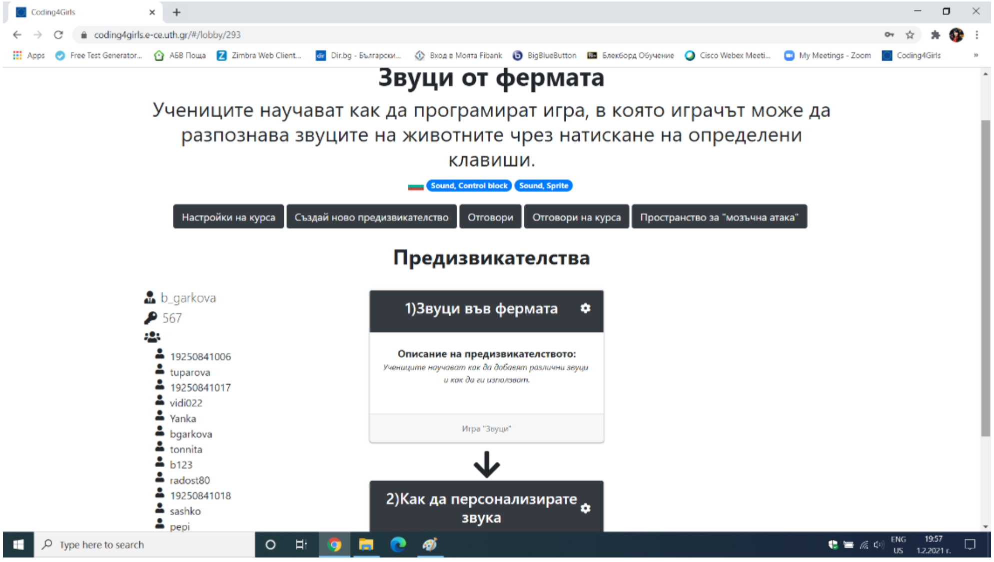

C4G Game
Балет
0
1
Накарай своя спрайт да се движи и говори.
Stepping Game
Start

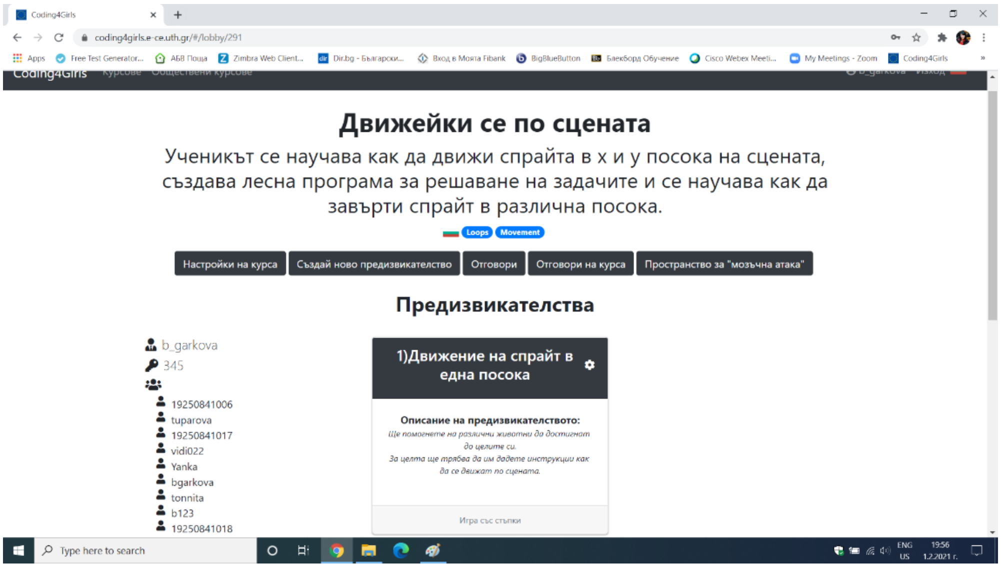

C4G Game
Балет
0
1
Instructions
Show

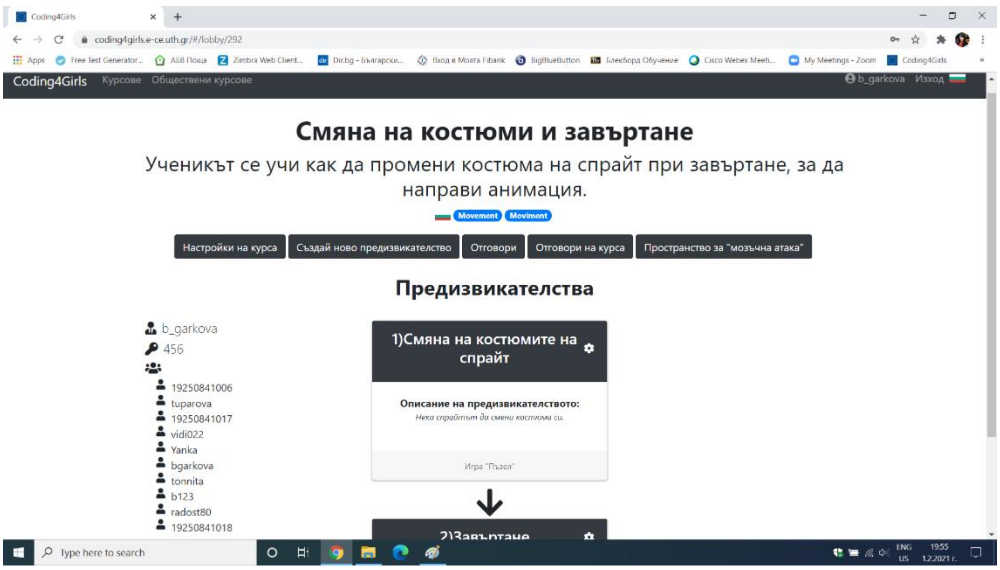

C4G Game
172
0
Коя секция блокчета използваме за движение на спрайт?
G
O

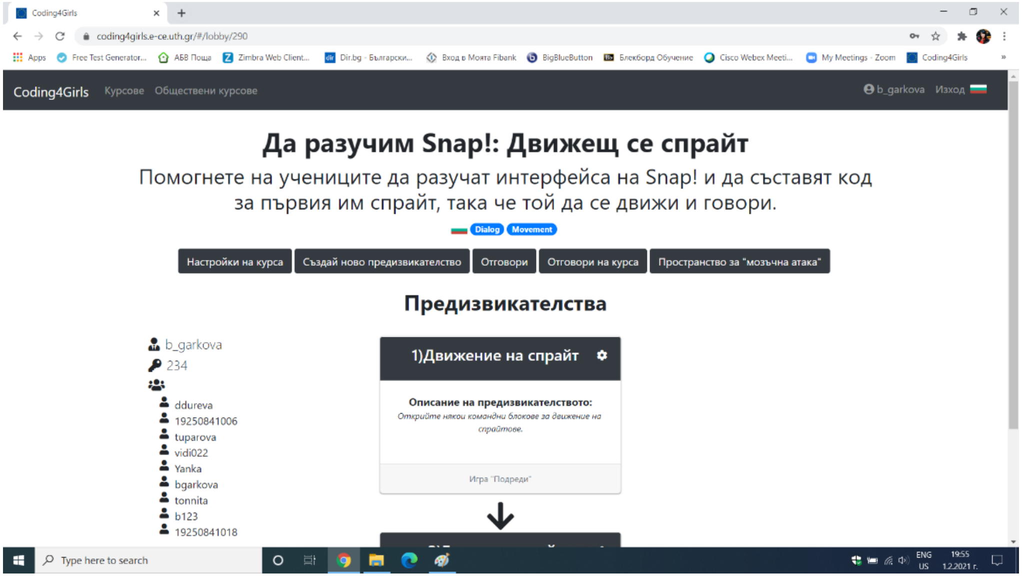

C4G Game
50
0
Как да накараме спрайта да говори?
A
R
G
S

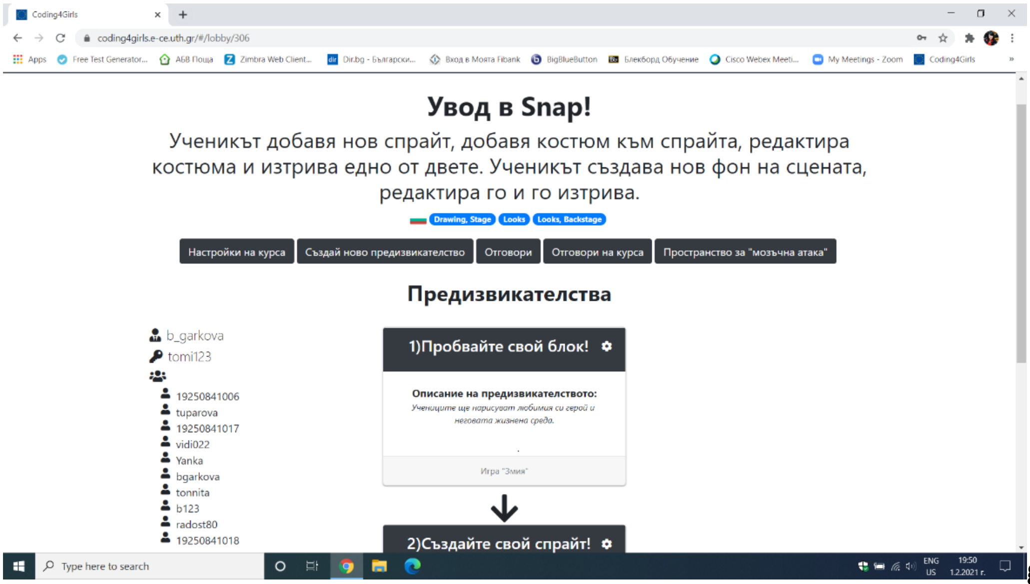
J. Screenshots from courses used in training of master students



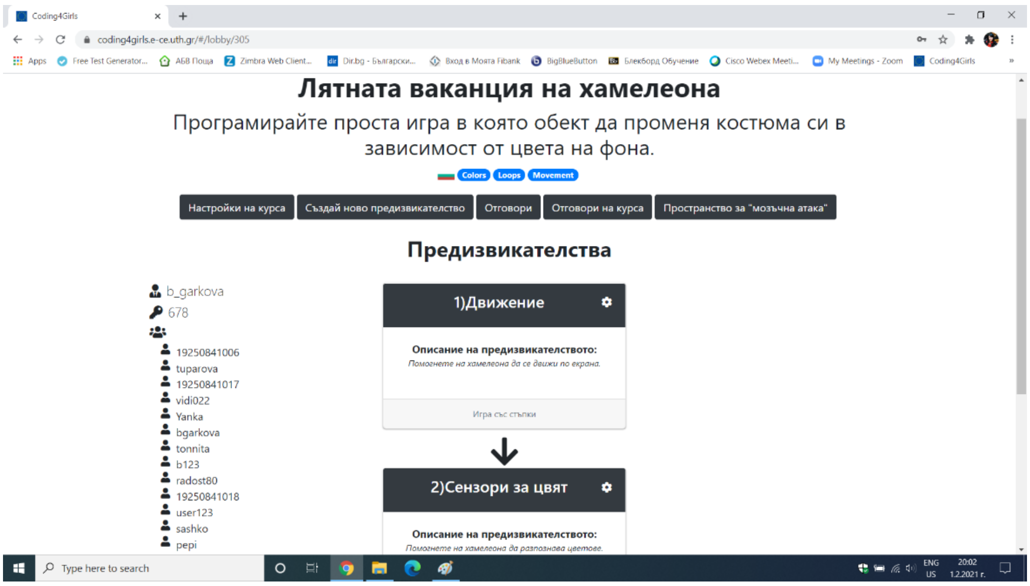





Coding4Girls
coding4girls.e-ce.uth.gr/#/lobby/290
Coding4Girls Курсове Обществени курсове
b_garkova Изход
Да разучим Snap!: Движещ се спрайт
Помогнете на учениците да разучат интерфейса на Snap! и да съставят код за първия им спрайт, така че той да се движи и говори.
Dialog
Movement
Настройки на курса
Създай ново предизвикателство
Отговори
Отговори на курса
Пространство за "мозъчна атака"
Предизвикателства
b_garkova
234
ddureva
19250841006
tuparova
vidi022
Yanka
bgarkova
tonnita
b123
19250841018
1)Движение на спрайт
Описание на предизвикателството:
Открийте някои командни блокове за движение на спрайтове.
Игра "Подреди"
Type here to search


Coding4Girls
coding4girls.e-ce.uth.gr/#/lobby/306
Увод в Snap!
Ученикът добавя нов спрайт, добавя костюм към спрайта, редактира костюма и изтрива едно от двете. Ученикът създава нов фон на сцената, редактира го и го изтрива.
Drawing, Stage
Looks
Looks, Backstage
Настройки на курса
Създай ново предизвикателство
Отговори
Отговори на курса
Пространство за "мозъчна атака"
Предизвикателства
b_garkova
tomi123
19250841006
tuparova
19250841017
vidi022
Yanka
bgarkova
tonnita
b123
radost80
19250841018
1)Пробвайте свой блок!
Описание на предизвикателството:
Учениците ще нарисуват любимия си герой и неговата жизнена среда.
Игра "Змия"
2)Създайте свой спрайт!
Type here to search

game


Coding4Girls
coding4girls.e-ce.uth.gr/#/lobby/305
Лятната ваканция на хамелеона
Програмирайте проста игра в която обект да променя костюма си в зависимост от цвета на фона.
Colors
Loops
Movement
Настройки на курса
Създай ново предизвикателство
Отговори
Отговори на курса
Пространство за "мозъчна атака"
Предизвикателства
b_garkova
678
19250841006
tuparova
19250841017
vidi022
Yanka
bgarkova
tonnita
b123
radost80
19250841018
user123
sashko
pepi
1)Движение
Описание на предизвикателството:
Помогнете на хамелеона да се движи по екрана.
Игра със стълки
2)Сензори за цвят
Описание на предизвикателството:
Помогнете на хамелеона да разпознава цветове.
Type here to search

NATIONAL REPORT: CROATIA

TABLE OF CONTENTS

EXECUTIVE SUMMARY

Implementation and validation of the C4G approach in Croatia took place from February to June 2020 as part of teaching of subject Informatics in primary schools. Due to the COVID-19 pandemic, Croatian schools were at that time closed so the approach was adapted for use in online environment.

Teachers (N_T=8) from eight primary schools in Rijeka and students - future teachers of graduate study programme of Informatics at University of Rijeka (N_{ST}=43) participated in the validation study and organized online game-based activities for building programming skills among students (N_S=773) from 5th to 8th grade of primary school. All implementation activities were based on the selected C4G learning scenarios and instructions for students and assumed independent work of students under the guidance of their teachers in virtual classrooms.

Using developed data collection tools, teachers' and students' attitudes, observations and comments regarding the game-based C4G methodology for building programming skills were collected. In addition, external experts (N_E=3) were included in the validation of the approach.

Results showed that students accepted the game-based C4G methodology. Conducted activities enabled them to develop their programming skills in a fun way. Students were motivated to learn programming using tasks that included solving real-life problems. Teachers, students – future teachers, and experts consider this approach as relevant and effective way of acquiring programming skills that is applicable and appropriate for the students aged 10 to 16 years. They also confirmed effectiveness of support tools used in the instructional process. Based on the performed C4G implementation and validation activities in Croatia, it can be concluded that with the help of the developed materials and guidance from teachers, students can achieve learning objectives also in the online environment. In order for the approach to be applied online, it would be useful to allow students to create programs using Scratch. In this way, the technical problems that students encountered when using Snap! on tablets could be avoided.

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

IMPLEMENTATION

Introductory workshops

In line with the C4G validation strategy, implementation of the game-based C4G approach in Croatia started with workshops for teachers and experts who agreed to take part in the implementation and validation activities (Figure 12).

Introductory workshops were organized at the University of Rijeka, Department of Informatics (UNIRI) on 21th of February and 2nd of March 2020. During the workshops, project members presented the information about the CODING4GIRLS project and approach for building programming skills. Details regarding the protocol for implementation and the validation of the approach in the Croatian schools have been agreed. The teachers and experts were also provided with all the necessary contents and tools.

Figure 12 - Introductory workshop with teachers and experts at UNIRI

Data collection tools

During the validation of C4G approach, all the data collection tools provided in the C4G validation strategy were used:

- S1 – Preliminary questionnaire (for students)
- S2 – Follow-up questionnaire (for students)
- S3 – Student’s comments
- T1 – Teacher’s observations
- T2 – Teacher’s comments

- E – Expert's comments

The data collection tools were before validation activities translated into the Croatian language.

Questionnaires S1 and S2 were created using Google Forms while data collection tools S3, T1, T2, and E for teachers and experts were prepared as Word documents in which they could write observations and comments.

Materials

During the implementation, learning scenarios and instructions for students that were developed by the project partners were used. Unfortunately, developed 3D game environment was not used since it should be used in computer classroom in schools and the implementation activities were carried out online.

In collaboration with the teachers and experts, the following subset of C4G learning scenarios with mini-projects (serious games) was selected to be used in schools:

1. Introduction to Snap! interface
2. Time to bring your sprite to life
3. Cameleon's summer vacation
4. Picking up the trash
5. Buying food for a picnic
6. Recycling
7. Simplified PACMAN game.

This subset covers the basic programming concepts that are in the focus of the C4G approach (loops, conditionals, variables, statements, operators, events, parallelism). Each learning scenario enable students to learn one or multiple programming concepts by creating a game that addresses real-world problem. To further motivate girls to learn programming, the topics of real-world problems are chosen to be attractive to girls. All resourced were translated into the Croatian language prior to implementation.

The implementation approach was adapted for online learning so teachers prepared additional learning materials with instructions and tasks for C4G activities in order to support student's independent work (e.g. Learning programming in Snap!, shown on Figure 13).

Figure 13 – Thinglink interactive learning material "Learning programming in Snap!"

Video tutorials were also recorded and published on YouTube (Figure 14) with the aim of making it easier for students to work independently in online environment. For example, sets of videos were prepared to introduce students with the tool (Introduction to Snap!) or to help them with the development of the projects included in the learning scenarios (Picking up the trash, Recycling).

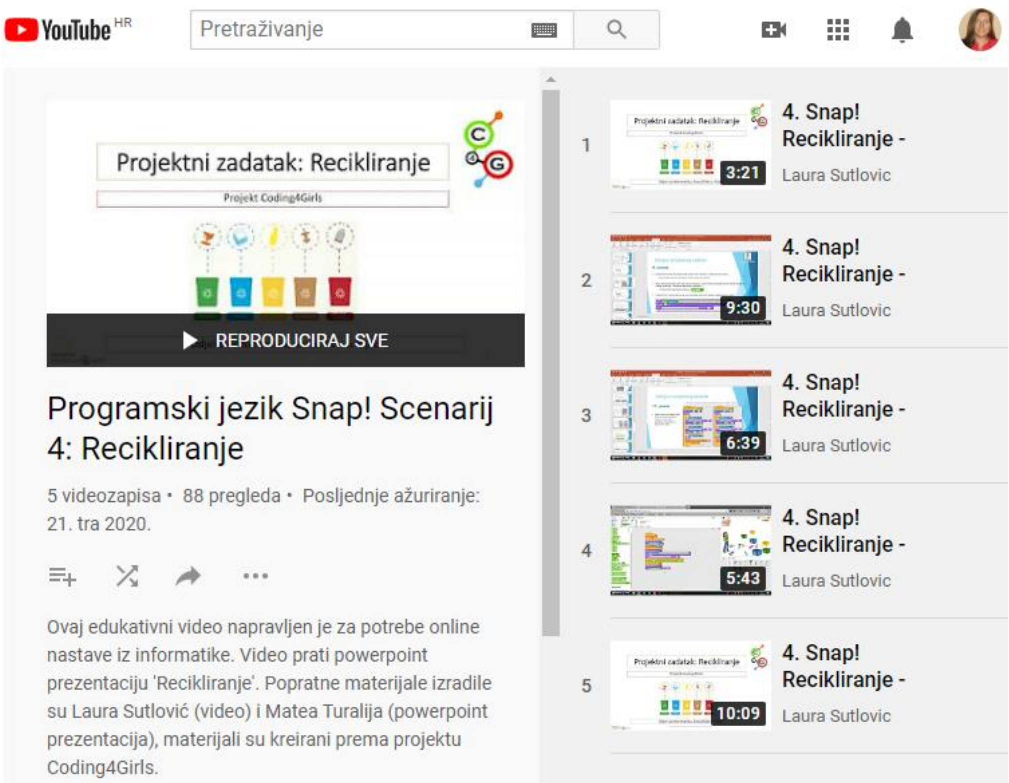


Figure 14 – A set of video tutorials for the learning scenario "Picking up the trash"

Setup model and procedure

Sessions for building programming skills using the C4G approach were organized as a part of regular teaching of subject Informatics in primary school that was at that time carried out in online learning environments due to COVID-19 pandemic. Implementation activities were conducted in 5th and 6th grade where the subject Informatics is compulsory and in 7th and 8th grade of primary where the subject is optional.

Depending on the teacher, implementation activities took place during 6-8 weeks between March and June 2020. Students were expected to dedicate 4 hours of independent work per week. Teachers delivered learning materials to students using virtual classrooms (created with Microsoft Teams, Edmodo or similar tools).

Teachers first organized sessions in order to introduce coding concepts. Students could practice those concepts using exercises and then they were expected to create a serious game using the learnt coding concepts. During the sessions, teachers provided guidance and help to the students with the given tasks. At the end of each session, students could present their games and experiences to peers and participate in de-briefing in the virtual classroom. At the beginning of the implementation in schools, students answered the preliminary questionnaire (S1). After the implementation, in the last session, students answered the follow-up questionnaire (S2) about their perception and views on the C4G learning approach. They were required to write the anonymised code received from the teacher to ensure comparison of results regarding the self-assessment of their programming skill. Teachers collected students' qualitative opinions and comments through a group discussion in virtual classrooms (S3).

Teachers also reported the reaction of students and their progress in building coding skills using the game-based C4G approach (T1) and their own views related to the relevance and effectiveness of the CODING4GIRLS game-based learning approach for building programming skills (T2).

To further improve project outputs and ensure that they meet the needs of learners and teachers, the game-based C4G approach for building programming skills views related to the relevance and effectiveness of the CODING4GIRLS game-based learning approach were collected from external experts (E). Experts were given access to project documentation and results as well as to contents created during the implementation.

Participants

The project team at UNIRI includes researchers and teachers (N_{PT}=4) in the field of game-based learning, programming, didactics of informatics, and e-learning. All of them were actively involved in the preparation of the implementation and validation activities, including selection of teachers and experts to participate in the study.

Direct participant of the study were teachers of informatics (N_T=8) from 7 primary schools in Rijeka, Croatia together with their students (N_S=773). All the selected teachers have years of experience in teaching informatics and they are mentors in informatics for students – future teachers of informatics from UNIRI during the teaching practice in informatics. Students – future teachers of informatics (N_{ST}=35) who are in the final year of study and therefore obliged to attend a teaching practice in informatics were also included in the implementation activities. Many of them will start working in schools next school year and will be able to apply the C4G approach with their students. Depending on the number of classes and students, each teacher - mentor was assigned with 3 to 6 students - future teachers who helped to prepare and conduct the C4G activities under mentor's supervision.

The C4G approach for building programming skills was applied in 38 mixed-gender classes and involved a total of 773 students aged from 11 to 15 years (5^{th} to 8^{th} grade of primary school). The subject Informatics is compulsory for 5^{th} and 6^{th} grade students while for 7^{th} and 8^{th} grade students the subject is optional. Table 1 shows number of students – participants of the study by age/grade. The number of students in the classes ranged from 13 to 28 while the average number of students in one class was 20. The most students were from 6^{th} grade (Figure 1).

Table 14 - Number of students by age/grade

Years of age	Grade	Classes	Number of students
11-12	5	9	191
12-13	6	14	308
13-14	7	8	146
14-15	8	7	128
	Total	**38**	**773**

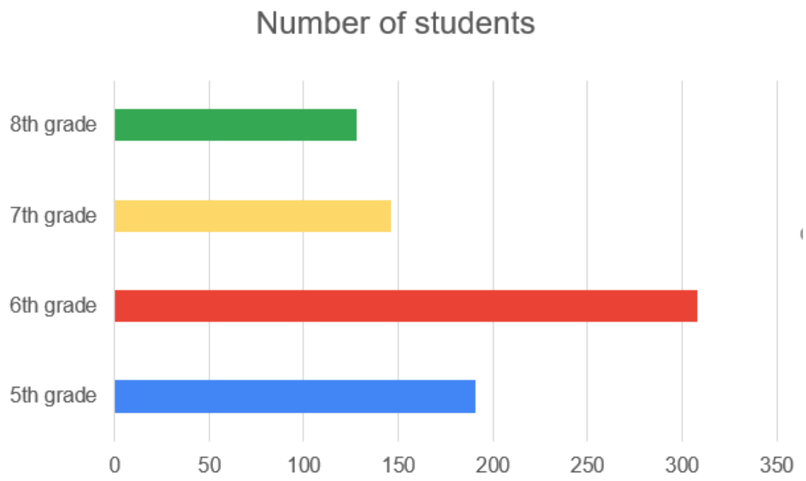


Figure 15 – Number of students by grade

Three external experts (N_E=3) were chosen for the validation activities based on their expertise. Two of them are university professors and researchers, one in the field of teacher education and the other in the fields of computer science and teaching programming. Third expert is a teacher advisor for informatics who works in a primary school.

RESULTS

Results of questionnaires for students

Two questionnaires for students were used: preliminary questionnaire about the use of digital devices and perceived level of programming and the follow-up questionnaire about satisfaction with programming and coding activities, satisfaction with the organization of the implementation, and perception on the acquired coding skills.

In both questionnaires students were asked to self-assess their current level of programming skill. Based on this question, the difference between students' self-assessed initial and final level of programming skill was calculated (the answers from the questionnaires were paired based on the code that students have entered).

A total of 569 students (73.61% of students who participated in C4G activities) solved preliminary questionnaire. A total of 424 students (54.85%) solved the follow-up questionnaire. Self-assessment results were compared only for students who solved both questionnaires - 347 students (44.89%).

S1 - Preliminary questionnaire

A total of 569 students solved the preliminary questionnaire about the use of digital devices and perceived level of programming. The mean age of students was 12.31 years (SD=1,024). Table 15 shows number of students who solved S1 by gender and grade. The number of girls and boys who responded is approximately equal (Figure 2).

Table 15 - Number of students who solved S1 - Preliminary questionnaire by gender and grade

	5th grade	6th grade	7th grade	8th grade	Total
Boys	68	111	57	47	283
Girls	74	121	52	39	286
Total	**142**	**232**	**109**	**86**	**569**
Response rate	74.35%	75.32%	74.66%	67.72%	73.61%

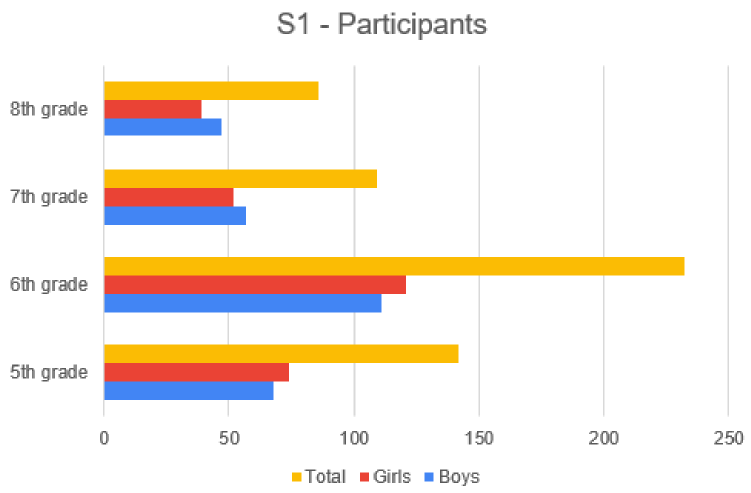


Figure 16 - Distribution of students who solved S1 - Preliminary questionnaire by gender and grade

Table 3 shows descriptive statistical analysis of participants' responses to the questions related to the use of digital devices, the internet and video-games. It is worth noting the values of the standard deviation, which for some questions indicates larger deviances from the average values. The comparison of the overall average results by gender (Figure 3) shows that boys and girls have been using digital devices for the same length of time. However, on a weekly basis, boys use digital devices and the Internet more and spend significantly more time playing games.

Table 16 - The use of digital devices, the internet and video-games by gender

Question		**N**	**Min**	**Max**	**Mean**	**SD**
9. For how long have you been using computers, tablets or other digital devices (in years)?	Boys	283	1	12	6.237	2.055
	Girls	286	0	14	5.767	1.882
	Total	**569**	**0**	**14**	**6.001**	**1.982**
10. How many hours per week do you use a computer, tablet or other digital device?	Boys	283	1	168	19.834	19.637
	Girls	281	0	168	16.196	19.419
	Total	**564**	**0**	**168**	**18.021**	**19.596**
11. How many hours per week do you use the Internet?	Boys	282	1	140	21.603	21.315
	Girls	277	0	168	17.643	19.502
	Total	**559**	**0**	**168**	**19.611**	**20.517**
12. How many hours per week do you play video games?	Boys	282	0	62	11.261	10.803
	Girls	284	0	35	2.905	4.922
	Total	**565**	**0**	**62**	**7.075**	**9.367**

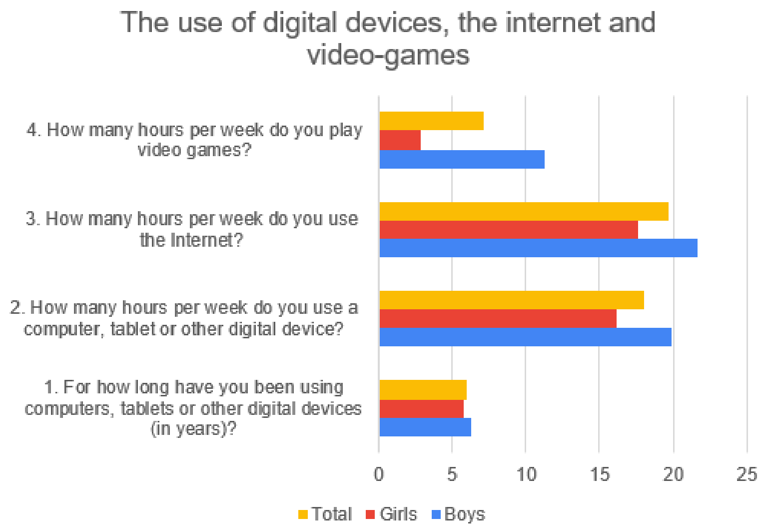


Figure 17 - The use of digital devices, the internet and video-games – comparison by gender

The average values show that students spend a little more time on the Internet than using digital devices. It can be assumed that such numbers are results of misconceptions. For example, some students may think that using their smartphone to access the Internet does not count.

By comparing the data by grade (Table 17) it can be noticed that 5th and 6th grade students use digital devices and the Internet less than 7th and 8th grade students. Analysis of individual responses shows that some 7th and 8th grade students reported very high values (e.g., 100 hours per week for the use of Internet) which affected these average results.

Table 17 - The use of digital devices, the internet and video-games by grade and gender

Question		**5th grade**	**6th grade**	**7th grade**	**8th grade**
1. For how long have you been using computers, tablets or other digital devices (in years)?	Boys	5.279	6.000	7.000	7.255
	Girls	4.804	5.876	6.192	6.692
	Total	**5.032**	**5.935**	**6.615**	**7.000**
2. How many hours per week do you use a computer, tablet or other digital device?	Boys	18.426	15.324	24.035	27.426
	Girls	12.528	14.819	18.250	24.333
	Total	**15.414**	**15.063**	**21.275**	**26.023**
3. How many hours per week do you use the Internet?	Boys	18.537	18.261	26.105	28.404
	Girls	12.522	15.534	22.510	26.487
	Total	**15.485**	**16.798**	**24.390**	**27.535**
4. How many hours per week do you play video games?	Boys	10.828	8.833	12.412	16.213
	Girls	2.603	3.213	2.981	2.410
	Total	**6.586**	**5.914**	**7.913**	**9.953**

The participants (N=569, 283 boys, 286 girls) self-assessed the level of their programming skills on the scale from *0 - I have never coded or programmed before* to *4 - I can design a solution of a problem in the form of a program*. Results are shown in the Table 4. Most of the students stated for themselves that they are at level *1 - novice programmers* (33.39%) or on level *2 – can code simple programs* (32.51%). If we compare these results by gender (Figure 4), it can be seen that the boys prevail among the students that self-assess their level of programming with the levels 3 and 4.

Table 18 - Self-assessment of programming skills by gender

Level of programming skills	**Boys**	**Girls**	**Total**
0 - I have never coded or programmed before	9.54%	7.34%	8.44%
1 - I am a novice programmer (just have basic ideas)	31.45%	35.31%	33.39%
2 - I can code simple programs	29.68%	35.31%	32.51%
3 - I am fluent in programming (can create a full program)	23.32%	17.48%	20.39%
4 - I can design a solution of a problem in the form of a program	6.01%	4.56%	5.27%

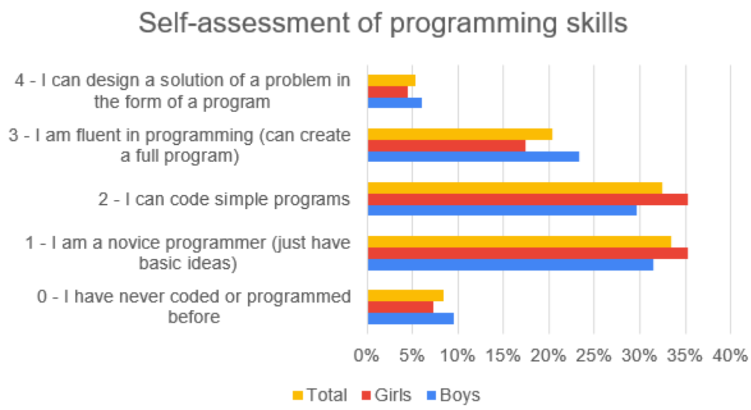


Figure 18 - Self-assessment of programming skills – comparison by gender

The analysis by grades (Table 19) shows that the largest number of students who have never coded (level 0) is from the 5th grade, as expected. In 6th, 7th and 8th grade most of the students stated that they can code simple programs (level 2).

Table 19 - Self-assessment of programming skills by grade and gender

Level of programming skills		**5th grade**	**6th grade**	**7th grade**	**8th grade**
0 - I have never coded or programmed before	Boys	19.12%	6.31%	10.53%	2.13%
	Girls	20.27%	2.48%	3.85%	2.56%
	Total	**19.72%**	**4.31%**	**7.34%**	**2.33%**
1 - I am a novice programmer (just have basic ideas)	Boys	41.18%	26.13%	26.32%	36.17%
	Girls	45.95%	32.23%	30.77%	30.77%
	Total	**43.66%**	**29.31%**	**28.44%**	**33.72%**
2 - I can code simple programs	Boys	23.53%	32.43%	35.09%	25.53%
	Girls	20.27%	38.02%	44.23%	43.59%

	Total	**21.83%**	**35.34%**	**39.45%**	**33.72%**
3 - I am fluent in programming (can create a full program)	Boys	13.24%	25.23%	24.56%	31.91%
	Girls	9.46%	23.14%	15.38%	17.95%
	Total	**11.27%**	**24.14%**	**20.18%**	**25.58%**
4 - I can design a solution of a problem in the form of a program	Boys	2.94%	9.91%	3.51%	4.26%
	Girls	4.05%	4.13%	5.77%	5.13%
	Total	**3.52%**	**6.90%**	**4.59%**	**4.65%**

In the preliminary questionnaire the participants also stated which programming concepts are they familiar with. The results (Table 5) show that students are mostly familiar with the *statements* (72.23%) and *loops* (61.51%) while they are the least familiar with the *operators* (12.48%) and *parallelism* (2.28%). According to the results, there is no major difference in familiarity of programming concepts between the genders (Figure 5). The largest difference in percentages can be observed for the concept *operators*.

Table 20 - Familiarity with the programming concepts

Concept	**Boys**	**Girls**	**Total**
Loops	60.78%	62.24%	61.51%
Conditionals	47.70%	46.50%	47.10%
Variables	51.24%	46.85%	49.03%
Statements (sounds, movement, looks, drawing)	71.38%	73.08%	72.23%
Operators	15.55%	9.44%	12.48%
Events	38.52%	36.01%	37.26%
Parallelism	1.77%	2.80%	2.28%

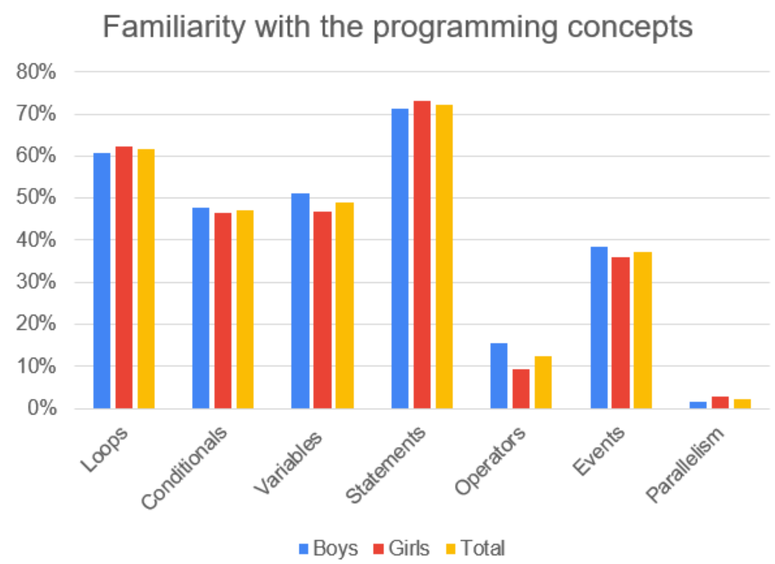


Figure 19 - Familiarity with the programming concepts – comparison by gender

Comparison of the results by grade and gender (Table 21) shows that 5th graders are at least familiar with all the concepts.

Table 21 - Familiarity with the programming concepts by grade and gender

Concept		5th grade	6th grade	7th grade	8th grade
Loops	Boys	39.71%	64.86%	68.42%	72.34%
	Girls	39.19%	71.07%	71.15%	66.67%
	Total	39.44%	68.10%	69.72%	69.77%
Conditionals	Boys	26.47%	45.95%	61.40%	65.96%
	Girls	25.68%	47.93%	63.46%	58.97%
	Total	26.06%	46.98%	62.39%	62.79%
Variables	Boys	16.18%	49.55%	73.68%	78.72%
	Girls	13.51%	45.45%	78.85%	71.79%
	Total	14.79%	47.41%	76.15%	75.58%
Statements (sounds, movement, looks, drawing)	Boys	63.24%	73.87%	70.18%	78.72%
	Girls	62.16%	75.21%	82.69%	74.36%
	Total	62.68%	74.57%	76.15%	76.74%
Operators	Boys	11.76%	11.71%	17.54%	27.66%
	Girls	9.46%	7.44%	9.62%	15.38%
	Total	10.56%	9.48%	13.76%	22.09%
Events	Boys	26.47%	45.05%	45.61%	31.91%
	Girls	22.97%	40.50%	48.08%	30.77%
	Total	24.65%	42.67%	46.79%	31.40%
Parallelism	Boys	0.00%	1.80%	0.00%	6.38%
	Girls	2.70%	2.48%	0.00%	7.69%
	Total	1.41%	2.16%	0.00%	6.98%

For some of the concepts (*loops*, *statements*), the results for 6th, 7th and 8th grade students do not differ, while for some (more advanced) concepts (*conditionals*, *variables*, *operators*) there is an increase in the level of familiarity. As in the case of overall results, there are no major gender differences in the familiarity with the programming concepts except of concept *operators*.

Table 6 shows students' responses about what motivates them to learn to program (students could choose one or more responses). The most of the students are motivated by a success in the programming class (60.63%). Comparison by gender (Figure 6) shows that this factor motivates girls (70.98%) to a greater extent than boys (50.18%). Also, remarkably more boys want to follow career in programming.

Table 22 - Motivation for learning programming

Response	Boys	Girls	Total
I'm not motivated	17.31%	15.38%	16.34%
I want to succeed in the programming class	50.18%	70.98%	60.63%
I want to show other students I can program	10.95%	8.04%	9.49%

I want to follow a career in programming	22.97%	5.24%	14.06%
I enjoy solving logic problems and puzzles	24.38%	19.58%	21.97%

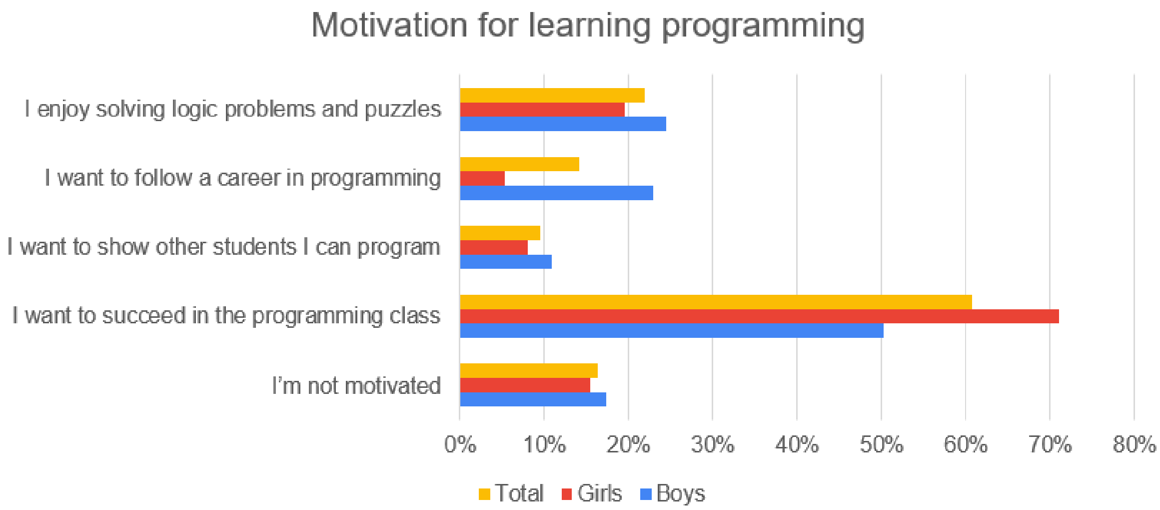


Figure 20 - Motivation for learning programming – Comparison by gender

Comparison by grade (Table 23) show that 6th graders are the most motivated, especially by wanting to succeed in the programming class. They also enjoy solving logic problems and puzzles more than students from other grades (particularly boys).

Table 23 - Motivation for learning programming by grade and gender

Statement		5th grade	6th grade	7th grade	8th grade
I'm not motivated	Boys	17.65%	13.51%	24.56%	17.02%
	Girls	17.57%	8.26%	19.23%	28.21%
	Total	**17.61%**	**10.78%**	**22.02%**	**22.09%**
I want to succeed in the programming class	Boys	42.65%	53.15%	49.12%	55.32%
	Girls	62.16%	80.99%	67.31%	61.54%
	Total	**52.82%**	**67.67%**	**57.80%**	**58.14%**
I want to show other students I can program	Boys	8.82%	11.71%	10.53%	12.77%
	Girls	9.46%	9.09%	7.69%	2.56%
	Total	**9.15%**	**10.34%**	**9.17%**	**8.14%**
I want to follow a career in programming	Boys	29.41%	20.72%	22.81%	19.15%
	Girls	4.05%	7.44%	1.92%	5.13%
	Total	**16.20%**	**13.79%**	**12.84%**	**12.79%**
I enjoy solving logic problems and puzzles	Boys	23.53%	30.63%	15.79%	21.28%
	Girls	20.27%	22.31%	19.23%	10.26%
	Total	**21.83%**	**26.29%**	**17.43%**	**16.28%**

Besides choosing among the offered responses, students had the opportunity to write everything else that motivates them to learn to program. Among the answers, they stated:

"It's fun", "I'm interested in making programs or games", "I want to learn how to make my own game", "I want to learn something new", "I want to acquire new skills", and *"I'm motivated by my uncle who also programs"*.

S2 – Follow-up questionnaire

A total of 424 students solved the follow-up questionnaire about satisfaction with programming and coding activities, satisfaction with the organization of the implementation, and perception on the acquired coding skills. The mean age of students was 12.25 years (SD=1,047). Table 7 shows number of students who solved S2 by gender and grades. The number of girls and boys who responded is approximately equal in all grades except in the 8th grade (Figure 7).

Table 24 - Number of students who solved S2 - Follow-up questionnaire by gender and grades

	5th grade	**6th grade**	**7th grade**	**8th grade**	**Total**
Boys	72	78	31	35	225
Girls	67	79	30	23	199
Total	**139**	**166**	**61**	**58**	**442**
Response rate	72.77%	53.9%	41.78%	45.31%	54.85%

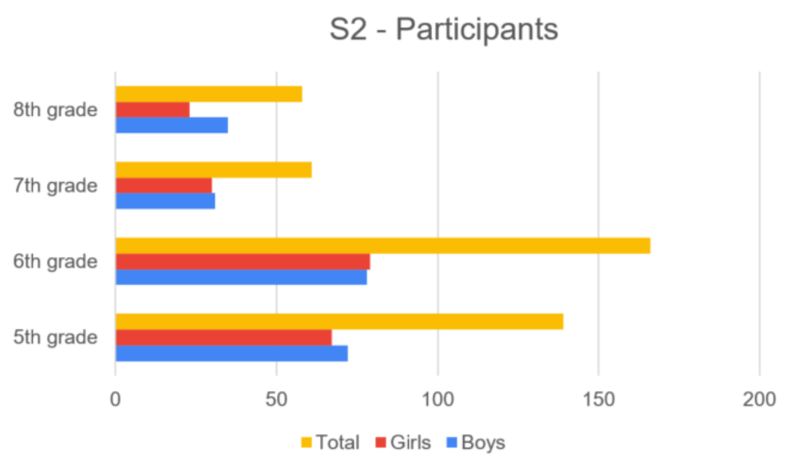


Figure 21 - Distribution of students who solved S2 - Follow-up questionnaire by gender and grades

In the follow-up questionnaire, students expressed their attitudes regarding the C4G learning methodology and the implementation of activities using the 5-point Likert scale (1 – strongly disagree, 2 – disagree, 3 – neutral, 4 – agree, 5 – strongly agree). According to the results (Table 8), both boys and girls felt engaged with this way of learning and think that conducted activities were relevant for learning programming. They understood presented concepts and had fun during conducted activities. Boys enjoyed programming to a slightly greater extent and think that things they have learned will be relevant for their future.

Table 25 – Satisfaction with C4G learning methodology

Statement		1	2	3	4	5	AVG	SD
21. I found programming challenging.	Boys	9.78%	25.33%	31.12%	24.44%	9.33%	2.982	1.126
	Girls	4.02%	23.12%	33.16%	31.16%	8.54%	3.171	1.011
	Total	**7.08%**	**24.29%**	**32.08%**	**27.59%**	**8.96%**	**3.071**	**1.076**
22. I found programming motivating.	Boys	2.67%	9.78%	18.22%	46.67%	22.66%	3.769	.995
	Girls	6.03%	13.57%	21.61%	41.2%	17.59%	3.508	1.114
	Total	**2.24%**	**11.56%**	**19.81%**	**44.11%**	**20.28%**	**3.646**	**1.06**
23. I found programming easy.	Boys	12.44%	28.44%	29.78%	20.44%	8.9%	2.849	1.151
	Girls	14.07%	30.65%	32.67%	18.59%	4.02%	2.678	1.057
	Total	**13.21%**	**29.48%**	**31.13%**	**19.58%**	**6.6%**	**2.769**	**1.11**
24. I enjoyed programming.	Boys	3.55%	7.56%	19.56%	28.89%	40.44%	3.951	1.107
	Girls	6.02%	11.06%	21.61%	33.67%	27.64%	3.658	1.169
	Total	**4.72%**	**9.2%**	**20.52%**	**31.13%**	**34.43%**	**3.814**	**1.145**
25. I understood most of programming concepts.	Boys	3.11%	7.56%	13.78%	48.88%	26.67%	3.884	.989
	Girls	4.53%	8.04%	20.6%	38.19%	28.64%	3.784	1.086
	Total	**3.77%**	**7.78%**	**16.98%**	**43.88%**	**27.59%**	**3.837**	**1.036**
26. Learning this way is fun.	Boys	4%	8.89%	15.11%	38.67%	33.33%	3.884	1.092
	Girls	4.02%	9.05%	21.61%	29.65%	35.68%	3.839	1.13
	Total	**4%**	**8.96%**	**18.16%**	**34.42%**	**34.42%**	**3.863**	**1.109**
27. I felt engaged with this way of learning.	Boys	1.33%	6.67%	7.56%	35.11%	49.33%	4.244	.949
	Girls	2.51%	5.02%	9.55%	29.15%	53.77%	4.266	.997
	Total	**1.88%**	**5.9%**	**8.49%**	**32.31%**	**51.42%**	**4.255**	**.971**
28. The activities were relevant to learn.	Boys	1.33%	4.89%	7.56%	40.89%	45.33%	4.24	.889
	Girls	3.01%	3.52%	13.57%	36.68%	43.22%	4.136	.983
	Total	**2.12%**	**4.25%**	**10.37%**	**38.92%**	**44.34%**	**4.191**	**.935**
29. At any time, it was clear what I had to do.	Boys	3.56%	11.56%	19.56%	35.11%	30.22%	3.769	1.11
	Girls	5.03%	16.58%	29.14%	28.14%	21.11%	3.437	1.144
	Total	**4.25%**	**13.92%**	**24.06%**	**31.84%**	**25.94%**	**3.613**	**1.137**
30. What I learned will be relevant for my future.	Boys	3.11%	4.89%	16.89%	36%	39.11%	4.031	1.019
	Girls	5.03%	7.03%	22.11%	37.69%	28.14%	3.769	1.09
	Total	**4%**	**5.9%**	**19.34%**	**36.79%**	**33.96%**	**3.908**	**1.06**

The participants again self-assessed the level of their programming skills on the scale from *0 - I have never coded or programmed before* to *4 - I can design a solution of a problem in the form of a program*. A total of 347 students (179 boys, 168 girls) solved the preliminary and the follow-up questionnaire so their self-assessment results were compared. Table 11 shows data on the difference between the self-assessed initial level and the self-assessed final level of programming skill. Over 40% of students stated that they have progressed, the most of them for 1 level (29.39%). Almost 5% of students self-assessed their programming skill level higher before participating in C4G activities. The analysis showed that most of them were students who initially self-assessed their skill with level 3 or 4. It can be assumed that these students were not able to self-assess their programming skill realistically before the C4G activities. Comparison by gender shows that slightly fewer girls remained at the same level of programming skill than boys (difference is 0). Also, slightly more girls progressed by one level than boys (difference is 1). For other values (differences), the results are approximately the same.

Table 26 - The difference between the self-assessed levels of programming skill

	Difference						
	-2	**-1**	**0**	**1**	**2**	**3**	**4**
Boys	0.56%	3.91%	55.31%	25.70%	11.73%	2.23%	0.56%
Girls	0.60%	4.76%	48.81%	33.33%	9.52%	2.98%	0%
Total	0.58%	4.32%	52.16%	29.39%	10.66%	2.59%	0.29%

A Wilcoxon's signed rank test for paired samples showed that students self-assessed their programming skill significantly higher after the C4G activities compared to self-assessment before the C4G activities (Table 12). The results of rank-biserial correlation (rB), which are considered as an effect size, show large effect size, overall and by gender.

Table 27 - Comparison of self-assessment of programming skill

		Descriptive statistics					**Wilcoxon's signed rank test results**		
		N	**MIN**	**MAX**	**MEAN**	**SD**	**W**	**p**	**Effect size (rB)**
Boys	S1	181	0	4	1.878	1.068	3112.5	< .001	.829
	S2	181	1	4	2.403	.982			
Girls	S1	166	0	5	1.825	1.015	3168	< .001	.818
	S2	166	1	4	2.380	.938			
Total	**S1**	**347**	**0**	**4**	**1.850**	**1.034**	**12702**	**< .001**	**.833**
	S2	**347**	**1**	**4**	**2.392**	**.960**			

Students' comments

In their comments after the implementation activities, the students stated that they are very happy with this way of learning, think that they have learned a lot, and feel like real developers because they created their games. During the implementation of C4G approach, they could hardly wait for every new task and new project. They were very satisfied with the received materials. This way of learning was very fun and they can't wait for more tasks like these.

Students who are familiar with the programming language Scratch stated that they would like to use it instead of the Snap!. Students prefer Scratch because it has more features and works very well on tablets while with Snap! students who used tablets had technical difficulties.

Teachers' observations and comments

After the implementation activities, teachers and students – future teachers were asked to express their qualitative opinions about the C4G methodology and the implementation process using the forms T1 and T2.

Teachers' observations

Using the form T1, teachers (N_T=8) and students – future teachers (N_{ST}=35) reported on students' participation and engagement as well as learning difficulties and problems.

All of them stated that the students were interested and actively participated in the activities. Most of the student successfully completed all the tasks with the help of prepared materials. Video tutorials were especially useful to them. The students' projects selected by the teachers were published in the collection C4G Croatia in Snap! cloud (Figure 22).

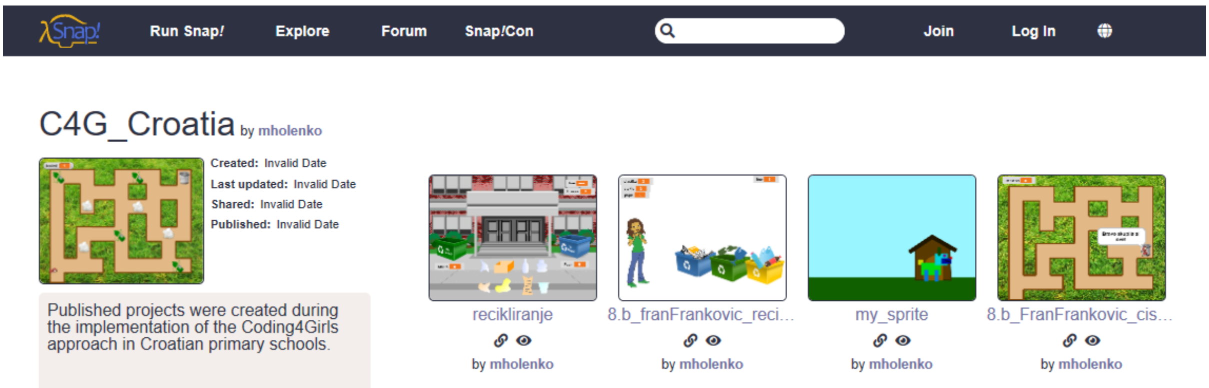


Figure 22 – Snap! collection "C4G Croatia"

Students collaborated in virtual classroom and were happy to answer each other's questions about the problems they encountered. However, teachers think that due to the specifics of online learning students were not able to collaborate to the extent that collaboration would be achieved in regular classes.

Due to technical limitations, some students were slower in completing assignments. Students working on tablets had problems with the Snap! since the tool did not work right and fast enough. Students had problems with adding costumes to sprites and with occasional freezing of its interface. The students who were creating projects on desktop computers or laptops had no problems. The teachers suggested programming language Scratch as a replacement since there is a mobile application that works well on tablets.

Teachers' comments

Using the form T2, teachers (N_T=8) and students – future teachers (N_{ST}=35) reported on accomplishment of learning objectives, relevance, effectiveness and acceptance of the proposed methodology by the students, and the overall organization of the implementation.

The opinion of the teachers is that game-based learning is fun for students. They are motivated to solve tasks (problems) which makes this way of learning effective for learning programming. All teachers stated that the learning objectives were fully achieved by the students during the C4G activities.

According to teachers, the students fully accepted the C4G methodology. The topics of the projects were very interesting to them and most of students enjoyed using newly acquired programming knowledge to create games. C4G projects had a positive effect on their desire and motivation to eliminate all mistakes. Students persisted until they reached the set goal - a game they could play.

Since the C4G activities were conducted online, the insight regarding achieved fun by the students could not be complete, but teachers stated that it is evident from the communication with the students that the students had fun and were looking forward to gaining new knowledge using the C4G methodology.

Regarding the overall organization of the implementation, teachers reported that it was fully aligned to the teaching needs (achievement of the outcomes related to programming). Created materials for implementation of C4G activities are comprehensive and clear. During the implementation, logistical support from project team members was efficient and available at any time.

Teachers also agree that the C4G game-based, design thinking educational framework is applicable in future work. Learning scenarios with projects that need to be developed in

Snap! are appropriate to the age of students. Teachers who participated in the implementation activities plan to use them in their future work. Teachers also believe that a design thinking approach in combination with game-based learning can be used not only for development of programming skills but also to enhance students' creative potential which can result in some new ideas and solutions.

Experts' comments

External validators - experts (N_E=3) were also asked to give their qualitative opinions regarding the accomplishment of learning objectives by the students, relevance, effectiveness and acceptance of the proposed methodology by the students, and the overall organization of the implementation.

All three experts agreed that for developing basic programming skills in among students from 10-16 years, the C4G methodology is very suitable. Snap! programming interface allow students to create interactive stories and games which is fun and stimulating for them. The advantage of coding using blocks is that students of that age do not need to learn the programming syntax because this negatively affects students' motivation to learn programming (they usually forget the syntax very quickly).

They stressed out that the C4G approach assumes solving real-life problems which is interesting to students, especially girls. In programming classes, mathematical tasks are very common (e.g. calculating the range, area of a square, rectangle or currency conversion and the like), which further demotivates students for learning programming. According to the experts, projects in C4G learning scenarios are well designed and enable accomplishment of learning objectives. The projects stimulate students to be creative and enable them to learn in a fun way by creating games. Topics included in the projects are interesting to the girls and motivate them to solve the given problem using newly acquired programming knowledge. At the same time, topics are interesting to boys as well.

According to experts' opinion, C4G design thinking educational framework is effective and applicable for teaching programming to girls as well as boys. Due to observed technical problems with Snap!, experts suggest that its further development include also possibility of learning programming using Scratch.

DISCUSSION AND CONCLUSIONS

The results of the preliminary questionnaire (S1) showed that students of both genders use the Internet and digital devices, on average a couple of hours a day, and have 5 to 6 years of experience in their use. This shows that the students had the appropriate digital skills necessary for the implementation of the C4G approach. The large number of hours that some students spend per week using digital devices and the Internet is partly conditioned by the online teaching that was conducted during this study because students were expected to study teaching materials, create assignments, and communicate with teachers in virtual classrooms. Results also showed that students play video games and that boys spend significantly more time playing them than girls. This indicates that game-based activities, such as those designed within the C4G approach, should be tailored to interests of the girls to keep the girls motivated.

Results of the preliminary questionnaire also indicated that younger students, especially 6th graders, are more motivated for learning programming than 7th and 8th grade students, even though for 7th and 8th grade students the subject Informatics is not compulsory, but optional. In general, students are mostly motivated by success in the programming class (girls to a greater extent that boys). Students (especially 6th graders) are motivated by the fact that they enjoy solving problems and puzzles and because creating their own games is fun for them. This confirms that the C4G methodology which includes creating games for solving real-life problems is appropriate for the target group of students. According to the results, boys (especially 5th graders) are further motivated by the desire to become programmers while girls are very little motivated by this factor. This shows that girls are less interested to follow a career in programming so they need to be motivated by approaches like C4G.

In the initial self-assessment of their programming skills, the most of the students stated that they are novice programmer s (level 1) or that they can code simple programs (level 2). This is confirmed by the results regarding the familiarity with programming concepts which showed that most students are familiar only with basic concepts such as statements and loops. Some students attend the subject Informatics for several years but do not consider that they have developed programming skills. The reason for this may be that they find programming difficult and are not interested in learning.

After the implementation activities, teachers and student teachers reported that conducted activities enable students to achieve learning outcomes and at the same time had fun. Teachers think that creating games is a very effective way for students to learn programing concepts and they plan to apply the C4G methodology in the future as well. They observed that C4G approach encouraged creativity and problem solving and students were motivated to complete the project (their own game) to the end. The external experts who participated in the validation activities agreed with these observations and support the application of game-based learning approach using visual programming tools for learning programming. They emphasized the good choice of topics of the projects included in the learning scenarios which are interesting to girls and encouraged them to apply their programming knowledge.

Results of the comparison of self-assessment confirmed the effectiveness of implemented activities for learning programming. Students self-assessed their programming skill significantly higher after the C4G activities compared to self-assessment before the C4G activities (large effect size is present for overall results and results grouped by gender).

Students' attitudes regarding the C4G methodology, expressed in the follow-up questionnaire, shown that they consider the approach relevant for learning programming and that they had fun and enjoyed programming which also supports the validation of the C4G approach. Student qualitative feedback was also very positive. They expressed their satisfaction with the approach and acquired skills but many of them stated that they would prefer to use Scratch over Snap!. This is not surprising since Scratch is the widely used tool for visual programming in Croatian schools so many students are used to it. In addition, students who used tablets experienced technical problems.

In conclusion, the C4G methodology is appropriate for students who are 10 – 16 years old and enable the achievement of learning outcomes in an effective and fun way. Additionally, the approach has proven applicable in an online environment. Regarding the possible improvements, the main problem were technical difficulties encountered by students who used Snap! on tablets, so the next version of the C4G methodology should include the possibility of using Scratch instead of Snap!.

ANNEXES

S1. PRELIMINARY QUESTIONNAIRE FOR STUDENTS (in Croatian)

S1. UVODNI UPITNIK ZA UČENIKE

Ovo je preliminarni upitnik o korištenju digitalnih uređaja i iskustva s programiranjem koji se provodi u okviru projekta CODING4GIRLS. Cilj projekta je poticanje razvoja vještina programiranja korištenjem obrazovnih igara.

Tvoji odgovori će biti **anonimni** i korišteni samo u svrhu istraživanja. Hvala na suradnji!

Za početak, **upiši kôd** koji si dobio/dobila od učitelja/učiteljice.

KOD I OSNOVNE INFORMACIJE

Kôd:	_______________	Škola:	_______________
Godine:	_______________	Razred:	_______________
Spol:	M Ž		

KORIŠTENJE DIGITALNIH UREĐAJA, INTERNETA I VIDEO IGARA

1. Koliko godina koristiš računala, tablete i ostale digitalne uređaje?	__________ godina
2. Koliko sati tjedno koristiš računalo, tablet ili neki drugi digitalni uređaj?	__________ sati
3. Koliko sati tjedno koristiš Internet?	__________ sati
4. Koliko sati tjedno igraš video igre?	__________ sati

ISKUSTVO S PROGRAMIRANJEM

5. Koliko si trenutno vješt/vješta u programiranju? *Zaokruži jedan odgovor.*
   a) Nisam nikad programirao/programirala
   b) Početnik/početnica sam (imam samo osnovna znanja)
   c) Mogu izraditi samo jednostavne programe
   d) Mogu izraditi i nešto složenije programe
   e) Mogu izraditi program kojim će se riješiti zadani problem

6. Ako već imaš iskustva s programiranjem, koji su ti od navedenih koncepata poznati? *Označi kvačicom jedan ili više odgovora.*
   - ☐ Petlje (ponavljanje)
   - ☐ Varijable
   - ☐ Događaji
   - ☐ Uvjeti (ako – onda)
   - ☐ Operatori
   - ☐ Paralelizam
   - ☐ Naredbe za kretanje i izgled likova, crtanje, zvukove

7. Što te motivira na učenje programiranja? *Označi kvačicom jedan ili više odgovora.*
   - ☐ Nisam motiviran/motivirana
   - ☐ Želim uspješno savladati nastavno gradivo vezano za programiranje
   - ☐ Želim pokazati drugim učenicima da znam programirati
   - ☐ U budućnosti želim raditi kao programer/programerka
   - ☐ Uživam rješavati logičke zadatke
   - ☐ Nešto drugo: ____________________________

S2. FOLLOW-UP QUESTIONNAIRE FOR STUDENTS (in Croatian)

S2. ZAVRŠNI UPITNIK ZA UČENIKE

Ovo je upitnik o zadovoljstvu s učenjem prema projektu CODING4GIRLS i aktivnostima koje su provedene za razvoj vještina programiranja. Tvoji odgovori će biti **anonimni** i korišteni samo u svrhu istraživanja. Hvala na suradnji!

Za početak, **upiši kôd** koji si dobio/dobila od učitelja/učiteljice (to je isti kôd kao i za uvodni upitnik).

KOD I OSNOVNE INFORMACIJE

Kôd:	_______________	Škola:	_______________
Godine:	_______________	Razred:	_______________
Spol:	M Ž		

C4G METODOLOGIJA

8. Izrazi mišljenje o sljedećim tvrdnjama:	*Uopće se ne slažem*	*Ne slažem se*	*Niti se slažem, niti se ne slažem*	*Slažem se*	*U potpunosti se slažem*
k) Smatram da je programiranje zahtjevno.	1	2	3	4	5
l) Smatram da je programiranje motivirajuće.	1	2	3	4	5
m) Smatram da je programiranje jednostavno.	1	2	3	4	5
n) Uživao/uživala sam u programiranju.	1	2	3	4	5
o) Razumijem većinu prezentiranih koncepata iz programiranja.	1	2	3	4	5
p) Smatram da je učenje na ovaj način zabavno.	1	2	3	4	5
q) Aktivno sam sudjelovao/sudjelovala tijekom ovakvog načina učenja.	1	2	3	4	5
r) Aktivnosti u kojima sam sudjelovao/sudjelovala su bile prikladne za učenje programiranja.	1	2	3	4	5
s) Uvijek mi je bilo jasno što trebam raditi.	1	2	3	4	5
t) Naučeno će mi koristiti u budućnosti.	1	2	3	4	5

ISKUSTVO S PROGRAMIRANJEM

9. Koliko si trenutno vješt/vješta u programiranju? *Zaokruži jedan odgovor.*
   a) Nisam nikad programirao/programirala
   b) Početnik/početnica sam (imam samo osnovna znanja)
   c) Mogu izraditi samo jednostavne programe
   d) Mogu izraditi i nešto složenije programe

e) Mogu izraditi program kojim će se riješiti zadani problem

S3. STUDENT'S COMMENTS (in Croatian)

S3. KOMENTARI UČENIKA			
Nakon primjene C4G pristupa za stjecanje vještina programiranja koji se zasniva na igrama, učitelj prikuplja kvalitativna mišljenja i komentare učenika u grupnom intervjuu. Molimo da grupirate sve učenike razrednog odjela te da kroz razgovor prikupite njihova kvalitativna mišljenja i komentare. Pitajte učenike o aspektima navedenim u nastavku i zabilježite njihove komentare pomoću ovog obrasca. Hvala Vam na Vašem vremenu i suradnji!			
OSNOVNE INFORMACIJE			
Nastavnik:	____________________	Razred:	__________
Škola:	____________________	Datum:	__________
CJELOKUPNA ORGANIZACIJA I ISKUSTVA UČENIKA			
Možete pitati učenike o cjelokupnoj organizaciji učenja programiranja putem C4G pristupa, o njihovoj percepciji o stečenom znanju, o relevantnosti i učinkovitosti korištenog pristupa učenju programiranja koje se temelji na igrama te da li im je ovakav način učenja bio zabavan.			
POTEŠKOĆE PRILIKOM UČENJA I PROBLEMI S TEHNOLOGIJOM			
Možete pitati učenika o poteškoćama u učenju ili problemima s kojima su se suočavali te što su radili kad su naišli na te probleme.			
STAVOVI UČENIKA O TOME KAKO POBOLJŠATI C4G METODOLOGIJU, ALATE I SADRŽAJE			
BILO ŠTO DRUGO ŠTO SMATRATE RELEVANTNIM			

T1. TEACHER'S OBSERVATIONS (in Croatian)

T1. ZAPAŽANJA UČITELJA
Tijekom implementacije, učitelj promatra i vodi bilješke o reakcijama učenika i njihovom napretku u usvajanju vještina programiranja pomoću C4G pristupa koji se zasniva na igrama. Molimo da koristeći ovaj obrazac navedete Vaša zapažanja o aspektima navedenim u nastavku. Hvala Vam na Vašem vremenu i suradnji!
OSNOVNE INFORMACIJE
Nastavnik: ____________________ Razred: _______________ Škola: ____________________ Datumi (od-do): _______________
SUDJELOVANJE I AKTIVNOST UČENIKA
Jesu li učenici aktivni? Surađuju li međusobno? Zabavljaju li se? itd.
POTEŠKOĆE PRILIKOM UČENJA I PROBLEMI S TEHNOLOGIJOM
Da li učenici imaju problema sa sadržajem i/ili tehnologijom? Traže li pomoć? itd.
BILO ŠTO DRUGO ŠTO SMATRATE RELEVANTNIM

T2. TEACHER'S COMMENTS (in Croatian)

<table>
<tr><th>T2. KOMENTARI UČITELJA</th></tr>
<tr><td>Nakon primjene C4G pristupa za stjecanje vještina programiranja koji se zasniva na igrama, prikupljaju se kvalitativna mišljenja i komentari učitelja.

Molimo da koristeći ovaj obrazac navedete Vaše stručno mišljenje o aspektima navedenim u nastavku.

Hvala Vam na Vašem vremenu i suradnji!</td></tr>
<tr><th>OSNOVNE INFORMACIJE</th></tr>
<tr><td>Nastavnik: ____________________ Razred: __________
Škola: ____________________ Datum: __________</td></tr>
<tr><th>OSTVARENOST ISHODA UČENJA KOD UČENIKA</th></tr>
<tr><td></td></tr>
<tr><th>VAŽNOST I UČINKOVITOST UČENJA TEMELJENOG NA IGRI ZA STJECANJE VJEŠTINA PROGRAMIRANJA – OPĆENITO TE SPECIFIČNO ZA C4G PRISTUP</th></tr>
<tr><td></td></tr>
<tr><th>PRIHVAĆANJE PREDLOŽENE C4G METODOLOGIJE OD UČENIKA</th></tr>
<tr><td></td></tr>
</table>

U KOJOJ MJERI SU SE UČENICI ZABAVLJALI?
VAŠE MIŠLJENJE O CJELOKUPNOJ ORGANIZACIJI IMPLEMENTACIJE C4G PRISTUPA
PRIMJENJIVOST I PRIHVATLJIVOST C4G OBRAZOVNOG OKVIRA ZASNOVANOG NA IGRAMA I *DIZAJN THINKING* PRISTUPU U BUDUĆAM RADU
BILO ŠTO DRUGO ŠTO SMATRATE RELEVANTNIM

E. EXPERT'S COMMENTS (in Croatian)

E. KOMENTARI STRUČNJAKA	
Nakon primjene C4G pristupa za stjecanje vještina programiranja koji se zasniva na igrama, kvalitativna mišljenja i komentari stručnjaka se prikupljaju u strukturiranom intervjuu. Upotrijebite ovaj obrazac i navedite stručno mišljenje o aspektima navedenim u nastavku.	
OSNOVNE INFORMACIJE	
Ime stručnjaka: ____________________	Radno mjesto: ___________
Institucija: ____________________	Datum: ___________
OSTVARENOST ISHODA UČENJA KOD UČENIKA	
VAŽNOST I UČINKOVITOST UČENJA TEMELJENOG NA IGRI ZA STJECANJE VJEŠTINA PROGRAMIRANJA – OPĆENITO TE SPECIFIČNO ZA C4G PRISTUP	
PRIHVAĆANJE PREDLOŽENE C4G METODOLOGIJE OD UČENIKA – OPĆENITO I OD STRANE POSEBNO DJEVOJČICA	

U KOJOJ MJERI SU SE UČENICI ZABAVLJALI?
VAŠE MIŠLJENJE O CJELOKUPNOJ ORGANIZACIJI IMPLEMENTACIJE C4G PRISTUPA
PRIMJENJIVOST I PRIHVATLJIVOST C4G OBRAZOVNOG OKVIRA ZASNOVANOG NA IGRAMA I *DIZAJN THINKING* PRISTUPU ZA UČENJE PROGRAMIRANJA, ZA DJEVOJČICE I OPĆENITO
BILO ŠTO DRUGO ŠTO SMATRATE RELEVANTNIM

NATIONAL REPORT: GREECE

Disclaimer

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EXECUTIVE SUMMARY

The report describes the validation phase organized in Greece to test the Coding4Girls learning approach and the tools developed. In particular, it explains the main steps of the implementation with all the target groups involved: experts, primary and secondary school teachers and 10-15 years-old students.

Moreover, it reports on the results achieved and collected through the qualitative evaluation tools developed and submitted before and after the implementation.

In today's digital economy, there is a pressing need for highly skilled professionals in information technology. This is a result of the evolution of digital technologies, and particularly broadband network speeds, that drive demand for digital tools and services. In the coming years growth is expected to be driven by innovation-related sectors including information technology. To be able to compete in the global market, European SMEs and larger companies in the information technology sector are in need of highly skilled professionals that not only are in a position to use digital services and applications, but also to program. Unfortunately, the engagement of women in the information technology sector is lagging behind that of men. This is not so much a result of the lesser capacity of girls, as the PISA survey demonstrates that girls perform as well as boys in STEAM at the age of 15. Rather, it is a result of perceptions and attitudes that discourage girls from pursuing studies and careers in information technology. The Coding4Girls project aims to build programming capacity of learners aged 10 – 15 years. This is pursued through the development of a learning game that helps build coding skills in an engaging and rewarding manner that provides rich educational experiences. The game is part of a wider learning intervention that aims to demonstrate that information technology is sector in which both girls and boys can excel and express themselves creatively and professionally. This report constitutes a summary of the piloting activities of the Coding4Girls project with external groups of students and their teachers in Greece.

● IMPLEMENTATION

The Coding4Girls learning intervention was validated with external groups of students in the area of Magnesia, Thessaly. Magnesia has 150K inhabitants while the broader area of Thessaly has 700K inhabitants and represents the central part of Greece. Thessaly has 4 main towns with populations ranging from 70K to 200K. Outside these urban environments, Thessaly is a broadly agricultural area as it is the biggest valley in Greece that produces agricultural goods for the internal market and for exports. The evaluation activities were designed to take into account this diverse environment, which includes both urban and rural schools.

In order to select the schools that were engaged in the evaluation activities and to ensure that all rules for the engagement of underage students were followed, the implementation team collaborated with the Regional Center of Educational Planning of the area of Thessaly. The Center is the Ministry of Education’s consulting organization on the adoption of innovative learning design and approves all activities taking place in schools before engaging students. The team worked with Mr. Alexandros Kapaniaris, the Coordinator of Educational Planning for Informatics for the area of Thessaly, and Mr. Constantinos Panagiotou, the Coordinator for Educational Planning for Mathematics for the area of Thessaly. Furthermore, the team worked with the Hellenic Mathematical Society Magnesia Division, a professional association that engages all secondary mathematics teachers in the area of Magnesia.

The Regional Center of Educational Planning recommended and gave approval for engaging the following schools in piloting activities:

- The 5th Gynmasium of Volos [1].
- The Gynmasium of Pteleos, Magnesia [2].
- The Saint Joseph Primary School of Volos [3].

Introductory workshops

The first step of the implementation involved engaging the informatics teachers in the selected schools to build their familiarity on the Coding4Girls software and to ensure that they are in a position to deploy the tool for designing educational activities for their students. The activities engaged the information technology teachers in the schools selected by the

Regional Center for Educational Planning to participate in the Coding4Girls evaluation listed above.

The 1st session took place virtually and aimed to familiarize the educators with the general objectives of the Coding4Girls project and specifically building programming skills for learners 10 – 15 with an emphasis on engaging girls. The session took place in November 2019.

A 2nd session took place face-to-face in December 2019. In this session educators were familiarized with the Coding4Girls digital learning game. The educators were guided step-by-step through the functionality of the learning game, including both the educator and the student views. On the educator view, the participants reviewed in practice the creation of educational activities in the Coding4Girls environment from scratch as well as by emulating and adapting existing public activities developed by peers. They reviewed how to define objectives, step-wise tasks for students, optionally linking mini-games to tasks for making activities more enticing, and reviewing student progress. On the student side, they reviewed the way students experienced the Coding4Girls learning game. This includes the services for collaborating and brainstorming in a group, reviewing learning activity objectives set by educators, programming in the Snap! environment, reviewing pre-defined correct solutions and comparing their work to those, collecting rewards in the form of coins, using the rewards to personalize their environment, and more.

Another virtual session took place in March 2020 in which another review of the game functionality took place for the benefit of educators.

Data collection tools

Data collection took place through qualitative evaluation approaches. Qualitative methods are deployed when evaluation input cannot be provided with a yes/no or numeric answer but rather is best described descriptively through text and comments. This approach is relevant in the Coding4Girls evaluation as the proposed learning intervention aims to document the evolution of perceptions and attitudes of boys and girls towards programming, which is best achieved in a descriptive manner.

Evaluation took place in the form of learning experiments that engaged external groups of students and their educators. Participatory observation methods were deployed, in which educators undertaking the role of a researcher observed their students during their engagement with the Coding4Girls learning game and documented their reactions, their perceptions, the challenges they faced, and the positive impact of the activities.

The following sections describe the activities that took place and document findings in a qualitative manner.

Materials

The materials used during the implementation of the validation phase were

- the learning scenarios and
- instructions for students

developed by the project partners.

These learning scenarios were re-adapted to the design thinking approach and the structure of the C4G software constituting of two parts:

- the Teacher's Training Platform and
- the Student Game Environment.

Setup models and procedure

At the beginning of the implementation phase, students answered the preliminary questionnaire (S1). After the implementation, they answered the follow-up questionnaire (S2) about their perception and views on the C4G learning approach. Moreover, teachers collected students' qualitative opinions and comments (S3).

The teachers reported on the students' participation and engagement and their learning difficulties during the implementation (T1) and on the accomplishment of the learning objectives, the relevance and effectiveness of the game-based learning, the acceptance of the proposed methodology, the fun achieved and the overall organization of the implementation (T2).

The external experts also gave their qualitative opinions regarding the accomplishment of the learning objectives, the relevance and effectiveness of the game-based learning, the acceptance of the proposed methodology, the fun achieved and the overall organization of the implementation (E).

Participants

Direct participant of the study were teachers of informatics (N_T=3) from 3 schools in Volos, Greece together with their students (N_S=156). All the selected teachers have years of experience in teaching informatics.

The C4G approach for building programming skills was applied in classes, involving a total of 156 students aged from 10 to 15 years (5th and 6th grade of primary school and 1st to 3rd grade of secondary school). Table 1 shows number of students – participants of the study by age/grade.

Table 28 - Number of students by age/grade

Years of age	Grade	Classes	Number of students
10-11	5	1	25
11-12	6	1	25
12-13	1	1	12
13-14	2	1	12
14-15	3	5	82
	Total	**9**	**156**

Descriptions of activities at the 5th Gymnasium of Volos

The 5th Gynmasium of Volos enrolls students aged 12 – 15 years. It is the only school in the centre of the town of Volos, which has 120K inhabitants, and it is significant as it addresses urban educational needs. The school's student body is very representative for a medium sized town out of the capital city of Athens. The other Gymnasiums of the town of Volos are located in the city outskirts.

Figure 23. Students arrive for class at the 5th Gymnasium of Volos.

The school has a computer lab with 12 workstations. The workstations operate on Windows®. The lab is used for informatics but also for digital activities related to any course in the school curriculum. This means that the lab is used by most teachers in the school. The lab also has a server that is used for sharing software with the students.

Figure 24. Students work in the computer laboratory at the 5th Gymnasium of Volos.

The Coding4Girls software was used in the context of the informatics course in the 3rd year of studies. The course aims to build general digital literacy for students focusing mostly on the deployment of typical and common digital tools and less on programming. Informatics is a heavily lab-based course. Even the underlying theory is delivered through lab activities, encouraging students to deploy concept graphs, spreadsheets, text processing, and more. However, Mr. Christos Christoforidis, the informatics teacher of the school, engages students in programming activities through tools such as Scratch, Logo, and code.org, an on-line environment for programming exercises that has the feel of the Scratch tool. Through these activities the teacher aims to go beyond the strict requirements of the formal curriculum for further fostering experimentation and exploration among students with a focus on programming and not only basic digital literacy. This is not uncommon for teachers in several, who research options for increasing interactivity in the classroom through games and simulations.

The evaluation activities took place in January, February, and March of 2020. 4 groups of learners were involved for a total of approximately 70 students. The activities took place in the context of obligatory information technology courses that address all students and are part of the formal curricula dictated by the Ministry of Education. The students worked in teams on the lab computers using 6-7 accounts Coding4Girls. The students were actively engaged not only in using the Cording4Girls software but also in setting up the learning activities. A series of sessions took place. In the 1st session the students installed the software on the lab computers. In the 2nd session the students created accounts in the Coding4Girls software. In the 3rd session the students connected to the Coding4Girls application and starting deploying the Chameleon activity. In subsequent sessions the students reviewed the

Chameleon activity objectives, explored the mini games, and brainstormed on a potential solution using the related functionality of the game. Finally, students worked on programming a solution to the Chameleon activity using the Snap! environment that is integrated into the Coding4Girls learning application. Notably, students were already familiar with Scratch. This allowed them to become easily accustomed to the similar Snap! environment.

One of the challenges that were faced was the size of the Coding4Girls application, which made it difficult to download to the laboratory computers due to their limited capacity and the low bandwidth of the network. The reason why the software is heavy is because it includes very nice 3D graphics that allow students to immerse into the learning activities and to have a more enjoyable educational experience. To overcome the challenges introduced by the size of the application, the implementation team provided the school with 14 USB sticks on which the software was stored. With the USB sticks it was no longer necessary to download the software as students could directly run it from the storage device that was attached to the computer.

The experience of the students from using the Coding4Girls learning tool was very positive. The teacher observed student reactions and engagement and reported that the software was attractive, enticing learning to want to explore it further. Part of the attractiveness is the 3D graphics of the application that are very similar to what students are used to when playing digital games for entertainment. The graphical environment and the user movement in the digital world is comparable to popular commercial games in terms of quality and fidelity and this is one of significantly positive aspects of the application. Furthermore, the students enjoyed the actual learning activities themselves and particularly the brainstorming and programming as they were challenging but within their reach. They further enjoyed the narrative of the game, specifically the Chameleon vacation theme, which introduced a fun and intuitive wide level objective for them to achieve through programming. Girls and boys participated equally in the activities, becoming aware that information technology is not gender specific and that all learners have the opportunity to think creatively through computer science.

For the teacher, one of the benefits was the fact that the tool provides some learning activities that are already complete, such as the Chameleon educational scenario. This allowed the teacher to directly engage with the tool immediately. The scenario further could be used as a good practice example that helped the teacher understand the functionality of the learning application and was used for inspiration towards designing additional educational activities for the class.

Descriptions of activities at the Gynmasium of Pteleos

Pteleos is a village at the south part of the region of Magnesia, which is one of the 4 smaller geographical regions of the wider area of Thessaly. The school engages 40 learners in total aged 12 – 15 years, approximately equally divided in the 3 academic years. Due to the small size of the school only one group of students exists for each class from the 1st to the 3rd. The school was selected because it is located in a village and out of urban areas. The students enrolled in the school are representative of rural populations. As such the information collected through the evaluation activities in this school is complementary to that collected in the urban 5th Gynmasium of Volos.

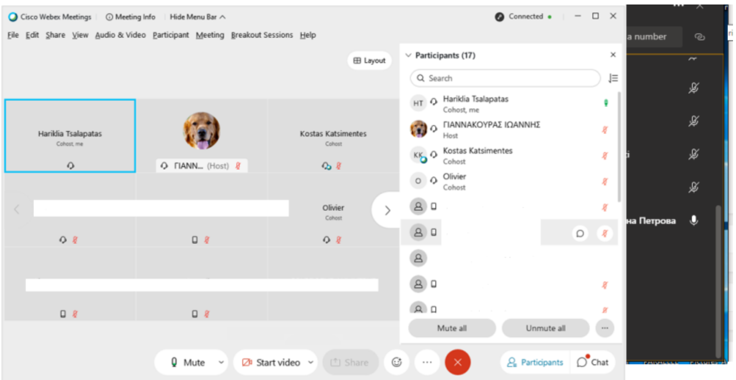

Figure 25. Students of the 3rd grade of the Gynmasium of Pteleos log into the information technology class session to deploy the Coding4Girls learning game.

The evaluation activities took part in the school computer lab. The lab has 12 computers that operate on a Windows environment and a server that operates on a Linux thin client. Similar to the 5th Gymnasium of Volos, the lab is used for the informatics course but also for all curriculum courses when there is an opportunity or need to deploy digital tools for enriching student experiences.

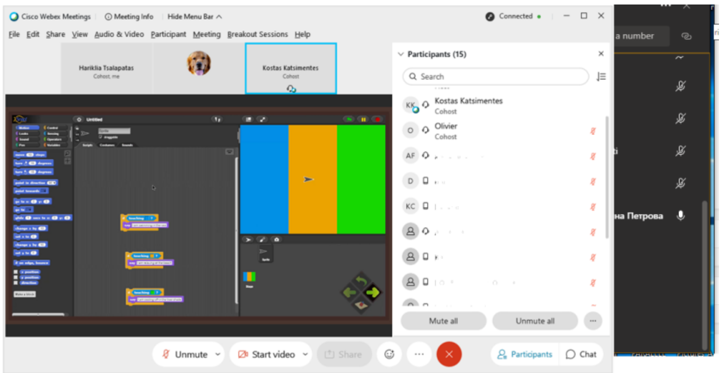

Figure 26. Students of the 3rd grade of the Gynmasium of Pteleos work on building programs in the context of the Chameleon learning scenario.

The informatics course is taught based on the curriculum that is dictated by the Ministry of Education. Students engage in programming by using the Scratch environment as well as the Logo programming language.

Evaluation activities started in the spring of 2020 engaging all 3 classes, namely 1st to 3rd. The educator, Mr. Giannis Giannakouras, presented to students the objectives of the Coding4Girls project and demonstrated the software application. The Coding4Girls software was installed on the school computers in the spring of 2020.

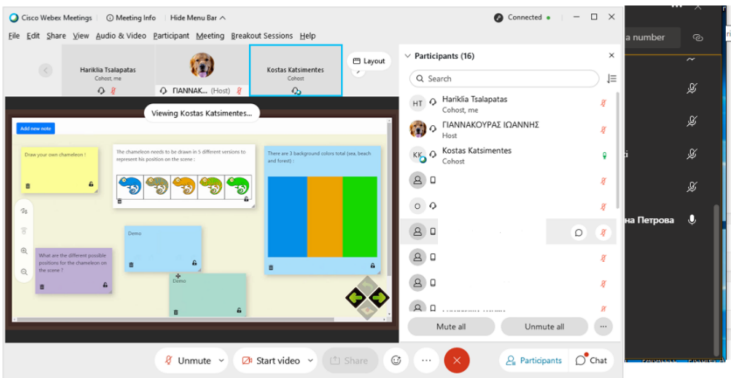

Figure 27. Students of the Gymnasium of Pteleos deploy the brainstorming tools of the Coding4Girls learning game.

Activities resumed in the fall of 2020. Unfortunately, activities were interrupted as a result of schools closing in March 2020 in the context of COVID-19 prevention measures.

The implementation team provided this school as well with USB sticks that include the software application in order to facilitate easy execution directly from the storage device, overcoming downloading speed challenges that are faced by the school due to its rural location. The USBs were also used to distribute the software to students for home deployment. More evaluation sessions took place in December 2020. The sessions took place virtually as school were again closed only a few weeks after opening in September 2020.

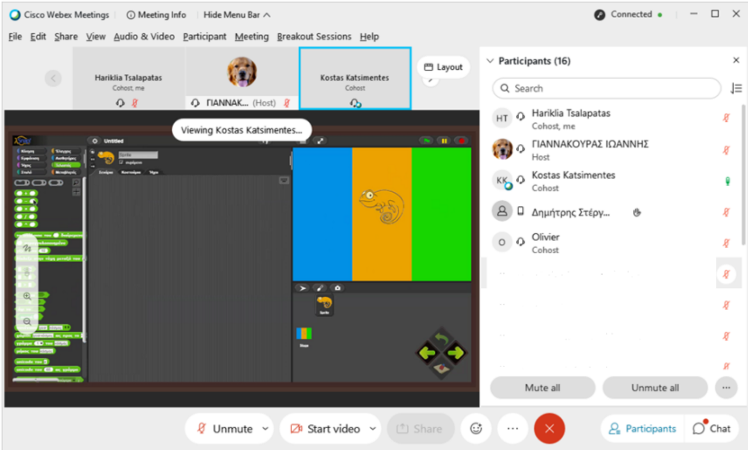

Figure 28. Students at the Gymnasium of Pteleos explore movement functions of programming through the Coding4Girls learning game.

The sessions engaged the 1st grade (12 students), the 2nd grade (12 students), and the 3rd grade (12 students). In other words, almost all students in the school engaged in programming games through Coding4Girls. The activities took place in the context of information technology courses in the context of the formal school curriculum.

During the sessions the students had the opportunity to experience the software tools. They were familiarized with account creation, logging in, entering a course room, reviewing the course objectives, and executing the course activities as these were defined by the educator. The students used the Chameleon learning scenario, similarly to the 5th Gymnasium of Volos. They students followed the tasks of the scenarios that involve playing a mini-game that demonstrates a programming concept and then programming in a step-by-step manner the behaviour of the Chameleon. The programming steps include motion, i.e. making the Chameleon move, sound, namely making the Chameleon speak, colour, namely making the Chameleon take the colour of his surroundings, and putting everything together. The students also explored the gamification elements of the software application, through which a user gains rewards in the form of coins that she may exchange for personalizing the game environment, for example adapting the colours of the lobby, changing the music, and more. Finally, the students experienced how they may adapt the parameters of the game appearance through the application menu.

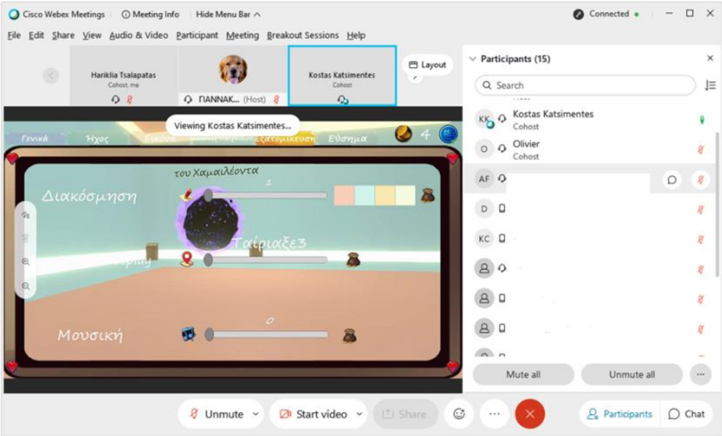

Figure 29. Students at the Gynmasium of Pteleos explore the personalization of the Coding4Girls environment through the use of gamification elements and specifically the use rewards in the form of coins gained as a result of their engagement in the learning game.

The students engaged in a discussion in which they asked both practical questions related to the execution of the game in diverse environments and devices as well as more high-level issues related to the importance of programming in the digital age. They further were able to understand that the evolution of technology, and more specifically of network speeds, is a driver for demand for ever evolving digital applications which in turn drives the need for qualified programming professionals. The students reflected on how girls and boys have equal opportunities in engineering careers and more specifically the software industry and that it is important for society to put all innovative minds to work for addressing emerging challenges.

Descriptions of activities at the Saint Joseph Primary School in Volos

The Coding4Girls software was evaluated with students in the 5th and 6th grades of the Saint Joseph primary school of Volos that enrol approximately 50 students. Primary schools in Greece enrol students aged 6-12 years. Saint Joseph is an innovative private primary school in Volos that aims to integrate innovation in all aspects of learning, including digital education.

Figure 30. Students at Saint Joseph Primary School engage in STEAM activities.

USB sticks with the software were provided to the informatics educator of the school, Ms. Zoi Stellou, who provided valuable insight on student needs as well as feedback. The teacher commented that one of the key advantages of the software is that it is developed in the form of a game that entices students to engage with building programming skills. In addition, the educator commented that the design of the software application took into account the needs of girls, aiming to bring them closer to computing. This is particularly important because the fact is that girls, although they do not lag behind boys in terms of mental development, do not choose learning paths related to science and in particular to computer science, mathematics, and engineering.

The teacher commented that in the Saint Joseph school, as well as in other schools, the number of girls that participate in technology workshops that go beyond the school obligatory activities are very few. For example, very few girls participate in after school activities related to robotics and STEAM skill development as compared to boys. This is a result from informally conveyed from generation to generation of attitudes, perceptions, and stereotypes that technology is exclusive to boys.

The educator commented that for the 7 years that she works at the school as an IT teacher, and while she expected girls to be encouraged to come to the afternoon non-obligatory STEAM and programming workshops, there are rarely more than 1 to 2 girls in a class of 10. This is something that is of particular concern. Furthermore, many girls in obligatory computer science classes that take place in the context of the formal school program in the morning become stressed if an exercise they are assigned proves to be challenging and will rarely try for a 2nd time without the teacher's encouragement and support. Girls tell the teacher that they are afraid that they will damage the computers. This may reflect an attitude of distancing themselves from an activity that they are not yet familiar with; it may also reflect attitudes that have been subconsciously passed on to them by their immediate environment that they cannot obtain this knowledge and, as such, should distance themselves from the equipment without even making an effort.

The Coding4girls software enables children in general and girls in particular to build and apply programming skills. Some of the benefits of the software include the attractive environment, its graphics, and it's the simplicity that makes it accessible. On the other hand, the application design, which integrates girls' preferences on engaging in digital games based on related research encourages the participation in programming of all children and aims to increase the participation of girls in digital activities.

More specifically, the school chose to apply the Coding4Girls software not only in the afternoon non-obligatory workshops but also in the morning formal curricula to which all students have access, in order to allow all students to familiarize themselves with the tool. Coding4Girls allows the design through an easy interface of educational activities by teachers for the benefit of their students. It may be deployed not only in the context of digital education but also for building STEAM skills. The software can help students demystify technology and to understand that it is not only a choice for boys but also for girls allowing them to participate equally in information technology.

The school aims to continue deploying the Coding4Girls application for the rest of the 2020 – 2021 academic period after schools reopen to live instruction. In addition to that, it aims to deploy the software in the coming years documenting the expectations and experiences of all students, with an emphasis on girls. More specifically, the school aims to evaluate the degree to which girls overcome their fear of technology as a result of using the Coding4Girls interventions and other digital tools, overcome difficulties, and move past stereotypes on information technology developing a more positive outlook towards it. Also, the school will evaluate the degree to which the Coding4Girls activities help attract more girls to the STEAM and digital competences afternoon workshops.

● RESULTS

Results of questionnaires for students

Two questionnaires for students were used:

- S1. Preliminary questionnaire about the use of digital devices and perceived level of programming and
- S2. Follow-up questionnaire about satisfaction with programming and coding activities, satisfaction with the organization of the implementation, and perception on the acquired coding skills.

Students were asked to self-assess their current level of programming skill. Based on this question, the difference between students' self-assessed initial and final level of programming skill was calculated (the answers from the questionnaires were paired based on the code that students have entered).

Teachers' observations and comments

After the implementation activities, teachers were asked to express their qualitative opinions about the C4G methodology and the implementation process using the forms T1 and T2.

Using the form T1, teachers reported that the students were interested and actively participated in the activities. Most of the students successfully completed all the tasks with the help of prepared materials. Moreover, they stated that the students were actively engaged in discussion, asking both practical questions related to the execution of the game in diverse environments and devices as well as more high-level issues related to the importance of programming in the digital age. They further were able to understand that the evolution of technology, and more specifically of network speeds, is a driver for demand for ever evolving digital applications which in turn drives the need for qualified programming professionals. The students reflected on how girls and boys have equal opportunities in engineering careers and more specifically the software industry and that it is important for society to put all innovative minds to work for addressing emerging challenges.

Teachers' comments

Using the form T2, teachers reported on accomplishment of learning objectives, relevance, effectiveness and acceptance of the proposed methodology by the students, and the overall organization of the implementation.

The opinion of the teachers is that game-based learning is fun for students. The students fully accepted the C4G methodology and felt motivated to solve tasks (problems) which makes this way of learning effective for learning programming. All teachers stated that the gamified learning and the serious game approach are very suitable and motivating for the students. C4G projects had a positive effect on their desire and motivation to eliminate all mistakes.

Game-based learning always attracts the attention of students and is particularly effective in areas where mental activities such as programming are intense. Serious game design and approach with proof of concept can be problematic, especially for low-level students (in groups where the concept of abstract concrete is not very clear). However, with the concept-proven serious game approach, the usability of coding training is extremely high. The approach of the coding4girls project seems positive, as gamification and design emerge as sub-skills in the acquisition of coding skills.

Regarding the overall organization of the implementation, teachers reported that it was fully aligned to the teaching needs (achievement of the outcomes related to programming). Created materials for implementation of C4G activities are comprehensive and clear. During the implementation, logistical support from project team members was efficient and available at any time.

Experts' comments

External experts (N_E=3) were also asked to give their qualitative opinions regarding the accomplishment of learning objectives by the students, relevance, effectiveness and acceptance of the proposed methodology by the students, and the overall organization of the implementation.

All three experts agreed that for developing basic programming skills in among students from 10-15 years, the C4G methodology is very suitable. Game-based learning and design thinking is considered as very effective. Students feel more motivated to complete the assigned tasks, since Snap! interface allows them to create interactive stories and games which is fun and stimulating for them.

According to the experts, the C4G learning scenarios are well designed and enable accomplishment of learning objectives. Topics included in the projects are interesting to the girls and motivate them to solve the given problem using newly acquired programming knowledge.

Overall, the students definitely enjoyed learning the programming concepts. They were very often motivated to understand and learn the concepts so they could solve/program the solutions of the activities. The learning materials are well designed and excellently presented to the participating students.

● DISCUSSION AND CONCLUSIONS

In addition to the above schools, Coding4Girls was demonstrated to 30 secondary education teachers at the multiplier event that took place on October 15, 2020. The event was organized in collaboration with the Regional Centre for Educational Planning of the area of Thessaly. The Centre is the Ministry of Education's coordinating regional authority on innovative educational design. In addition, the event was organized in collaboration with the Hellenic Mathematical Society. The co-organization of the event with authorities and professional bodies ensures the broad dissemination and adoption of project results. Notably, the University of Thessaly consciously organized a relatively small in audience event in order to comply with COVID-19 rules that dictate that no more than 50 individuals be in the same room at any given time. With the organizers, invited speakers, and service professionals (such as caterers and photographers) the event was planned to have a total attendance of 40 individuals.

Figure 31. Educators explore the Coding4Girls learning game.

During the event the teachers had the opportunity to reflect on the needs of both society and industry to develop programming skills for the 21st century. Educators reflected on the fact that there is a significant shortage on skills programming professionals in Europe which reaches 900K empty positions.

Figure 32. Mr. Alexandros Kapaniaris, Coordinator of Educational Planning for Informatics for the Regional Center for Educational Planning for the area of Thessaly addresses educators in a Coding4Girls event.

This is a result of the evolution of network speeds that lead to ever increasing demand for on-line applications and services in today's digital age. As a result, Europe has a very active information technology landscape with SMEs and larger companies striving to meet the demand for digital tools and services. To effectively pursue business opportunities, the information technology sector relies on the development of a pool of skilled professionals. In other words, growth in the coming years will be very positively affected by information technology and will be heavily dependent on the development of human capital. The shortage of qualified information technology professionals requires that society and industry do more to attract all bright minds to innovation related sectors, such as the digital economy, including both girls and boys.

The feedback from educators was very positive. Educators perceived the software to be of great value for introducing programming to wider audiences and for attracting all children, including both girls and boys, to information technology studies and careers. In addition, the teachers found the application functionality on allows teachers to review and reproduce courses and activities produced by others as value adding features that help individuals that have less experience with the deployment of serious games to design activities for their students by being inspired and guided by activities designed by others and made public for all to use. Finally, the educators found the link between programming and STEAM particularly useful as both fields help build critical and analytical thinking and combined offer opportunities for positive multiplier effects on student transversal, soft skill development.

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

● ANNEXES

S1. PRELIMINARY QUESTIONNAIRE FOR STUDENTS (in Greek)

S1. ΠΡΟΚΑΤΑΡΚΤΙΚΟ ΕΡΩΤΗΜΑΤΟΛΟΓΙΟ ΓΙΑ ΜΑΘΗΤΕΣ	
Πρόκειται για μια προκαταρκτική έρευνα σχετικά με τη χρήση ψηφιακών συσκευών και την εμπειρία στον προγραμματισμό που πραγματοποιείται στο πλαίσιο του έργου CODING4GIRLS που στοχεύει στη δημιουργία ενός σοβαρού παιχνιδιού για την ανάπτυξη δεξιοτήτων προγραμματισμού. Οι απαντήσεις σας θα είναι **ανώνυμες** και θα χρησιμοποιούνται μόνο για ερευνητικούς σκοπούς. Σας ευχαριστούμε για το χρόνο και τη συνεργασία σας! Αρχικά, γράψτε τον **κωδικό** που λάβατε από τον καθηγητή σας παρακάτω.	
ΚΩΔΙΚΟΣ ΚΑΙ ΓΕΝΙΚΕΣ ΠΛΗΡΟΦΟΡΙΕΣ	
Κωδικός: ______________ Σχολείο: ______________ Ηλικία: ______________ Τάξη: ______________ Φύλο: Α Γ	
ΧΡΗΣΗ ΨΗΦΙΑΚΩΝ ΣΥΣΚΕΥΩΝ, ΔΙΑΔΙΚΤΥΟΥ ΚΑΙ ΒΙΝΤΕΟΠΑΙΧΝΙΔΙΩΝ	
10. Για πόσο καιρό χρησιμοποιείτε υπολογιστές, tablet ή άλλες ψηφιακές συσκευές;	_________ χρόνια
11. Πόσες ώρες την εβδομάδα χρησιμοποιείτε υπολογιστή, tablet ή άλλη ψηφιακή συσκευή;	__________ ώρες
12. Πόσες ώρες την εβδομάδα χρησιμοποιείτε το Διαδίκτυο;	__________ ώρες
13. Πόσες ώρες την εβδομάδα παίζετε βιντεοπαιχνίδια;	__________ ώρες
ΕΜΠΕΙΡΙΑ ΣΤΟ ΓΡΑΨΙΜΟ ΚΩΔΙΚΑ ΚΑΙ ΣΤΟΝ ΠΡΟΓΡΑΜΜΑΤΙΣΜΟ	
14. Ποιο είναι το επίπεδό σας στον προγραμματισμό, τώρα; *Κυκλώστε την πιο κατάλληλη απάντηση*. f) Δεν έχω γράψει κώδικα ή δεν έχω προγραμματίσει ξανά g) Είμαι αρχάριος προγραμματιστής (έχω βασικές ιδέες) h) Μπορώ να γράψω κώδικα για απλά προγράμματα i) Είμαι πολύ καλός στον προγραμματισμό (μπορώ να δημιουργήσω ολοκληρωμένο πρόγραμμα) j) Μπορώ να σχεδιάσω μια λύση ενός προβλήματος σε μορφή προγράμματος	
15. Αν έχετε ξαναγράψει κώδικα, ποιες από τις παρακάτω έννοιες σας είναι οικείες; *Τσεκάρετε μια ή περισσότερες απαντήσεις.* ☐ Βρόχοι ☐ Μεταβλητές ☐ Συμβάντα ☐ Συνθήκες ☐ Τελεστές ☐ Παραλληλισμός ☐ Statements (ήχοι, κίνηση, εμφάνιση, ζωγραφική)	

16. Τι σας παρακινεί να μάθετε να προγραμματίζετε; *Τσεκάρετε μια ή περισσότερες απαντήσεις.*

- ☐ Δεν έχω κίνητρο
- ☐ Θέλω να επιτύχω στο μάθημα της πληροφορικής
- ☐ Θέλω να δείξω στους άλλους μαθητές ότι μπορώ να προγραμματίζω
- ☐ Θέλω να ακολουθήσω μια καριέρα στο επάγγελμα του προγραμματισμού
- ☐ Μου αρέσει να επιλύω λογικά προβλήματα και γρίφους
- ☐ Άλλο ____________________________

S2. FOLLOW-UP QUESTIONNAIRE FOR STUDENTS (in Greek)

S2. ΣΥΝΕΧΕΙΑ ΕΡΩΤΗΜΑΤΟΛΟΓΙΟΥ ΓΙΑ ΜΑΘΗΤΕΣ

Πρόκειται για μια συνέχεια της έρευνας σχετικά με την ικανοποίηση με τη μεθοδολογία μάθησης C4G και την υλοποίηση δραστηριοτήτων για την απόκτηση δεξιοτήτων προγραμματισμού και εγγραφής κώδικα.
Οι απαντήσεις σας θα είναι **ανώνυμες** και θα χρησιμοποιούνται μόνο για ερευνητικούς σκοπούς. Σας ευχαριστούμε για το χρόνο και τη συνεργασία σας!
Γράψτε τον **κωδικό** που λάβατε από τον καθηγητή σας παρακάτω (είναι ο ίδιος κωδικός που χρησιμοποιήσατε στο προκαταρκτικό ερωτηματολόγιο).

ΚΩΔΙΚΟΣ ΚΑΙ ΓΕΝΙΚΕΣ ΠΛΗΡΟΦΟΡΙΕΣ

Κωδικός: ______________ Σχολείο: ______________
Ηλικία: ______________ Τάξη: ______________
Φύλο: Α Γ

ΜΕΘΟΔΟΛΟΓΙΑ ΜΑΘΗΣΗΣ C4G

17. Ταξινομήστε τις ακόλουθες δηλώσεις:	*Διαφωνώ απόλυτα*	*Διαφωνώ*	*Ουδέτερο*	*Συμφωνώ*	*Συμφωνώ απόλυτα*
u) Βρήκα τον προγραμματισμό σαν μια πρόκληση.	1	2	3	4	5
v) Βρήκα τον προγραμματισμό ενθαρρυντικό.	1	2	3	4	5
w) Βρήκα τον προγραμματισμό εύκολο.	1	2	3	4	5
x) Μου άρεσε ο προγραμματισμός.	1	2	3	4	5
y) Κατάλαβα τις περισσότερες από τις έννοιες προγραμματισμού.	1	2	3	4	5
z) Η εκμάθηση με αυτόν τον τρόπο είναι διασκεδαστική.	1	2	3	4	5
aa) Ένιωσα αφοσιωμένος με αυτόν τον τρόπο μάθησης.	1	2	3	4	5
bb) Οι δραστηριότητες ήταν σχετικές στο να τις μάθεις.	1	2	3	4	5
cc) Ανά πάσα στιγμή, ήταν σαφές τι έπρεπε να κάνω.	1	2	3	4	5
dd) Αυτό που έμαθα θα είναι σχετικά με το μέλλον μου.	1	2	3	4	5

ΑΝΤΙΛΗΠΤΟ ΕΠΙΠΕΔΟ ΠΡΟΓΡΑΜΜΑΤΙΣΜΟΥ

18. Ποιο είναι το επίπεδό σας στον προγραμματισμό, τώρα; *Κυκλώστε την πιο κατάλληλη απάντηση.*

k) Δεν έχω γράψει κώδικα ή δεν έχω προγραμματίσει ξανά
l) Είμαι αρχάριος προγραμματιστής (έχω βασικές ιδέες)
m) Μπορώ να γράψω κώδικα για απλά προγράμματα
n) Είμαι πολύ καλός στον προγραμματισμό (μπορώ να δημιουργήσω ολοκληρωμένο πρόγραμμα)
o) Μπορώ να σχεδιάσω μια λύση ενός προβλήματος σε μορφή προγράμματος

ΧΡΗΣΙΜΟΤΗΤΑ ΤΟΥ ΠΕΡΙΒΑΛΛΟΝΤΟΣ ΤΟΥ ΠΑΙΧΝΙΔΙΟΥ

19. Ταξινομήστε τις ακόλουθες δηλώσεις:	*Διαφωνώ απόλυτα*	*Διαφωνώ*	*Ουδέτερο*	*Συμφωνώ*	*Συμφωνώ απόλυτα*
k) Θα ήθελα να χρησιμοποιώ συχνά αυτό το παιχνίδι.	1	2	3	4	5
l) Βρήκα το παιχνίδι πολύπλοκο.	1	2	3	4	5
m) Το παιχνίδι ήταν εύκολο στη χρήση.	1	2	3	4	5
n) Χρειάζομαι την υποστήριξη ενός προσώπου που γνωρίζει από τεχνολογία για να μπορώ να χρησιμοποιήσω αυτό το παιχνίδι.	1	2	3	4	5
o) Οι διάφορες λειτουργίες σε αυτό το παιχνίδι ήταν καλά ενσωματωμένες.	1	2	3	4	5
p) Υπήρχε πάρα πολύ ασυνέπεια σε αυτό το παιχνίδι.	1	2	3	4	5
q) Οι περισσότεροι άνθρωποι θα μάθουν να χρησιμοποιούν αυτό το παιχνίδι πολύ γρήγορα.	1	2	3	4	5
r) Το παιχνίδι ήταν πολύ «δυσκίνητο» στη χρήση.	1	2	3	4	5
s) Αισθάνθηκα πολλή αυτοπεποίθηση χρησιμοποιώντας το παιχνίδι.	1	2	3	4	5
t) Έπρεπε να μάθω πολλά πράγματα πριν μπορέσω να ξεκινήσω με αυτό το παιχνίδι.	1	2	3	4	5

GAME EXPERIENCE

20. Ταξινομήστε τις ακόλουθες δηλώσεις:	*Διαφωνώ απόλυτα*	*Διαφωνώ*	*Ουδέτερο*	*Συμφωνώ*	*Συμφωνώ απόλυτα*
a) Ένιωσα ικανοποιημένος.	1	2	3	4	5
b) Ένιωσα επιδέξιος.	1	2	3	4	5
c) Με ενδιέφερε η ιστορία του παιχνιδιού.	1	2	3	4	5

d) Μου φάνηκε διασκεδαστικό.	1	2	3	4	5
e) Μου άρεσε πλήρως το παιχνίδι.	1	2	3	4	5
f) Ένιωσα χαρούμενος/η.	1	2	3	4	5
g) Μου έδωσε κακή διάθεση.	1	2	3	4	5
h) Σκεφτόμουν άλλα πράγματα.	1	2	3	4	5
i) Το βρήκα κουραστικό.	1	2	3	4	5
j) Ένιωσα ικανός.	1	2	3	4	5
k) Νόμιζα ότι ήταν δύσκολο.	1	2	3	4	5
l) Ήταν αισθητικά ευχάριστο.	1	2	3	4	5
m) Ξέχασα τα πάντα γύρω μου.	1	2	3	4	5
n) Ένιωσα καλά.	1	2	3	4	5
o) Ήμουν καλός/ή σε αυτό.	1	2	3	4	5
p) Ένιωθα ότι βαριέμαι.	1	2	3	4	5
q) Ένιωσα επιτυχημένος/η.	1	2	3	4	5
r) Ένιωσα ότι έχω φαντασία.	1	2	3	4	5
s) Ένιωσα ότι μπορούσα να εξερευνήσω πράγματα.	1	2	3	4	5
t) Το απόλαυσα.	1	2	3	4	5
u) Ήμουν γρήγορος στην επίτευξη των στόχων του παιχνιδιού.	1	2	3	4	5
v) Ένιωσα ενοχλημένος/η.	1	2	3	4	5
w) Ένιωσα πίεση.	1	2	3	4	5
x) Ένιωθα ευερέθιστος/η.	1	2	3	4	5
y) Έχασα την αίσθηση του χρόνου.	1	2	3	4	5
z) Ένιωσα πρόκληση.	1	2	3	4	5
aa) Το βρήκα εντυπωσιακό.	1	2	3	4	5
bb) Ήμουν βαθιά συγκεντρωμένος/η στο παιχνίδι.	1	2	3	4	5
cc) Ένιωσα απογοητευμένος/η.	1	2	3	4	5
dd) Ένιωσα ότι ήταν μια πλούσια εμπειρία.	1	2	3	4	5
ee) Έχασα τη σύνδεση με τον έξω κόσμο.	1	2	3	4	5
ff) Ένιωσα πίεση χρόνου.	1	2	3	4	5

gg) Έπρεπε να κάνω πολλή προσπάθεια σε αυτό.	1	2	3	4	5

S3. STUDENTS' COMMENTS (in Greek)

S3. ΣΧΟΛΙΑ ΜΑΘΗΤΩΝ			
Μετά την εφαρμογή της προσέγγισης C4G με βάση το παιχνίδι για την ανάπτυξη δεξιοτήτων προγραμματισμού, οι εκπαιδευτικοί συλλέγουν τις ποιοτικές απόψεις και σχόλια των μαθητών σε μια ομαδική συνέντευξη και τις μεταγράφουν. Παρακαλώ, ομαδοποιήστε όλους τους μαθητές και συλλέξτε τις ποιοτικές απόψεις και σχόλια. Ρωτήστε τους μαθητές σχετικά με τις απόψεις που αναφέρονται παρακάτω και μεταγράψτε τα σχόλιά τους χρησιμοποιώντας αυτήν τη φόρμα. Σας ευχαριστούμε για το χρόνο και τη συνεργασία σας!			
ΓΕΝΙΚΕΣ ΠΛΗΡΟΦΟΡΙΕΣ			
Εκπαιδευτικός:	___________________	Τάξη:	______________
Σχολείο:	___________________	Ημερομηνία:	______________
ΣΥΝΟΛΙΚΗ ΟΡΓΑΝΩΣΗ ΚΑΙ ΑΝΤΙΛΗΨΕΙΣ ΤΩΝ ΦΟΙΤΗΤΩΝ			
Μπορείτε να ρωτήσετε τους μαθητές για τη συνολική οργάνωση της υλοποίησης, την αντίληψή τους για τις γνώσεις που αποκτήθηκαν, την αντίληψή τους για τη συνάφεια και την αποτελεσματικότητα της μάθησης με βάση το παιχνίδι και την αντίληψή τους για την επιτευχθείσα διασκέδαση.			
ΜΑΘΗΣΙΑΚΕΣ ΔΥΣΚΟΛΙΕΣ ΚΑΙ ΠΡΟΒΛΗΜΑΤΑ			
Μπορείτε να ρωτήσετε τους μαθητές για τυχόν μαθησιακές δυσκολίες ή προβλήματα που αντιμετώπισαν κατά τη διάρκεια του μαθήματος και τι έκαναν όταν βρήκαν αυτά τα προβλήματα.			
ΑΠΟΨΕΙΣ ΜΑΘΗΤΩΝ ΓΙΑ ΤΗ ΒΕΛΤΙΩΣΗ ΤΗΣ ΜΕΘΟΔΟΛΟΓΙΑΣ, ΤΩΝ ΕΡΓΑΛΕΙΩΝ ΚΑΙ ΤΟΥ ΠΕΡΙΕΧΟΜΕΝΟΥ ΤΟΥ C4G			
ΟΤΙΔΗΠΟΤΕ ΑΛΛΟ ΘΕΩΡΕΙΤΕ ΣΧΕΤΙΚΟ			

T1. TEACHERS' OBSERVATIONS (in Greek)

T1. ΠΑΡΑΤΗΡΗΣΕΙΣ ΕΚΠΑΙΔΕΥΤΙΚΩΝ
Κατά τη διάρκεια των συνεδριών εφαρμογής, οι εκπαιδευτικοί παρατηρούν και τεκμηριώνουν την αντίδραση των μαθητών και την πρόοδό τους στην οικοδόμηση δεξιοτήτων προγραμματισμού χρησιμοποιώντας την προσέγγιση C4G που βασίζεται στο παιχνίδι. Παρακαλώ, χρησιμοποιήστε αυτήν τη φόρμα και υποδείξτε τις παρατηρήσεις σας σχετικά με τις απόψεις που αναφέρονται παρακάτω. Σας ευχαριστούμε για το χρόνο και τη συνεργασία σας!
ΓΕΝΙΚΕΣ ΠΛΗΡΟΦΟΡΙΕΣ
Εκπαιδευτικός: ___________________ Τάξη: ___________________ Σχολείο: ___________________ Ημερομηνίες(από-έως): ________________
ΣΥΜΜΕΤΟΧΗ ΚΑΙ ΔΕΣΜΕΥΣΗ ΜΑΘΗΤΩΝ
Συμμετέχουν ενεργά οι μαθητές; Συνεργάζονται; Διασκεδάζουν; κλπ.
ΜΑΘΗΣΙΑΚΕΣ ΔΥΣΚΟΛΙΕΣ ΚΑΙ ΠΡΟΒΛΗΜΑΤΑ
Οι μαθητές αντιμετωπίζουν δυσκολίες με το περιεχόμενο ή/και την τεχνολογία; Ζητούν υποστήριξη; κλπ.
ΟΤΙΔΗΠΟΤΕ ΑΛΛΟ ΘΕΩΡΕΙΤΕ ΣΧΕΤΙΚΟ

T2. TEACHERS' COMMENTS (in Greek)

T2.2 ΣΧΟΛΙΑ ΕΚΠΑΙΔΕΥΤΙΚΩΝ
Συλλέγονται ποιοτικές απόψεις και σχόλια των εκπαιδευτικών σχετικά με την προσέγγιση C4G που βασίζεται στο παιχνίδι για την ανάπτυξη δεξιοτήτων προγραμματισμού. Παρακαλώ, χρησιμοποιήστε αυτήν τη φόρμα και υποδείξτε τις παρατηρήσεις σας σχετικά με τις απόψεις που αναφέρονται παρακάτω. Σας ευχαριστούμε για το χρόνο και τη συνεργασία σας!
ΓΕΝΙΚΕΣ ΠΛΗΡΟΦΟΡΙΕΣ
Εκπαιδευτικός: ________________ Ημερομηνία: __________ Σχολείο: ___________________
ΣΥΜΒΟΛΗ ΤΗΣ ΠΡΟΣΕΓΓΙΣΗΣ ΤΟΥ C4G ΣΤΗ ΔΥΝΑΜΙΚΗ ΑΠΟΔΟΧΗ ΤΩΝ ΣΤΟΧΩΝ ΜΑΘΗΣΗΣ ΑΠΟ ΤΟΥΣ ΜΑΘΗΤΕΣ
ΣΧΕΤΙΚΟΤΗΤΑ ΚΑΙ ΑΠΟΤΕΛΕΣΜΑΤΙΚΟΤΗΤΑ ΤΗΣ ΜΑΘΗΣΗΣ ΠΟΥ ΒΑΣΙΖΕΤΑΙ ΣΤΟ ΠΑΙΧΝΙΔΙ ΓΙΑ ΤΗΝ ΑΝΑΠΤΥΞΗ ΔΕΞΙΟΤΗΤΩΝ ΠΡΟΓΡΑΜΜΑΤΙΣΜΟΥ ΚΑΙ ΤΗΣ ΕΙΔΙΚΗΣ ΜΑΘΗΣΙΑΚΗΣ ΠΡΟΣΕΓΓΙΣΗΣ *CODING4GIRLS*
ΠΙΘΑΝΟΤΗΤΑ ΑΠΟΔΟΧΗΣ ΤΗΣ ΠΡΟΤΕΙΝΟΜΕΝΗΣ ΜΕΘΟΔΟΛΟΓΙΑΣ ΑΠΟ ΤΟΥΣ ΜΑΘΗΤΕΣ

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

ΔΙΑΣΚΕΔΑΣΗ ΠΟΥ ΘΑ ΕΧΟΥΝ ΟΙ ΜΑΘΗΤΕΣ ΧΡΗΣΙΜΟΠΟΙΩΝΤΑΣ ΑΥΤΗ ΤΗΝ ΠΡΟΣΕΓΓΙΣΗ
Η ΓΝΩΜΗ ΣΑΣ ΓΙΑ ΤΗ ΣΥΝΟΛΙΚΗ ΟΡΓΑΝΩΣΗ ΤΗΣ ΕΚΠΑΙΔΕΥΣΗΣ ΤΩΝ ΚΑΘΗΓΗΤΩΝ
ΧΡΗΣΗ ΚΑΙ ΑΠΟΔΟΧΗ ΤΗΣ ΠΡΟΣΕΓΓΙΣΗΣ ΤΟΥ ΣΟΒΑΡΟΥ ΠΑΙΧΝΙΔΙΟΥ (που σχετίζεται με το εκπαιδευτικό πλαίσιο σχεδιαστικής σκέψης που βασίζεται στο παιχνίδι CODING4GIRLS)
ΟΤΙΔΗΠΟΤΕ ΑΛΛΟ ΘΕΩΡΕΙΤΕ ΣΧΕΤΙΚΟ

E. EXPERTS' COMMENTS (in Greek)

Ε. ΣΧΟΛΙΑ ΕΙΔΙΚΩΝ	
Μετά την εφαρμογή της προσέγγισης βασισμένης στο παιχνίδι C4G για την ανάπτυξη δεξιοτήτων προγραμματισμού, συλλέγονται οι ποιοτικές απόψεις και σχόλια των ειδικών σε μια δομημένη συνέντευξη. Παρακαλώ, χρησιμοποιήστε αυτήν τη φόρμα και υποδείξτε τη γνώμη των ειδικών για τις απόψεις που αναφέρονται παρακάτω.	
ΓΕΝΙΚΕΣ ΠΛΗΡΟΦΟΡΙΕΣ	
Όνομα ειδικού: ____________________ Οργανισμός: ____________________	Θέση: ___________ Ημερομηνία: ___________
ΣΥΜΒΟΛΗ ΤΗΣ ΠΡΟΣΕΓΓΙΣΗΣ ΤΟΥ C4G ΣΤΗ ΔΥΝΑΜΙΚΗ ΑΠΟΔΟΧΗ ΤΩΝ ΣΤΟΧΩΝ ΜΑΘΗΣΗΣ ΑΠΟ ΤΟΥΣ ΜΑΘΗΤΕΣ	
ΣΧΕΤΙΚΟΤΗΤΑ ΚΑΙ ΑΠΟΤΕΛΕΣΜΑΤΙΚΟΤΗΤΑ ΤΗΣ ΜΑΘΗΣΗΣ ΠΟΥ ΒΑΣΙΖΕΤΑΙ ΣΤΟ ΠΑΙΧΝΙΔΙ ΓΙΑ ΤΗΝ ΑΝΑΠΤΥΞΗ ΔΕΞΙΟΤΗΤΩΝ ΠΡΟΓΡΑΜΜΑΤΙΣΜΟΥ ΚΑΙ ΤΗΣ ΕΙΔΙΚΗΣ ΜΑΘΗΣΙΑΚΗΣ ΠΡΟΣΕΓΓΙΣΗΣ *CODING4GIRLS*	
ΠΙΘΑΝΟΤΗΤΑ ΑΠΟΔΟΧΗΣ ΤΗΣ ΠΡΟΤΕΙΝΟΜΕΝΗΣ ΜΕΘΟΔΟΛΟΓΙΑΣ ΑΠΟ ΤΟΥΣ ΜΑΘΗΤΕΣ	

ΔΙΑΣΚΕΔΑΣΗ ΠΟΥ ΘΑ ΕΧΟΥΝ ΟΙ ΜΑΘΗΤΕΣ ΧΡΗΣΙΜΟΠΟΙΩΝΤΑΣ ΑΥΤΗ ΤΗΝ ΠΡΟΣΕΓΓΙΣΗ
Η ΓΝΩΜΗ ΣΑΣ ΓΙΑ ΤΗ ΣΥΝΟΛΙΚΗ ΟΡΓΑΝΩΣΗ ΤΗΣ ΥΛΟΠΟΙΗΣΗΣ
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ΟΤΙΔΗΠΟΤΕ ΑΛΛΟ ΘΕΩΡΕΙΤΕ ΣΧΕΤΙΚΟ

REFERENCES

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2. The Saint Joseph Primary School of Volos, on-line at: https://www.saintjoseph.gr/cgi-bin/pages/index.pl?arlang=Greek&type=index&landing=true
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NATIONAL REPORT: ITALY

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EXECUTIVE SUMMARY

The report describes the validation phase organized in Italy to test the Coding4Girls approach and the tools developed. In particular, it explains the main steps of the implementation with all the target groups involved: experts, primary and secondary school teachers and 10-16 years-old students. Moreover, it reports on the results achieved and collected through the qualitative and quantitative evaluation tools developed and submitted before and after the implementation.

The activities for the implementation and validation of C4G approach and tools took place in Italy from February to October 2020 by involving teachers and students from primary and secondary schools.

The target groups involved were teachers and students from primary and secondary schools. In addition, external experts were reached in order to validate the methodology proposed.

During all these events the qualitative and quantitative data were collected by using the evaluation tools and questionnaires designed during the project. They were constructed in the framework of a wider validation strategy foreseen in the Coding4Girls project activities with the aim to verify if the proposed pedagogical framework meets the target groups' needs in terms of relevance, acceptance, usability, and effectiveness.

According to the final results obtained, C4G platform and the game-based approach of learning scenarios permit students to achieve their learning goals with greater ease, including the students with learning difficulties. The tools developed facilitate the understanding of the contents, one learns by doing, from an interdisciplinary perspective, mixing creativity with imagination and logic with mathematics. The approach is seen as capable of overcoming the limitations of traditional teaching and favoring active learning. Therefore the proposed methodology is fully accepted because it is engaging and interesting for both girls and boys. Teacher-led "challenges" can keep the relationship between teacher/pupil and pupil/pupil alive. Students with this type of methodology have a lot of fun, as coding is an agile and effective fun tool that makes the content easy to understand. In this way, they learn to develop computational thinking to solve complex situations and problems in a playful way. Nevertheless, as one of the main obstacles towards its use, the time necessary to establish a

good use and knowledge of the environment is considered. Moreover, for some, it may be too complicated and the instrument may be adaptable for some specific subjects only. Despite some teachers consider game-based learning as very effective, coding-based learning, according to them, is unsuitable for upper secondary students. For example, even though pupils are usually drawn to play and challenges, some may get tired and demotivated in the long run. Furthermore, the fun of the student is directly proportional to his ability to master the tools available otherwise they could feel frustrated, especially those with learning difficulties. A possible improvement could be to have more types of games available. The game is fun but some teachers think that the proposed methodology is too simple for the second cycle of secondary school pupils (14-16 years old). However, seen generally, the C4G approach can be used for all ages because it can stimulate pupils' ability to develop collaborative ideas and skills and to learn complex programming concepts by playing. Usability was rated positively because it is effective due to being closely linked to the technological tools available to students both in the classroom and at home, as well as to the composition of the class. To conclude, the game-based C4G approach for developing programming skills is considered interesting in teaching because it focuses on the needs and peculiarities of the female world. Continuous training on these activities would also be interesting. Thanks to the use of these new tools, students can learn to program, analyse a problem, invent solutions, verify and communicate. Furthermore, paths focused on play seem capable of favoring receptivity to the new, emotional regulation and the possession of effective learning strategies.

IMPLEMENTATION

Workshops with teachers

According to the validation strategy defined to test C4G approach and software, three different events were organized to involved n. 102 teachers from primary and secondary schools. The events were organized in both online modality and face-to-face due to Covid19 restrictions.

The first event was held during the 2020 STEM Discovery Campaign on the 16th April 2020 in order to present to n. 16 primary and secondary school teachers both the Teachers' Platform and the Students' Game Environment were shown with special attention to the project approach, design thinking (Figure 33).

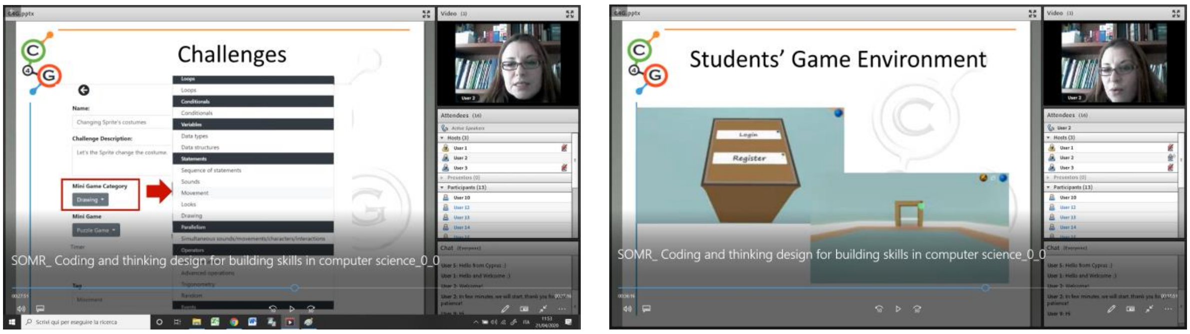


Figure 33 – First workshop with teachers

The second event was a part of the courses organized for initial teachers' education from 22nd April to 18th May for 10 hours. It involved 24 teachers from primary and secondary schools (Figure 34).

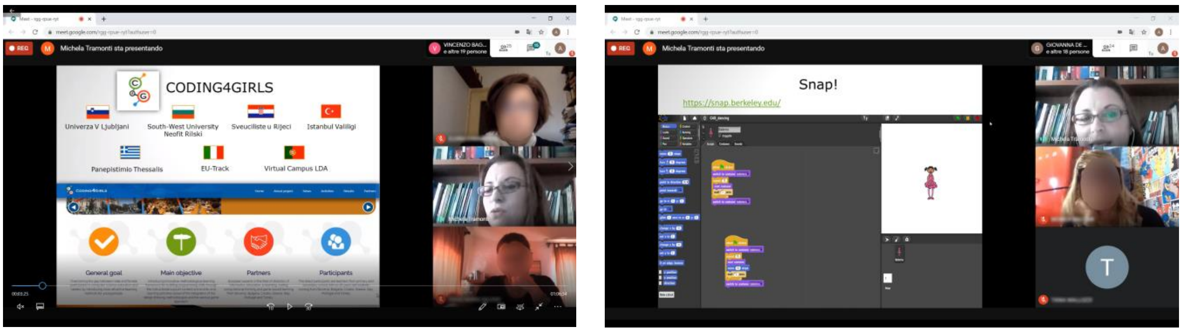


Figure 34 - Training course with teachers

Finally, the third workshop was organized in the framework of Erasmus+ KA1 Mobility for School Education at EU-Track educational center in Terracina on August 19th 2020 for 4 hours for the training “Multimedia learning environment: how to use new technologies to strengthen teaching and learning processes”.

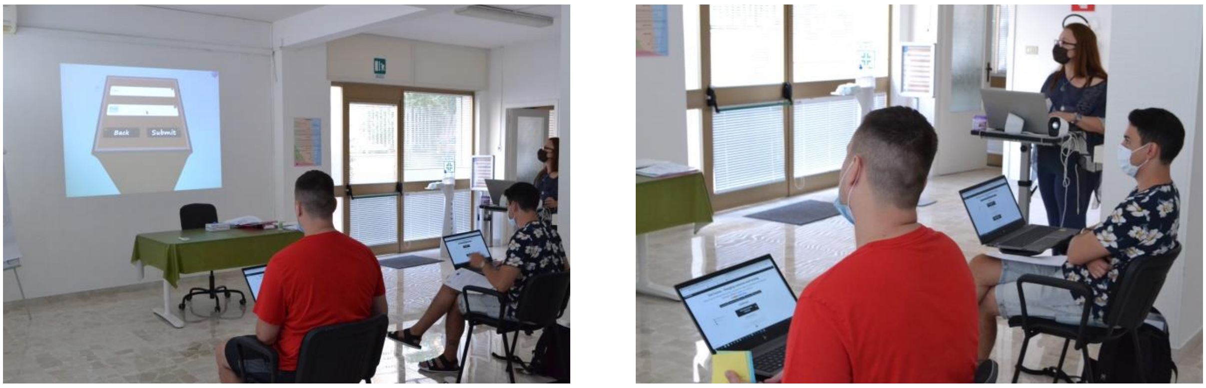


Figure 35 – Workshop with teachers during KA1 –Erasmus+ Mobility

In addition, 26 external experts in digital teaching tools were included in the validation phase organized in online modality on 10th of April 2020.

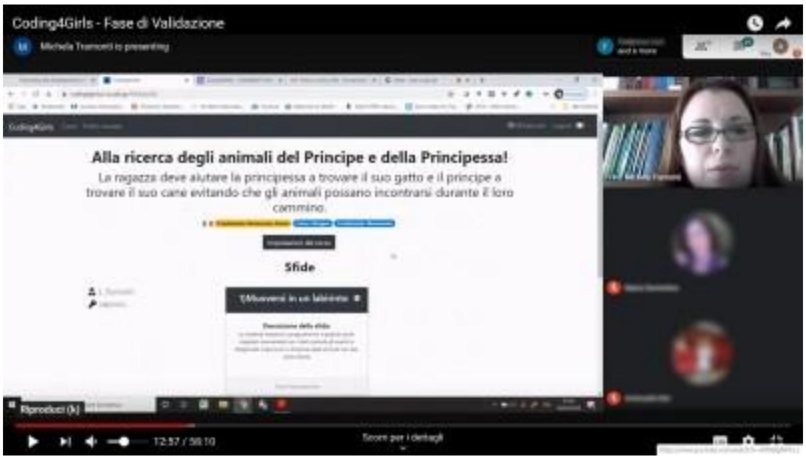


Figure 36 – Online webinar with external experts

During all these events, the project team presented the main project aims and results, the C4G approach including game-based learning and design-thinking and the Teachers’ Platform and the Students’ Game Environment. After that, both teachers and external experts were provided with all the documents needed to carry out the validation activities. Additional guideline in Italian was provided in order to facilitate these tasks, mainly in the online modality.

Data collection tools

During all these events the qualitative and quantitative data were collected by using the evaluation tools and questionnaires designed during the project. They were constructed in the framework of a wider validation strategy foreseen in the Coding4Girls project activities according to the following dimensions:

- the programming level evolution;
- the motivation for coding;
- the programming environment usability.

Specifically, the aim was to verify if the proposed pedagogical framework meets the target groups' needs in terms of relevance, acceptance, usability, and effectiveness.

In particular, the following tools were used:

- S1 – Preliminary questionnaire (for students)
- S2 – Follow-up questionnaire (for students)
- S3 – Student's comments
- T1 – Teacher's observations
- T2 – Teacher's comments
- E – Expert's comments

Before the submission, all the tools were translated into Italian and moved in the Google Forms (due to Covid19 restrictions). However, the data were collected through the compilation of papers only for the teachers came for the Erasmus KA1 training and the first group of the students.

Materials

The materials used during the implementation of the validation phase were the learning scenarios and instructions for students developed by the project partners; these learning scenarios were re-adapted to the design thinking approach and the structure of the C4G software constituting of two parts: the Teacher's Training Platform and the Student Game Environment.

In addition, the Italian team prepared additional materials in order to support both teachers and external expert to carry out their experience: the project summary, the instruction and a video tutorial on how to test both the Teachers' platform and the Students' Game Environment and a video tutorial.

Setup model and procedure

The target group of students involved was from primary and secondary schools. They were dived into three groups.

The first one was constituted of students participating in an experimental experience combining two approaches, namely computational design thinking and educational robotics is described in a specific article.[7] During the first part of the experience, C4G software and approach were used to develop design thinking and game-based learning. The activities in the class lasted 10 hours.

Figure 37 – Validation activities with primary and secondary school students

Besides, other several activities were organized in October 2020 with students aged 10-12 and 13-15 years-old. Despite Covid19, the sessions with the students were held in face-to-face modality taking into attention the healthy restrictions rules.

For the first group, the workshops organized lasted 8 hours while for the second group 20 hours. In fact, the duration of the activities carried out is changed accordingly the pandemic evolution and the equipment available in the schools.

[7] The extended results of this experience are described in the following article: Dochshanov, A.; Tramonti, M. Computational Design Thinking and Physical Computing: Preliminary Observations of a Pilot Study. *Robotics* 2020, *9*, 71.

All the activities were supported by the project Italian members to help both teachers and students mainly with C4G software.

Before starting the activities the preliminary questionnaire (S1) was submitted and after the experience with the Students' Game Environment and the learning scenarios in Snap!, the follow-up questionnaire (S2) was distributed among students.

During the implementation activities, also the qualitative data on the students and teachers feedback were collected through S3 and T2.

First of all the students sessions were introduced with the mini-games and the learning scenarios where the students were expected to become familiar with the Snap! commands and to program simply scenarios. When they got experiences, they could try also advanced learning scenarios.

During the implementation, the brainstorming activities were very important to let students share and create new ideas with their class.

The T1 was compiled by teachers through Google Form in April 2020 after a specific training session addressed to them.

Moreover, the C4G approach and software were tested by an external expert. Their comments and feedback were collected through the form (E) by using Google Form during April-May 2020 due to the lock-down for Covid19.

The experts were supported by project Italian team who provided them with the access to the project documentation and to the contents designed for the Italian teachers, such as the instructional guide and the video tutorial on how to use the Teachers' Platform and the Students' game Environment.

Participants

The target group involved in the validation activities were students, teachers and experts.

Regarding the students, these activities involved 129 learners from primary and secondary schools. They took place on three different occasions. The first group participated in an experimental experience combining two approaches, namely computational design thinking and educational robotics is described. During the first part of the experience, C4G software and approach were used to develop design thinking and game-based learning. The experience was organized from February to July 2020 for n. 15 students.

The second group was constituted of 5 classes with 20 students for each (Total 100 students aged 13-15) tested both the project approach and the Students' Game Environment in October 2020 for 20 hours. In the same month, another group of 20 students aged 10-12 years old was involved in the validation phase for 8 hours.

Table 1 and Figure 1 show the number of students – participants of the study by age/grade.

Table 29 - Number of students by age/grade

Years of age	Grade	Classes	Number of students
9-10	4	1	7
10-11	5	1	20
11-12	6	1	2
12-13	7	4	81
13-14	8	3	19
Total		**10**	**129**

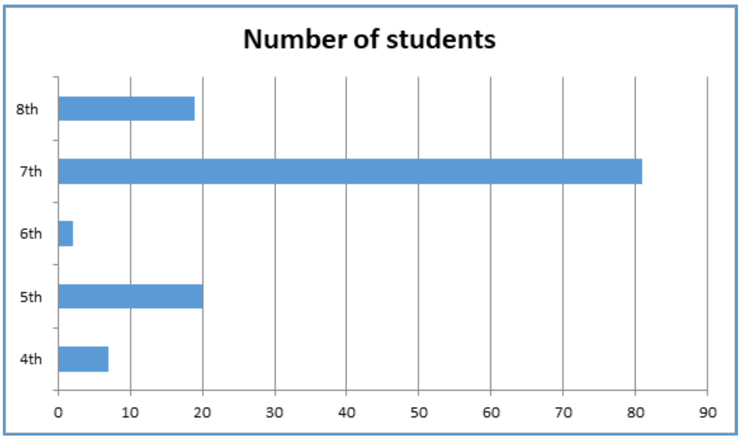


Figure 38 – Number of students by grade

Concerning the teachers, n. 102 primary and secondary schools teachers were involved in three events in both face-to-face and online modality to validate the C4G approach and the software. The first was organized on April 16th for one hour. The second was a part of the courses organized for initial teachers' education from 22nd April to 18th May for 10 hours and the third event was organized in the framework of Erasmus+ KA1 Mobility for School Education on August 19th 2020 for 4 hours.

Finally, 26 experts in digital teaching tools were included in the validation phase organized in the online modality in April 2020. They are mainly, digital animators, who are teachers experts in the ICT introduction into local, regional and national schools and they are responsible for training and updating skills development in ICT of teachers at the national level.

RESULTS

Results of questionnaires for students

In order to collect qualitative and quantitative data, two questionnaires were submitted to students. The first, preliminary questionnaire, intended to gather information about the digital device used and the level of programming. The second, the follow-up questionnaire aimed to verify the following dimension:

- the programming level evolution;
- the motivation for coding;
- the programming environment usability.

In addition, the project member or the teachers wrote down their comment in the grid S3.

A total of 129 students were involved in the C4G activities filled in both the questionnaires according to previous planning agreed with the schools.

S1 - Preliminary questionnaire

A total of 129 students solved the preliminary questionnaire about the use of digital devices and the perceived level of programming. The mean age of students was 12.67 years (SD=1,07). Table 15 shows the distribution of the students by gender in the classes with the corresponding response rate (100% in each case) of students who solved S1. As can be seen, (Figure 2) except for 4th and 6th grades, where the only participants were boys, the female participation is dominant.

Table 30 - Number of students who solved S1 - Preliminary questionnaire by gender and grade

	4th grade	**5th grade**	**6th grade**	**7th grade**	**8th grade**	**Total**
Boys	7	5	2	23	7	44
Girls	0	15	0	58	12	85
Total	**7**	**20**	**2**	**81**	**19**	**129**
Response rate	100%	100%	100%	100%	100%	100%

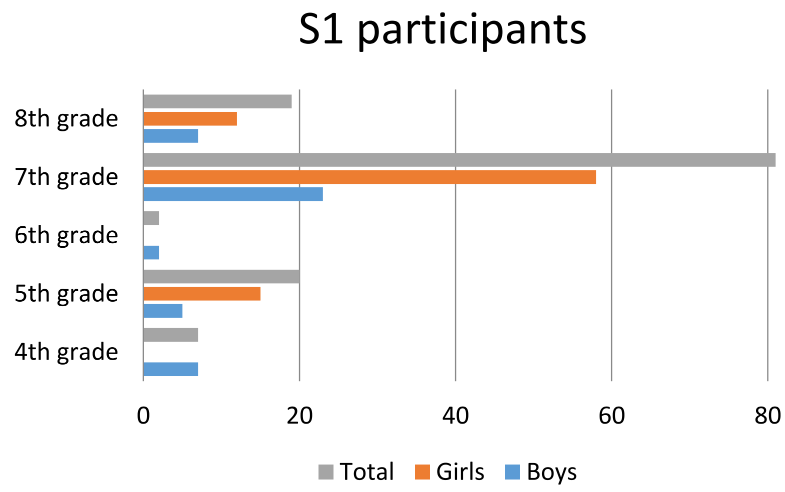


Figure 39 - Distribution of students who solved S1 - Preliminary questionnaire by gender and grade

Table 3 shows descriptive statistical analysis of participants' responses to the questions related to the use of digital devices, the internet and video-games. It is worth noting that standard deviation values reported demonstrating particular deviances for the three last questions of the inquiry in case of the boys. As to the pairwise comparison of average values obtained for boys and girls, the results (Figure 3) demonstrate clearly that boys are major consumers of the digital devices, the internet and video-games. In particular, the prevalence is more obvious for the last dimension.

Table 31 - The use of digital devices, the internet and video-games by gender

Question		N	Min	Max	Mean	SD
13. For how long have you been using computers, tablets or other digital devices (in years)?	Boys	44	2	7	4.59	1.28
	Girls	85	1	6	3.87	1.088
	Total	**129**	**1**	**7**	**4.12**	**1.203**
14. How many hours per week do you use a computer, tablet or other digital device?	Boys	44	1	15	5	2.615
	Girls	85	1	6	4.47	1.324
	Total	**129**	**1**	**15**	**4.651**	**1.874**
15. How many hours per week do you use the Internet?	Boys	44	1	21	5.432	4.117
	Girls	85	0	20	4.047	2.849
	Total	**129**	**0**	**21**	**4.519**	**3.384**
16. How many hours per week do you play video games?	Boys	44	1	21	4.068	4.915
	Girls	85	0	4	1.776	0.762
	Total	**129**	**0**	**21**	**2.558**	**3.112**

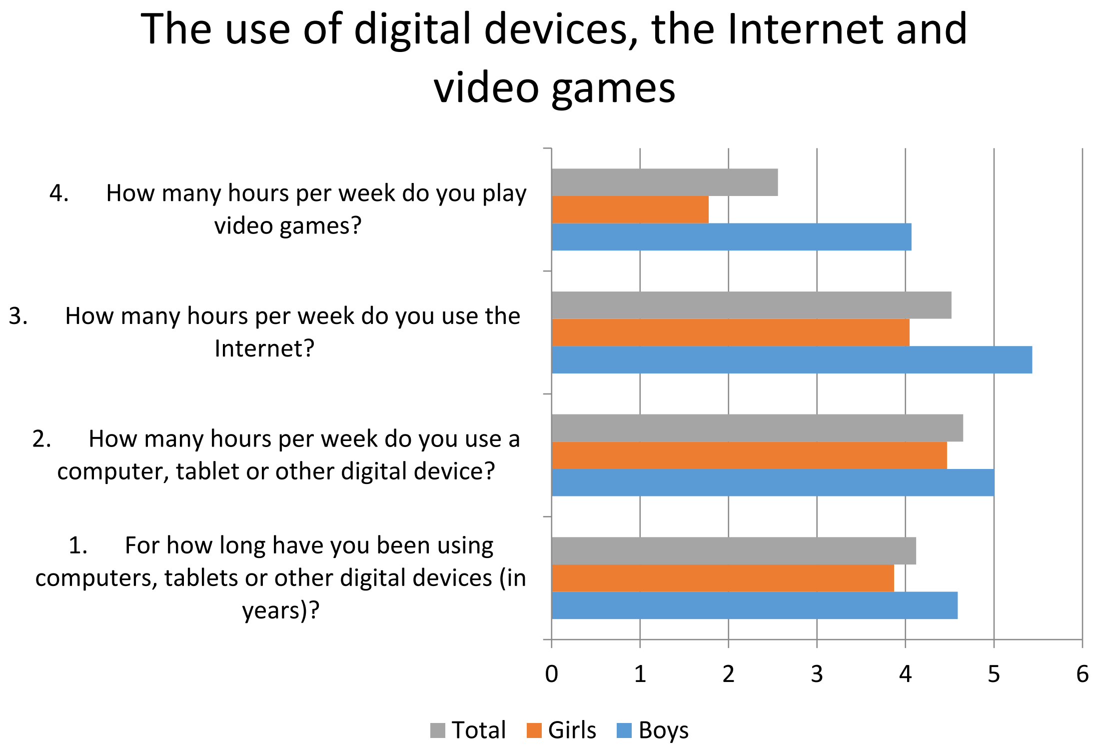


Figure 40 - The use of digital devices, the internet and video-games – comparison by gender

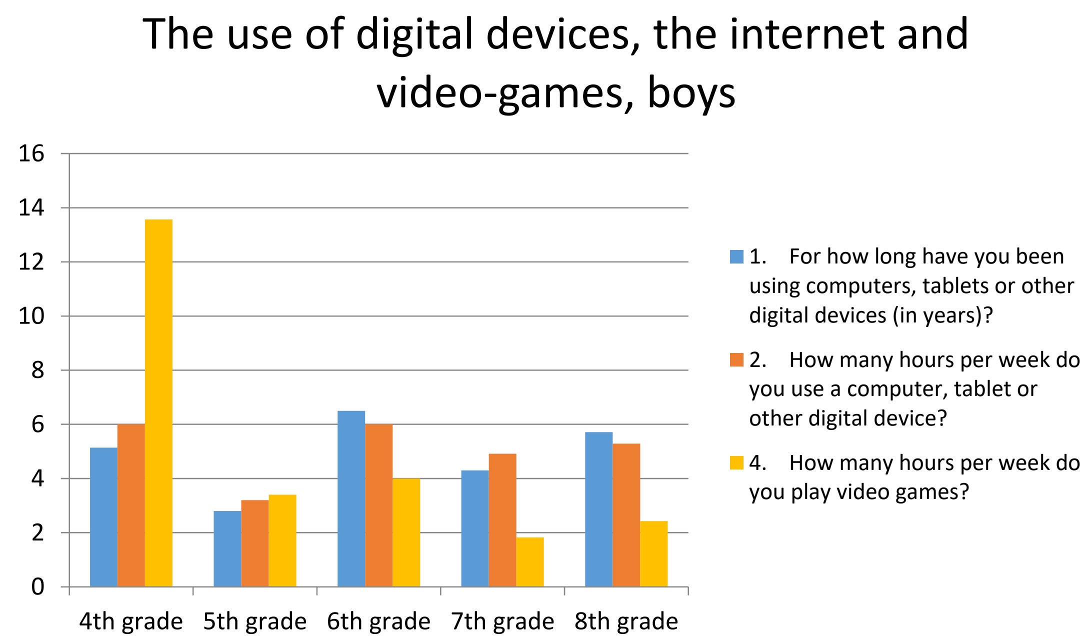
The average values demonstrate that girls' answers regarding the use of digital devices and the Internet are more consistent when compared to boys', namely the hours spent on the Internet per week is logically less than the value of the hours spent with a digital device. Such a discrepancy, to our opinion, may be caused by the gender differences in the Internet perception when the access instrument itself shifts backwards and simply doesn't count.

By comparing the data by grade (Table 17) the most prominent values to note are the hours per week spent for the Internet and video games on average by the boys of the 4th grade. Analysed individually, only one respondent has declared to use the Internet for 21 hours per week and 2 respondents have specified 20 and 21 hours as the time spent weekly for video games, which inevitably have significantly raised the elevated average point gained. The second-ranked is the time spent on the Internet by the boys of the sixth grade. But when seen generally (Figure 41) there is no continuous trend ranging from 4th to 8th grade.

Finally, as regards the girls, as one can see, the female students of the 7th and 8th grade in average are more active consumers of digital technology, excluding the video games, which is quite the same in all three grades.

Table 32 - The use of digital devices, the internet and video-games by grade and gender

Question		4th grade	5th grade	6th grade	7th grade	8th grade
5. For how long have you been using computers, tablets or other digital devices (in years)?	Boys	5.14	2.8	6.5	4.3	5.714
	Girls	0	2.53	0	4.14	4.25
	Total	**5.14**	**2.6**	**6.5**	**4.1852**	**4.7895**
6. How many hours per week do you use a computer, tablet or other digital device?	Boys	6	3.2	6	4.913	5.286
	Girls	0	2	0	4.914	4.583
	Total	**6**	**2.8**	**6**	**4.9136**	**4.8421**
7. How many hours per week do you use the Internet?	Boys	12.14	2	9	4.043	4.714
	Girls	0	2.13	0	4.31	5.167
	Total	**12.14**	**2.1**	**9**	**4.2346**	**5**
8. How many hours per week do you play video games?	Boys	13.57	3.4	4	1.826	2.429
	Girls	0	1.6	0	1.78	2
	Total	**13.57**	**2.05**	**4**	**1.7901**	**0.7672**



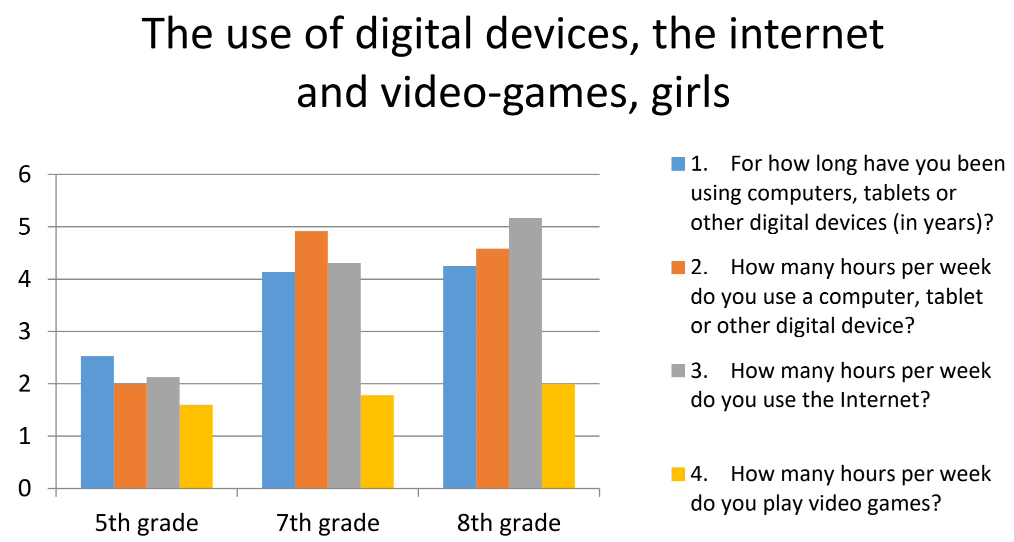


Figure 41 - The use of digital devices, the internet and video-games – comparison by gender.

The results of the participants' (N=129, 44 boys, 85 girls) programming skills self-assessment are shown in Table 4. As can be seen, the results obtained present almost no gender difference (Figure 42). Moreover, most of the students (around 70%) considered themselves as capable to code simple programs. While the resting part is composed of the novice programmers (13.95%) and those, who have never coded before (15.5%).

Table 33 - Self-assessment of programming skills by gender

Level of programming skills	**Boys**	**Girls**	**Total**
0 - I have never coded or programmed before	15,91%	15,29%	**15,5 %**
1 - I am a novice programmer (just have basic ideas)	13,64%	14,12%	**13,95%**
2 - I can code simple programs	70,45%	70,59%	**70,54%**
3 - I am fluent in programming (can create a full program)	0%	0%	0%
4 - I can design a solution of a problem in the form of a program	0%	0%	0%

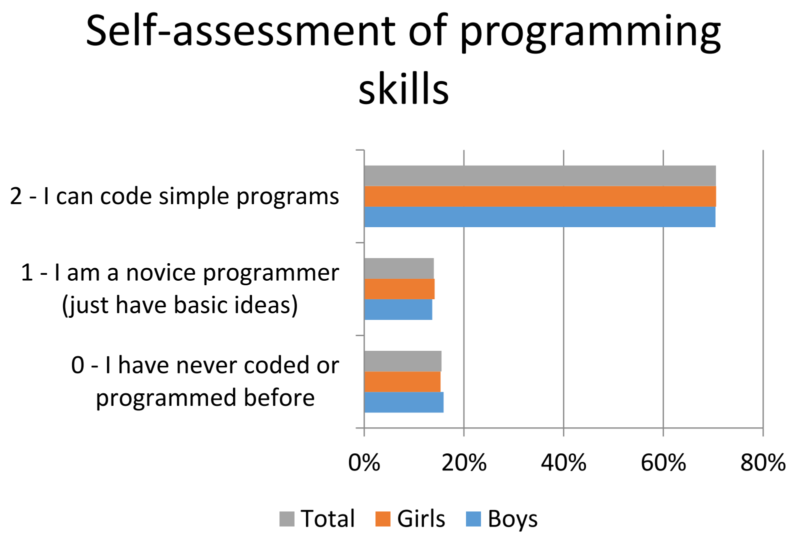


Figure 42 - Self-assessment of programming skills – comparison by gender

The analysis by grades (Table 19) shows that the largest number of students who have never coded (level 0) is from the 4th and 5th grades, as expected. While mainly the 7th and 8th-grade students are those who can code simple programs, with similar percentages obtained for males and females.

Table 34 - Self-assessment of programming skills by grade and gender

Level of programming skills		**4th grade**	**5th grade**	**6th grade**	**7th grade**	**8th grade**
0 - I have never coded or programmed before	Boys	57,14%	40%	50%	0%	0%
	Girls	0%	86,67%	0%	0%	0%
	Total	**57,14%**	**75%**	**50%**	**0%**	**0%**
1 - I am a novice programmer (just have basic ideas)	Boys	0%	60%	50%	8,7%	0%
	Girls	0%	13,33%	0%	15,52%	8,33%
	Total	**0%**	**25%**	**50%**	**13,58%**	**5,26%**
2 - I can code simple programs	Boys	42,86%	0%	0%	91,3%	100%
	Girls	0%	0%	0%	84,48%	91,67%
	Total	**42,86%**	**0%**	**0%**	**86,42%**	**94,74%**

The preliminary questionnaire has been intended to reveal the programming concepts the participants are familiar with before the experimental phase of the project. As the results revealed, the most familiar concepts are *statements* (65,12%) with no particular gender difference (Table 5), the second and third-ranked are *events* (18,6%) and *loops* (15,5%) correspondingly. As to the *variables* and *conditionals*, female awareness on these topics noticeably prevails over that of males. Finally, operators and parallelism concepts have gained no attention at all (Figure 43).

Table 35 - Familiarity with the programming concepts

Concept	Boys	Girls	Total
Loops	15,9%	15,29%	15,5%
Conditionals	6,81%	14,12%	7,75%
Variables	4,55%	16,47%	8,53%%
Statements (sounds, movement, looks, drawing)	65,9%	63,53%	65,12%
Operators	0%	0%	0%
Events	18,18%	18,82%	18,6%
Parallelism	0%	0%	0%

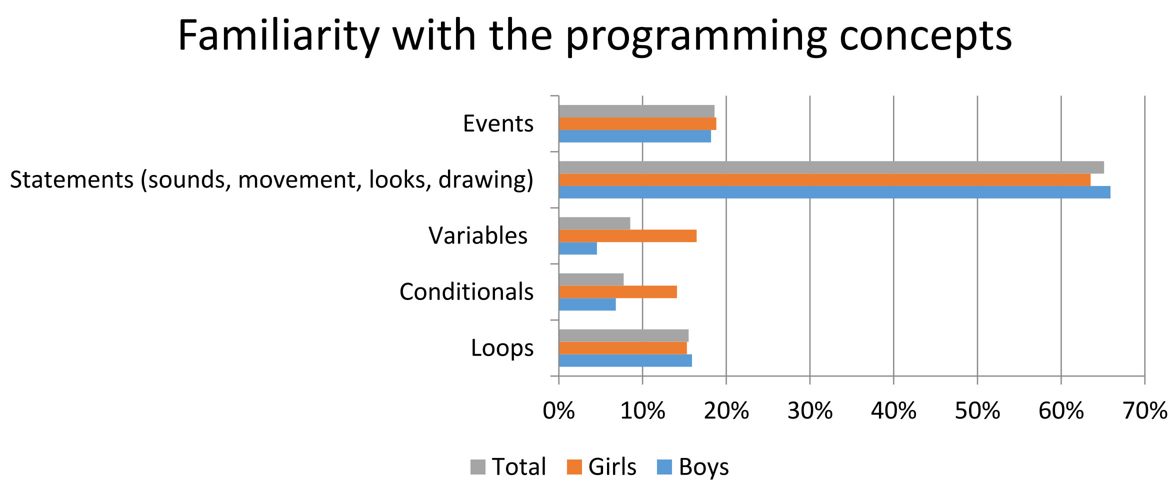


Figure 43 - Familiarity with the programming concepts – comparison by gender

Comparison of the results by grade and gender (Table 21) shows that 5th and 6th graders are at least familiar with all the concepts, with the only chosen concepts as loops and statements only.

Table 36 - Familiarity with the programming concepts by grade and gender

Concept		4th grade	5th grade	6th grade	7th grade	8th grade
Loops	Boys	28,57%	40%	0%	13,04%	0%

	Girls	0%	13,33%	0%	34,78%	16,67%
	Total	28,57%	80%	0%	14,81%	10,53%
Conditionals	Boys	0%	0%	0%	0%	0%
	Girls	0%	0%	0%	16,67%	16,67%
	Total	0%	0%	0%	16,05%	10,53%
Variables	Boys	0%	0%	0%	4,35%	14,29%
	Girls	0%	0%	0%	12,07%	25%
	Total	0%	0%	0%	9,88%	21,05%
Statements (sounds, movement, looks, drawing)	Boys	28,57%	0%	50%	86,96%	100%
	Girls	0%	0%	0%	75,86%	75%
	Total	28,57%	0%	50%	80,25%	84,21%
Operators	Boys	0%	0%	0%	0%	0%
	Girls	0%	0%	0%	0%	0%
	Total	0%	0%	0%	0%	0%
Events	Boys	14,29%	0%	0%	17,39%	42,86%
	Girls	0%	0%	0%	22,41%	25%
	Total	14,29%	0%	0%	20,99%	31,58%
Parallelism	Boys	0%	0%	0%	0%	0%
	Girls	0%	0%	0%	0%	0%
	Total	0%	0%	0%	0%	0%

Worth noticing, that the concepts' mastery with the reference to the gender is similar only regarding the *statements*. As to the resting concepts, the results gained by boys and girls differ significantly. For example, conditionals have resulted to be familiar only to girls of the 7th and 8th grades.

Table 6 reports students' responses on what motivates them to learn to program (students could choose one or more responses). Most of the students are motivated by the desire to show others the capacity to code (56.59%). Comparison by gender (Figure 44) shows that this factor motivates girls (38.76%) to a greater extent than boys (17.83%). While following a career in programming cannot be considered an attractive option for both sexes, succeeding in programming class as well as enjoying to solve logic problems and puzzles result to be more diffused options for the students' motivation.

Table 37 - Motivation for learning programming

Response	**Boys**	**Girls**	**Total**
I'm not motivated	0,78%	0,78%	0,78%
I want to succeed in the programming class	3,10%	17,83%	20,93%
I want to show other students I can program	17,83%	38,76%	56,59%
I want to follow a career in programming	3,10%	0,78%	3,88%
I enjoy solving logic problems and puzzles	10,08%	8,53%	18,6%

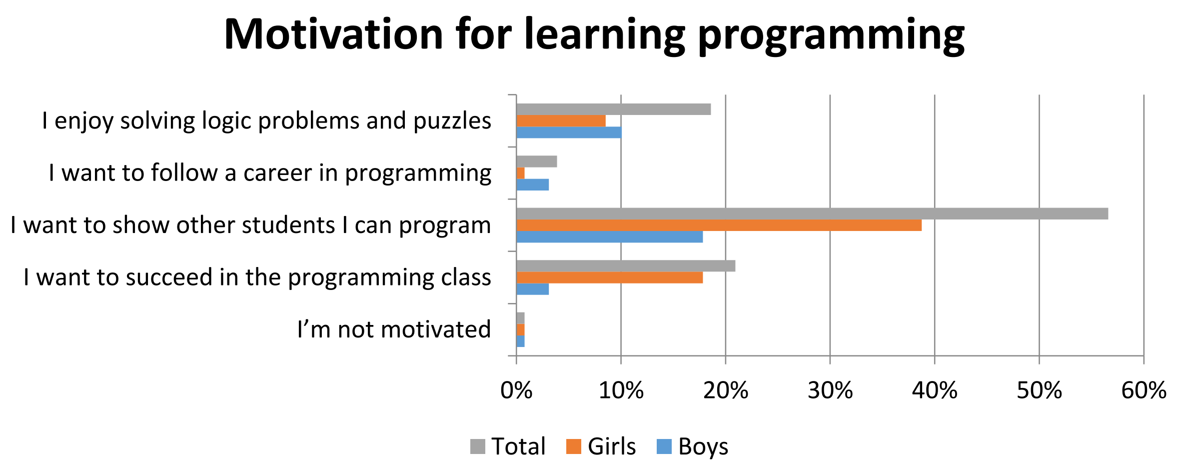


Figure 44 - Motivation for learning programming – Comparison by gender

Comparison by grade (Table 23) shows that 5th graders are the most motivated, especially by wanting to succeed in the programming class. According to the results gained the enjoyment of solving logic problems and puzzles attracts enough attention of the boys throughout all the grades, whereas the idea of following a career in programming remains attractive till the 6th grade only.

Table 38 - Motivation for learning programming by grade and gender

Statement		4th grade	5th grade	6th grade	7th grade	8th grade
I'm not motivated	Boys	14,29%	0%	0%	0%	0%
	Girls	0%	0%	0%	0%	0%
	Total	**0%**	**0%**	**0%**	**0%**	**0%**
I want to succeed in the programming class	Boys	28,57%	20%	0%	13,04%	0%
	Girls	0%	53,33%	0%	22,41%	16,67%
	Total	**28,57%**	**45%**	**0%**	**19,75%**	**10,53%**
I want to show other students I can program	Boys	14,29%	40%	0%	69,57%	14,29%
	Girls	0%	13,33%	0%	67,24%	75%
	Total	**14,29%**	**20%**	**0%**	**67,90%**	**68,42%**
I want to follow a career in programming	Boys	28,57%	20%	50%	0%	0%
	Girls	0%	6,67%	0%	0%	0%
	Total	**28,57%**	**10%**	**50%**	**0%**	**0%**
I enjoy solving logic problems and puzzles	Boys	57,14%	20%	50%	17,39%	28,57%
	Girls	0%	26,67%	0%	10,34%	8,33%
	Total	**57,14%**	**25%**	**50%**	**12,35%**	**21,05%**

S2 – Follow-up questionnaire

An equal number of students, justifying the 100% response rate, solved the follow-up questionnaire about satisfaction with programming and coding activities, satisfaction with the organization of the implementation, and perception on the acquired coding skills. The mean age of students is the same (12.67 years, SD=1,07).

In the follow-up questionnaire, students expressed their attitudes regarding the C4G learning methodology and the implementation of activities using the 5-point Likert scale (1 – strongly disagree, 2 – disagree, 3 – neutral, 4 – agree, 5 – strongly agree). From the data presented, one can see that both boys and girls have considered this way as fun. Generally, the methodology used may be considered as well accepted by either of the genders, given the averages have gained close values throughout most dimensions in both cases. Interesting, that the respondents' estimation of the programming being challenging is almost the same as its being easy. Finally, the weak side revealed, which might be of particular interest for the future adaptation of the methodology, is relatively low points for the dimension "at any time, it was clear what to do".

Table 39 – Satisfaction with C4G learning methodology

Statement		**1**	**2**	**3**	**4**	**5**	**AVG**	**SD**
31. I found programming challenging.	Boys	2,27%	20,45%	18,18%	52,27%	6,82%	3,409	0,972
	Girls	2,35%	20,00%	12,94%	61,18%	3,53%	3,435	0,932
	Total	**2,33%**	**20,16%**	**14,73%**	**58,14%**	**4,65%**	**3,426**	**0,942**
32. I found programming motivating.	Boys	0,00%	0,00%	2,27%	81,82%	15,91%	4,136	0,409
	Girls	0,00%	0,00%	0,00%	80,00%	20,00%	4,200	0,402
	Total	**0,00%**	**0,00%**	**0,78%**	**80,62%**	**18,60%**	**4,178**	**0,404**
33. I found programming easy.	Boys	0,00%	13,64%	29,55%	50,00%	6,82%	3,500	0,821
	Girls	0,00%	17,65%	31,76%	48,24%	2,35%	3,353	0,797
	Total	**0,00%**	**16,28%**	**31,01%**	**48,84%**	**3,88%**	**3,403**	**0,805**
34. I enjoyed programming.	Boys	0,00%	0,00%	0,00%	75,00%	25,00%	4,250	0,438
	Girls	0,00%	0,00%	1,18%	77,65%	21,18%	4,200	0,431
	Total	**0,00%**	**0,00%**	**0,78%**	**76,74%**	**22,48%**	**4,217**	**0,432**
35. I understood most of programming concepts.	Boys	0,00%	2,27%	4,55%	84,09%	9,09%	4,000	0,482
	Girls	0,00%	0,00%	2,35%	83,53%	14,12%	4,118	0,391
	Total	**0,00%**	**0,78%**	**3,10%**	**83,72%**	**12,40%**	**4,078**	**0,426**
36. Learning this way is fun.	Boys	0,00%	0,00%	0,00%	61,36%	38,64%	4,386	0,493
	Girls	0,00%	0,00%	0,00%	60,00%	40,00%	4,400	0,493
	Total	**0,00%**	**0,00%**	**0,00%**	**60,47%**	**39,53%**	**4,395**	**0,491**
37. I felt engaged with this way of learning.	Boys	0,00%	2,27%	6,82%	72,73%	18,18%	4,068	0,587
	Girls	0,00%	0,00%	0,00%	68,24%	31,76%	4,318	0,468
	Total	**0,00%**	**0,78%**	**2,33%**	**69,77%**	**27,13%**	**4,233**	**0,523**
	Boys	2,27%	0,00%	6,82%	65,91%	25,00%	4,114	0,722

38. The activities were relevant to learn.	Girls	0,00%	0,00%	4,71%	70,59%	24,71%	4,200	0,507
	Total	**0,78%**	**0,00%**	**5,43%**	**68,99%**	**24,81%**	**4,171**	**0,588**
39. At any time, it was clear what I had to do.	Boys	0,00%	4,55%	18,18%	75,00%	2,27%	3,750	0,576
	Girls	0,00%	2,35%	16,47%	72,94%	8,24%	3,871	0,573
	Total	**0,00%**	**3,10%**	**17,05%**	**73,64%**	**6,20%**	**3,829**	**0,575**
40. What I learned will be relevant for my future.	Boys	0,00%	0,00%	4,55%	65,91%	29,55%	4,250	0,534
	Girls	0,00%	0,00%	12,94%	56,47%	30,59%	4,176	0,640
	Total	**0,00%**	**0,00%**	**10,08%**	**59,69%**	**30,23%**	**4,202**	**0,604**

To reveal the trend of programming skills evolution the corresponding inquiry scaled from *0 - I have never coded or programmed before* to *4 - I can design a solution of a problem in the form of a program* has been undertaken. A total of 129 students (44 boys, 85 girls) solved the preliminary and the follow-up questionnaire, thus enabling the self-assessment comparison. Table 11 shows data on the difference between the self-assessed initial level and the self-assessed final level of programming skill. As can be seen, despite the majority remained at the same level (57,36%), essential percentage of the participants (29,47%, taking into account the total percentage of the positive differences) have improved their programming skills, with the difference of 1 point as the major one. Worth noting, the significant percentage of the participants with deteriorated self-assessment (13,18%). Analysed individually, all the contributors with negative evolution trend initially have self-assessed themselves at the level 2 – corresponding to the capacity of simple programs coding. Nevertheless, it might be concluded that the situation is caused by the over-estimation of ones' capabilities. Taking into account gender differences, it can be concluded that slightly more girls discovered their preliminary self-assessment inconsistency with the actual situation (14,12%), but at the same time, significantly more girls progressed by one level than boys. And only a certain percentage of boys result to have progressed for more than 3 points.

Table 40 - The difference between the self-assessed levels of programming skill

	Difference				
	-1	**0**	**1**	**2**	**3**
Boys	11,36%	59,09%	13,64%	9,09%	6,82%
Girls	14,12%	56,47%	23,53%	5,88%	0,00%
Total	13,18%	57,36%	20,16%	6,98%	2,33%

A Wilcoxon's signed rank test for paired samples showed that students self-assessed their programming skill significantly higher after the C4G activities compared to self-assessment before the C4G activities (Table 12). The results of rank-biserial correlation (rB), which are considered as an effect size, show large effect size, overall and by gender. The negative effect size speaks in a favour of the S2 prevalence. The result may be considered as statistically significant, as p is well below 5% threshold.

Table 41 - Comparison of self-assessment of programming skill

		Descriptive statistics					Wilcoxon's signed rank test results		
		N	**MIN**	**MAX**	**MEAN**	**SD**	**W**	**p**	**Effect size (rB)**
Boys	S1	44	0	2	1,523	0,846	24	0.00424	-0.6555
	S2	44	0	3	1,932	0,587			
Girls	S1	85	0	2	1,565	0,731	198	0.02034	-0.3806
	S2	85	1	2	1,776	0,419			
Total	**S1**	**129**	**0**	**2**	**1,550**	**0,75**	**374**	**0.0009**	**-0.4474**
	S2	**129**	**0**	**3**	**1,829**	**0,486**			

Students' comments

The analysis of the students' comments reveals that for those who were approaching the coding for the first time the project experience was captivating because through the games they have learnt simple basic programming, although requiring more time to become familiar with the tools of the Students' Game Environment. Instead, for those, who already had basic skills in coding, the experience was a way to learn more through more complex learning scenarios. For all students, the experience of using the games in the Students Game Environment was both fun and interesting because enabled them to see actually what kind of product is attainable through the coding. No relevant differences between boys and girls were noticed.

Among the suggested improvements the students have underlined: a) increasing the number of the games available; b) improving some graphics elements related to the lobby setting; c) the possibility to use some more complex and attractive learning scenarios through Snap! (mainly for secondary school students).

Teachers' observations and comments

Teachers' observations

According to teachers' observations, students were actively involved in solving the challenges provided in the learning scenarios. The activities were individual and in small groups. While the first were carried out for coding simple games already prepared in the developed learning scenarios. The others were carried out, mainly, in the Students' Game Environment, when they were challenged to play the different games available. Besides, the attention of a whole class of students was captured by the brainstorming activities where they were asked to share and to generate new ideas, to perform alternative programs and to discuss the topics met on the coding operations. The use of the games supported the learning and teaching process effectively because in this way students were more interested and motivated to learn even more complex scenarios, including the use of variables and operations.

The C4G approach is suitable for different kinds of learning styles thanks to the use of challenges and the learning scenarios designed for several levels of difficulty. However, a time required for some students to become familiar with the Students' Game Environment, being related to their background ICT competences, is crucial for the motivation level maintaining. But, once "ice is broken" the motivation and interest were greater than before. Some technical issues arose due to the weak technological infrastructure in the schools or the devices available at home. No particular differences in the learning process and involvement levels between girls and boys were observed.

It would be desirable, in the case of the secondary school (Second cycle), that the learning scenarios proposed are more complex and articulated.

Teachers' comments

The analysis of teachers' comments has shown that according to the majority C4G is considered as a good tool for supporting teaching activities and learning objectives' achievement through mediation with the teacher, even in cases of students with learning difficulties. The interacting Teachers' platform and Student Game Environment, the vast variety of learning scenarios and games, being engaging, increase the pupil's motivation and commitment, facilitate the understanding of the contents, one learns by doing, following interdisciplinary perspective, mixing creativity with imagination and logic with mathematics.

With this activity, the pupil is fully involved in active learning. This approach is believed to potentially overcome the limitations of traditional teaching. Furthermore, if a teacher were able to plan and propose activities of this type frequently, it is strongly believed that the whole class would be more involved. Once the students became familiar with the medium, teacher-led "challenges" can keep the relationship between teacher/pupil and pupil/pupil alive.

Additionally, this approach challenges students and helps them see the big picture before designing a detailed solution. The game-based C4G approach is effective thanks to the structure of the challenges and the different levels of difficulty and the ability to discuss them in the brainstorming section ensuring its effectiveness.

However, even though pupils are usually drawn to play and challenges, some may get tired and demotivated in the long run. A possible improvement could be to have more types of games available.

Worth noting, that both the implementation and validation processes were perceived as well organized and surely are to be proposed and shared with teachers and students. In addition, platform’s usability was rated positively, because it is effective and closely linked to the technological tools available to students both in the classroom and at home, as well as to the composition of the class.,

Notwithstanding of some teachers’ opinion that the proposed methodology is too simple for the second cycle of secondary school pupils (14-16 years old), the C4G approach can be used for all ages because it can stimulate pupils' ability to develop collaborative ideas and skills and to learn complex programming concepts by playing while bringing into the focus the interests of the community and challenging them to think entrepreneurially about digital technologies and their use to address real-world problems.

Furthermore, paths focused on play seem capable of favoring receptivity to the new, emotional regulation and the possession of effective learning strategies. Some suggestions: 1. Maybe polishing the software a bit more, making it more stable and intuitive; 2. It would be useful to create an App to be installed on mobile.

To conclude, the proposed learning methodology was found as captivating for both girls and boys, stimulate a greater interest in the discipline, enhance computer skills, keep curiosity high, fix information through play, educate for innovation, invite to continually descend in to the field by exploiting the collaboration of others, while maintaining and promoting one's individuality.

Experts' comments

The C4G proposed tools and methodology may favour the achievement of learning objectives due to their suitability for all age groups. It is an interactive and alternative way to acquire skills by stimulating curiosity and motivation. The activities within the platform are well structured according to the reference objectives; and the achievement of the last, in turn, will also depend on how the teacher has structured them inside the Teachers' Platform through the coding scenarios.

Developing programming skills through game-based learning and design thinking is considered as very effective especially when facilitated through multiple interaction modalities: individual or group work, face to face sessions or online. In this way, students are more motivated to complete the assigned tasks. The challenges structure guides and stimulates the students to move on to the next advanced steps.

Besides, the integration of the teacher and student platforms acts as an interactive guide and facilitates programming skills by creating customized learning scenarios. Therefore, the C4G approach will be effective to build coding skills in both girls and boys, especially if mediated by the teacher.

Special attention of experts was paid to the graphics design in the Students' Game Environment that was reported as captivating together with the challenge modalities at different levels that are suitable for the age of the engaged students, including those who have difficulty with traditional teaching as well. However, an improvement, which could be made, is to have more types of games available and to improve the graphics at the initial part in the Students' Game Environment (lobby room).

The overall organization of the implementation as well as usability and acceptance are excellent. The method, which is innovative compared to traditional teaching methods, can bring teachers and educators closer to students' world. Finally, according to the experts, the methodology can be used, above all, in two-year classes where the skills to be acquired are still the basic ones.

DISCUSSION AND CONCLUSIONS

Thus, on the base of the data presented, the overall experience of C4G methodology introduction can be estimated from two points: 1) the actual perception of the platform by students and teachers, and 2) the benefits revealed during the comparison of programming skills self-assessment before and after C4G activities.

Regarding the first point, as one can see from the students' and teachers' comments provided previously, the quality of interaction with the platform was assessed positively by both parties involved. In particular, the methodology adopted turned out to be flexible in practice, permitting students to benefit equally well according to their initial background. The use of the games in the Students Game Environment, as a part of the multiperspective exposition of the underlying concepts (show the big idea before a detailed elaboration), has attracted the attention of participants enabling them to see the products attainable through coding. The approach is well accepted by either of the genders, given the averages have gained close values throughout most dimensions in both cases. Finally, in terms of the room for future improvements, it is recommended to adopt measures to raise the points got by inquiry - "at any time, it was clear what to do".

From their side, teachers have consensually declared that, while mediated, C4G platform and methodology is a good tool for supporting teaching activities and learning objectives, and is believed to overcome the limitations of traditional teaching. Moreover, both teachers and experts agreed upon the usability of the approach in case of the students with learning difficulties as well.

Furthermore, the general trend of the participants' coding skills evolution is reflected in the essential percentage of the participants who improved their programming skills. Interesting to add, that following initial intentions of the project, a significant percentage of girls (major as compared to the same difference level of boys) declared to have improved their coding skills by 1 point. Certainly, the results achieved could be even higher provided that the preliminary self-assessment procedures were more detailed and elaborated.

Important to note, that most teachers, involved in the testing phase, have shown their interest in deepening of the use of C4G approach even after the validation activities organized by the project team.

To conclude, below the most recognized strong points of the methodology are listed:

- Personalized learning scenarios for programming skills developing;
- Development of the students' specific skills focused on the problem analysis and solving, creating new solutions and ideas, verifying new opportunities and communicating with others in team working;
- The serious games designed can facilitate emotional involvement and development and promote more effective learning strategies, mainly in girls.

And to promote the methodology refinement during the future implementations the following points were stressed:

- The software should be more stable and intuitive to reduce the training time that teachers need before implementing the C4G software in their practice;
- Improving the graphics of the games to make them more appealing for secondary school students;
- Increasing the number and type of the serious mini-games available in both Teachers' Platform and Students' Game Environment.

ANNEXES

S1. PRELIMINARY QUESTIONNAIRE FOR STUDENTS (in Italian)

S1. QUESTIONARIO PRELIMINARE PER GLI STUDENTI

Questo è un sondaggio preliminare relativo all'uso dei dispositivi digitali e all'esperienza nella programmazione condotta all'interno del progetto CODING4GIRLS che mira a favorire lo sviluppo delle capacità di programmazione attraverso i *serious game*.

Le tue risposte saranno **anonime** e usate solo per gli scopi della ricerca.
Grazie in anticipo per il tempo e la cooperazione!

Prima di tutto, per favore **leggi il codice** ricevuto prima dal tuo insegnante.

INFORMAZIONI GENERALI

Codice: ______________ Scuola: ______________

Età: ______________ Classe: ______________

Sesso: M F

L'USO DEI DISPOSITIVI DIGITALI, INTERNET E VIDEO-GAMES

1. Da quanto tempo usi computer, tablet o altri dispositivi digitali?	_________ anni
2. Per quante ore alla settimana usi il computer, tablet o altri dispositivi digitali?	_________ ore
3. Per quante ore alla settimana usi Internet?	_________ ore
4. Per quante ore alla settimana giochi ai video games?	_________ ore

ESPERIENZA NEL CODING E NELLA PROGRAMMAZIONE

5. Qual è il tuo livello di programmazione, adesso? *Indica la risposta più appropriata.*
   p) Non ho mai usato il coding o mai programmato prima
   q) Sono un programmatore principiante (ho solo idee di base)
   r) Posso codificare programmi semplici
   s) Sono in grado di programmare (posso creare un programma completo)
   t) Sono in grado di progettare una soluzione di un problema sotto forma di un programma

6. Se hai già fatto un po' di coding, quale dei seguenti concetti ti è familiare? *Scegli uno o più risposte.*

☐ Loop ☐ Variabili ☐ Eventi
☐ Condizionali ☐ Operatori ☐ Parallelismi
☐ Comandi (suoni, movimento, aspetto, disegno)

7. Qual è la tua motivazione per programmare? *Scegli uno o più risposte.*
- ☐ Non sono motivato
- ☐ Voglio riuscire nella programmazione realizzata in classe
- ☐ Voglio mostrare agli altri studenti che posso programmare
- ☐ Voglio perseguire una carriera nella programmazione
- ☐ Mi diverto a risolvere problemi di logica e puzzles
- ☐ altro ______________________________

S2. FOLLOW-UP QUESTIONNAIRE FOR STUDENTS (in Italian)

S2. QUESTIONARIO DI FOLLOW-UP PER GLI STUDENTI

Questo è un sondaggio di approfondimento sulla soddisfazione avuta con la metodologia di apprendimeto C4G e l'implementazione delle attività per l'acquisizione di competenze di programmazione e del coding.

Le tue risposte saranno anonime e usate solo per gli scopi della ricerca.
Grazie in anticipo per il tempo e la cooperazione!
Per favore, scrivi sotto **il codice** ricevuto dal tuo insegnante (è lo stesso codice che ha usato nel questionario preliminare).

INFORMAZIONI GENERALI

Codice: ______________ Età: ______________ Sesso: M F	Scuola: ______________ Classe: ______________

METODOLOGIA DI APPRENDIMENTO C4G

8. Classifica le seguenti affermazioni:	*Fortemente in disaccordo*	*In disaccordo*	*Neutrale*	*D'accordo*	*Molto d'accordo*
a) ho trovato la programmazione impegnativa.	1	2	3	4	5
b) ho trovato la programmazione motivante.	1	2	3	4	5
c) ho trovato la programmazione facile.	1	2	3	4	5
d) mi è piaciuto programmare.	1	2	3	4	5
e) ho compreso la maggior parte dei concetti di programmazione.	1	2	3	4	5
f) imparare in questo modo è divertente.	1	2	3	4	5
g) mi sono sentito impegnato in questo modo di apprendere.	1	2	3	4	5
h) le attività erano rilevanti per l'apprendimento.	1	2	3	4	5

i) in qualsiasi momento, era chiaro cosa dovevo fare.	1	2	3	4	5
j) quello che ho imparato sarà rilevante per il mio futuro.	1	2	3	4	5

LIVELLO PERCEPITO DI PROGRAMMAZIONE

9. Qual è il tuo livello di programmazione, ora? *Indica la risposta più appropriata.*

a) Non ho mai usato il coding o non mai programmato prima

b) Sono un programmatore principiante (ho solo un'idea di base)

c) Posso codificare programmi semplici

d) Sono in grado di programmare (posso creare un programma completo)

e) Sono in grado di progettare una soluzione di un problema sotto forma di un programma

USABILITA' DELL'AMBIENTE DI GIOCO

10. Classifica le seguenti affermazioni:	*Fortemente in disaccordo*	*In disaccordo*	*Neutrale*	*D'accordo*	*Molto d'accordo*
a) vorrei usare questo gioco frequentemente.	1	2	3	4	5
b) ho trovato il gioco complesso.	1	2	3	4	5
c) il gioco è stato facile da usare.	1	2	3	4	5
d) ho avuto bisogno del supporto di un tecnico per poter usare questo gioco.	1	2	3	4	5
e) le varie funzioni di questo gioco sono ben integrate.	1	2	3	4	5
f) c'è stata troppa incoerenza nel gioco.	1	2	3	4	5
g) molte persone imparerebbero ad usare questo gioco rapidamente.	1	2	3	4	5
h) il gioco è stato molto complicato da usare.	1	2	3	4	5
i) mi sono sentito molto fiducioso durante l'utilizzo del gioco.	1	2	3	4	5
j) avevo bisogno di imparare molte cose prima di poter iniziare con questo gioco.	1	2	3	4	5

S3. STUDENT'S COMMENTS (in Italian)

S3. I COMMENTI DEGLI STUDENTI	
Dopo l'implementazione dell'approccio basato sul gioco C4G finalizzata allo sviluppo delle capacità di programmazione, gli insegnanti raccolgono le opinioni e i commenti qualitativi degli studenti emersi in un'intervista di gruppo e li trascrivono. Per favore, raggruppa tutti gli studenti e raccogli le loro opinioni e commenti qualitativi. Chiedi agli studenti gli aspetti elencati di seguito e trascrivi i loro commenti, esposti oralmente, utilizzando questo modulo. Grazie per il tempo e la collaborazione!	
INFORMAZIONI GENERALI	
Insegnante: ____________________	Classe: ______________
Scuola: ____________________	Data: ______________
ORGANIZZAZIONE GENERALE E PERCEZIONI DEGLI STUDENTI	
Puoi chiedere agli studenti la loro opinione in merito all'organizzazione complessiva dell'implementazione, la loro percezione sulle conoscenze acquisite, la loro percezione sulla pertinenza e l'efficacia dell'apprendimento basato sul gioco e la loro percezione sul divertimento raggiunto.	
PROBLEMI O DIFFICOLTA' DI APPRENDIMENTO	
Puoi chiedere agli studenti sulle difficoltà di apprendimento o sui problemi che hanno dovuto affrontare durante il corso e cosa hanno fatto quando hanno riscontrato questi problemi.	
VISUALIZZAZIONI DEGLI STUDENTI SU COME MIGLIORARE LA METODOLOGIA C4G, GLI STRUMENTI E I CONTENUTI	
QUALSIASI ALTRA COSA RITENUTA RILEVANTE	

T1. TEACHER'S OBSERVATIONS (in Italian)

T1. OSSERVAZIONI DEGLI INSEGNANTI	
Durante l'implementazione delle sessioni, gli insegnanti osservano e documentano la reazione degli studenti nonché i loro progressi nella costruzione delle capacità di programmazione usando l'approccio C4G basato sul gioco. Per favore, usa questa scheda e indica ciò che hai osservato riguardo gli aspetti indicati precedentemente. Grazie per il tuo tempo e la cooperazione!	
INFORMAZIONI GENERALI	
Insegnante: ____________________	Classe: __________________
Scuola: ____________________	Data (da-a): __________________
PARTECIPAZIONE E IMPEGNO DEGLI STUDENTI	
Gli studenti sono attivamente coinvolti? Stanno collaborando? Si stanno divertendo? ecc.	
DIFFICOLTA' O PROBLEMI DI APPRENDIMENTO	
Gli studenti stanno avendo difficoltà con il contenuto e / o la tecnologia? Stanno chiedendo supporto? ecc.	
OGNI ALTRA COSA CHE RITIENI RILEVANTE	

T2. TEACHER'S COMMENTS (in Italian)

T2. COMMENTI DEGLI INSEGNANTI
Durante l'implementazione dell'approccio C4G basato sul gioco sullo sviluppo delle competenze di programmazion, vengono raccolte le opinioni e i commenti degli insegnanti. Per favore, usa questa scheda e indica ciò che hai osservato riguardo gli aspetti indicati precedentemente. Grazie per il tuo tempo e la cooperazione!
INFORMAZIONI GENERALI
Insegnante: ____________________ Classe: __________ Scuola: ____________________ Data: __________
RAGGIUNGIMENTO DEGLI OBIETTIVI DI APPRENDIMENTO DA PARTE DEGLI STUDENTI
RILEVANZA ED EFFICACIA DELL'APPRENDIMENTO BASATO SUL GIOCO PER LO SVILUPPO DELLE COMPETENZE DI PROGRAMMAZIONE E DELLO SPECIFICO APPROCCIO DI APPRENDIMENTO *CODING4GIRLS*
GRADIMENTO DELLA METODOLOGIA PROPOSTA DA PARTE DEGLI STUDENTI

DIVERTIMENTO RAGGIUNTO DAGLI STUDENTI
LA TUA OPINIONE IN MERITO ALL'IMPLEMENTAZIONE
USABILITA' E GRADIMENTO DELL'APPROCCIO CODING4GIRLS AL *SERIOUS GAME*
QUALSIASI COSA CHE TU RITIENI RILEVANTE

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

E. EXPERT'S COMMENTS (in Italian)

E. COMMENTI DEGLI ESPERTI	
Dopo l'implementazione dell'approccio C4G basato sul gioco per lo sviluppo delle competenze di programmazione, le opinioni e i commenti verbali degli esperti sono raccolte tramite un'intervista strutturata. Usa questo modulo e indica l'opinione dell'esperto sugli aspetti riportati di seguito	
INFORMAZIONI GENERALI	
Nome dell'esperto: ____________________ Istituzione: ____________________	Posizione: __________ Data: __________
RAGGIUNGIMENTO DEGLI OBIETTIVI DI APPRENDIMENTO DA PARTE DEGLI STUDENTI	
RILEVANZA ED EFFICACIA DELL'APPRENDIMENTO BASATO SUL GIOCO PER LO SVILUPPO DELLE COMPETENZE DI PROGRAMMAZIONE E DELLO SPECIFICO APPROCCIO DI APPRENDIMENTO *CODING4GIRLS*	
GRADIMENTO DELLA METODOLOGIA PROPOSTA DA PARTE DEGLI STUDENTI	
DIVERTIMENTO RAGGIUNTO DAGLI STUDENTI	

LA TUA OPINIONE IN MERITO ALL’IMPLEMENTAZIONE DELL'ORGANIZZAZIONE GLOBALE
USABILITA’ E GRADIMENTO DELL’APPROCCIO CODING4GIRLS BASATO SUL SERIOUS GAME
QUALSIASI COSA CHE TU RITIENI RILEVANTE

PROJECT SUMMARY (in Italian)

Progetto Coding4Girls

Rif. 2018-1-SI01-KA201 -047013

Il progetto CODING4GIRLS affronta il divario esistente tra la partecipazione maschile e femminile all'insegnamento delle scienze informatiche e alle professioni correlate introducendo interventi didattici precoci per rendere l'informatica attraente per tutti.

In questo sforzo i partner di progetto introducono interventi che puntano ai diversi fattori che tengono, in particolare, le ragazze lontano dall'informatica. Il principale obiettivo è di attirare più ragazze verso questo settore rendendole più consapevoli delle ricche opportunità di crescita professionale e personale che vengono offerte per prepararle ad un futuro coinvolgimento nelle professioni correlate.

Il progetto introduce un nuovo approccio pedagogico: il *Design Thinking*. Questo approccio sfida gli studenti e li aiuta a vedere il quadro generale prima di progettare una soluzione dettagliata, li incoraggia a considerare gli interessi della comunità e li sfida a riflettere in modo imprenditoriale sulle tecnologie digitali e su come utilizzarle per affrontare problemi reali.

Sulla base di questo approccio, il team di progetto ha sviluppato un software che consiste in due parti interconnesse. La prima è una piattaforma per gli insegnanti mentre la seconda è un ambiente di gioco per gli studenti (entrambi sono disponibili al link https://www.coding4girls.eu/results_02.php).

Seguendo la metodologia del *Design Thinking*, il team del progetto ha preparato alcuni corsi e scenari di apprendimento progettati per affrontare uno specifico problema di codifica in modo collaborativo e individuale.

I corsi vengono creati da un insegnante sulla piattaforma dedicata e funzionano come uno spazio di raggruppamento per attività correlate. Queste attività sono chiamate sfide che vengono affrontate da ogni studente. Ogni sfida potrebbe avere un mini-gioco a cui lo studente dovrà giocare nel suo ambiente di apprendimento opportunatamente sviluppato, seguendo una pagina con delle istruzioni preparate precedentemente dall'insegnante.

Gli insegnanti interessati, che hanno già esperienza sull’argomento, possono supportare il team di progetto nel processo di convalida del framework di apprendimento proposto utilizzando il software sviluppato per promuovere la progettazione e lo sviluppo di serious game.

Magggiori informazioni:

Sito web di progetto https://www.coding4girls.eu/

INSTRUCTIONS TO TEST THE TEACHERS' PLATFORM AND THE STUDENTS' GAME ENVIRONMENT (in Italian)

ISTRUZIONI PER TESTARE LA PIATTAFORMA PER I DOCENTI E IL SOFTWARE DI GIOCO

Il presente documento ha l'obiettivo di supportarvi in questa fase indicandovi le principali attività da svolgere sia per la piattaforma dedicata ai docenti (Fase 1) e sia per l'ambiente di gioco dedicato agli studenti (Fase 2).

Vi consigliamo di:

- leggere l'intera guida. È breve ma potresti avere una visione completa del processo;
- visualizzare il video preparato;
- seguire le istruzioni passo dopo passo e portare a termine le attività descritte.
- Inizia dalla piattaforma dedicata ai docenti (Fase 1) e successivamente passa alla Fase 2, poichè le due piattaforme sono interconnesse.
- dopo aver testato ogni strumento, compila il questionario indicato alla fine della presente guida.
- nella guida sono specificate le attività basi per comprendere al meglio le funzionalità di entrambe le piattaforme, ma siete liberi di navigarle e di testarle
- come meglio credete.

FASE 1 - Istruzioni per procedere alla fase di testing della piattaforma dedicata ai docenti:

1. Digitare il seguente link **https://coding4girls.e-ce.uth.gr/#/login**.
2. Scegliere la lingua che preferite dal menu in alto a destra.
3. Iniziate la procedura di registrazione.

Poiché questa è una piattaforma progettata solo per gli insegnanti, gli studenti non possono accedere. Per questo motivo nel momento della registrazione viene chiesto di inserire il codice che fornisce i diritti „insegnante".

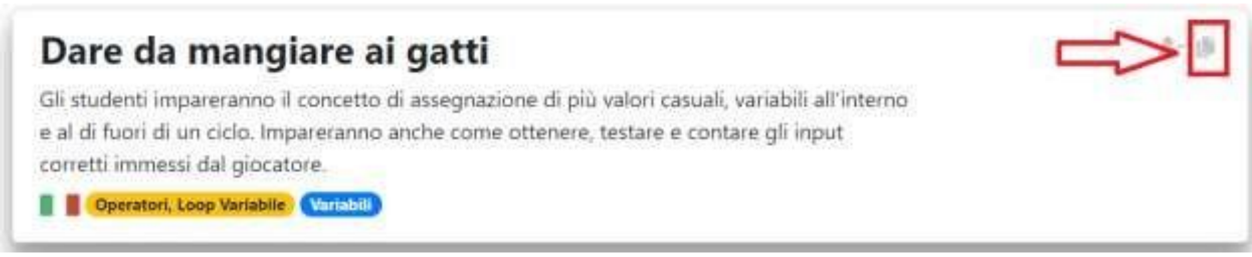
Il codice che va inserito è il seguente: **C4G TEACHER**

4. Fate il login.
5. Visualizzate tutti i corsi disponibili nella sezione "Public Courses"/"Corsi Pubblici".
6. Scegliete un corso e cliccate due volte per aprirlo.

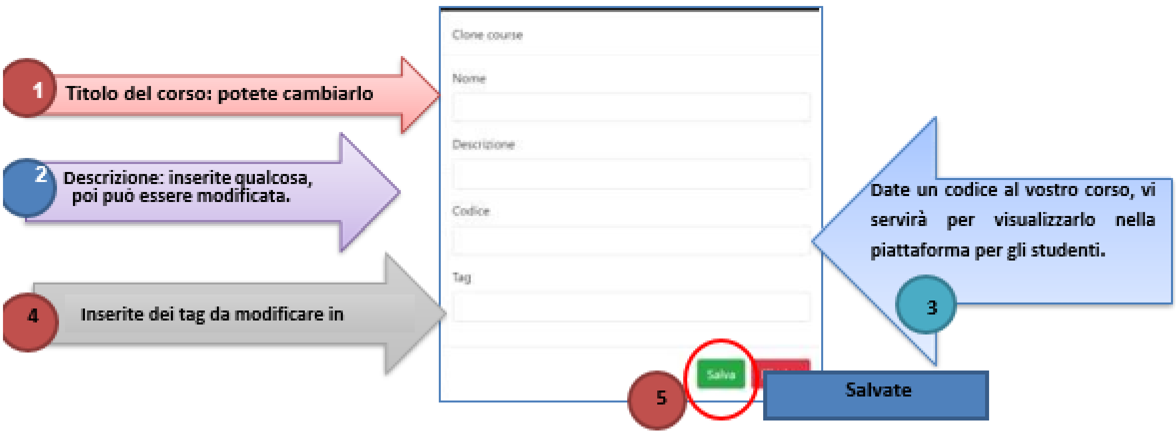
7. Curiosate all'interno del corso scelto, in particolare nelle "impostazioni del corso" e nelle sfide.

8. Ritornate nella sezione "Public Courses"/"Corsi Pubblici".

9. Cliccate sulla seguente icona per clonare/copiare il corso (per capire meglio le funzionalità del sistema all'interno di un corso già preparato):



10. Visualizzerete la seguente scheda:



11. Cliccate sulla sezione "Corsi" in alto a sinistra per visualizzare il corso clonato.
12. Entrate nel corso clonato, provate a modificare le impostazioni del corso, le sfide esistenti e a crearne una nuova, brainstorming, ecc.
13. Nella sezione "Corsi", potete provare a creare un corso sul modello dei corsi già creati oppure iscrivervi ad un corso inserendo il codice identificativo di un altro corso già preparato da un altro docente in questa sezione:

Per maggiori informazioni sulle funzionalità e sulla metodologia, visualizzare il seguente video:

https://www.youtube.com/watcH?v=TR2cCElhoX8&feature=emb_logo

Il video è in inglese ma sono disponibili i sottotitoli in italiano. Per attivare i sottotitoli in un video pubblicato su Youtube, cliccare sul pulsante indicato dalla freccia rossa.

oppure scaricare Teachers' Platform – User Manual dal portale:

https://www.coding4girls.eu/results_02.PHP

Provate ora a sperimentare liberamente!

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

FASE 2 - Istruzioni per procedere alla fase di testing dell'ambiente di gioco dedicato agli studenti:

1. Scaricare il software da uno di questi link disponibili:

   - Windows: **https://ctll.e-ce.uth.gr/downloads/c4g/launcher/w64/c4g_win.zip**
   - Mac: **https://ctll.e-ce.uth.gr/downloads/c4g/launcher/m64/c4g_m64.zip**
   - Linux: **https://ctll.e-ce.uth.gr/downloads/c4g/launcher/linux/c4g_linux.tar.gz**

2. Seguire le istruzioni date nel seguente video per installare e avviare il software:

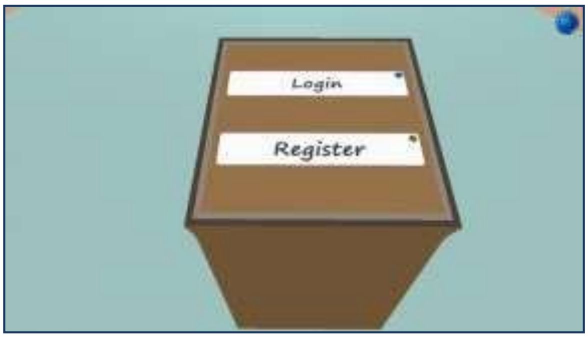
https://www.youtube.com/watch?v=to6UoJizWVg&feature=emb_logo

Il video è in inglese ma sono disponibili i sottotitoli in italiano. Per attivare i sottotitoli in un video pubblicato su Youtube, cliccare sul pulsante indicato dalla freccia rossa.

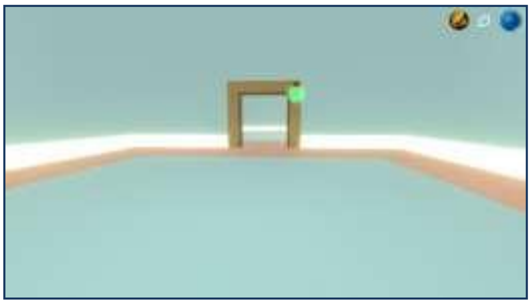
oppure scaricare il documento "Students' Game Environment" – User Manual dal portale:

https://www.coding4girls.eu/results_02.php

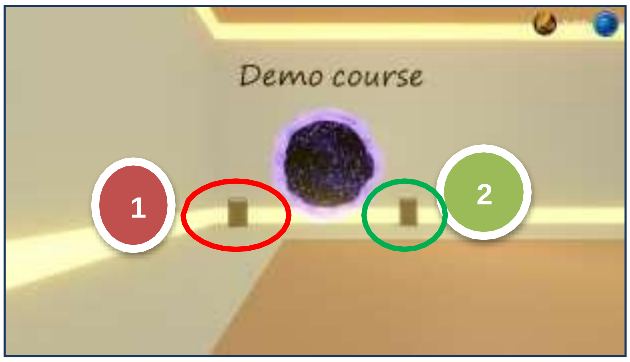
3. Avviato lo *Students' Game Environment*, potete creare nuove credenziali, come se foste uno studente.



4. Dopo il login, cliccate su "Continua" ed entrate nell'altra stanza attraversando la porta di fronte a voi.

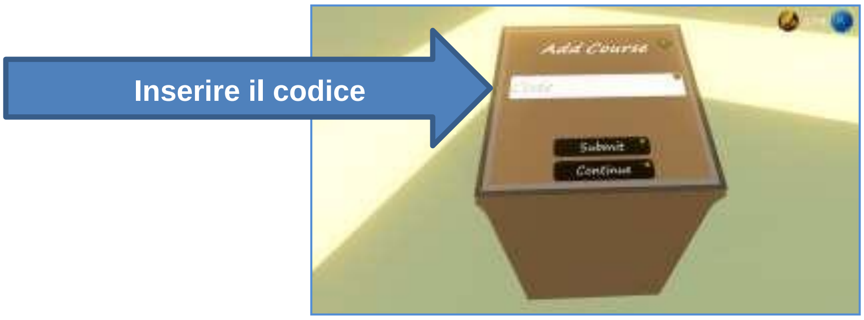


5. E vi ritrovate in questa stanza:



1 Dal terminale sulla sinistra, è possibile aggiungere il codice del corso che l'insegnate ha attribuito al corso creato nella piattaforma dedicata agli insegnanti.

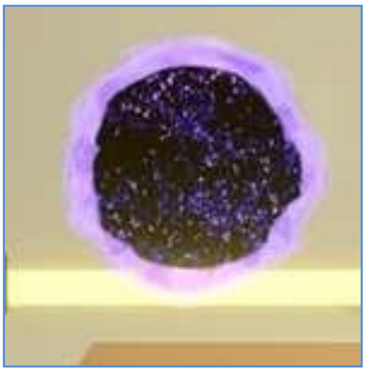
Il codice è quel valore immesso dal docente, vedi pag. 2 della presente guida.



2 Dal terminale sulla destra, è possibile scegliere un corso se si è iscritti a diversi corsi.

Iscriversi ad un corso, vuol dire che è stato già registrato il relativo codice nel terminale.

6. Successivamente potete dirigervi verso lo spazio per iniziare le attività:



7. Per maggiori informazioni sulle funzionalità e sui giochi disponibili, visualizzare il seguente video:

https://www.youtube.com/watch?v=to6UoJizWVg&feature=emb_logo

Il video è in inglese ma sono disponibili i sottotitoli in italiano. Per attivare i sottotitoli in un video pubblicato su Youtube, cliccare sul pulsante indicato dalla freccia rossa.

oppure scaricare il documento "Students' Game Environment" – User Manual dal portale:

https://www.coding4girls.eu/results_02.php

8. Per avere un'idea più completa, si possono utilizzare i **corsi** e gli **scenari** di apprendimento **già preparati**.

   I corsi si riferiscono ad un **livello base di coding**.

   Di seguito, viene riportata una tabella con i **titoli dei corsi** e i **codici** corrispondenti sia nella versione **inglese** che in **italiano**:

N.	Corsi in inglese	Codice	Corsi in italiano	Codice
1	**Introduction to Snap! interface**	starting	**Snap!: introduzione**	Primipassi
2	**Discover Snap! : move a spite**	dispubeng	**Scoprire Snap!**	Snap!
3	**Moving around the stage**	monkey	**Muoversi sullo "stage"**	stage
4	**Changing costumes and turning**	Dancer	**Cambiare il costume e creare rotazioni**	ballerina
5	**Sounds of the farm**	farm	**I suoni di una fattoria**	fattoria
6	**Chameleon's summer vacation**	chameleonen g	**Vacanze estive di un Camaleonte**	camaleonte
7	**Helping Prince and Princess to find their animals**	finding	**Alla ricerca degli animali del Principe e della Principessa!**	labirinto
8	**Drawing with a chalk**	chalk	**Disegnare con un gesso**	gesso
9	**Picking up trash and cleaning the park**	cleaning	**Raccogliere la spazzatura e pulire il parco**	spazzatura
10	**Feeding the cats**	feeding	**Dare da mangiare ai gatti**	gatto
11	**Guessing the number of cats in a shelter**	shelter	**Indovinare il numero di gatti in un rifugio**	rifugio

9. Compilare il questionario disponibile al seguente link: https://forms.gle/AAzEM1Qjiq92UG6f8

Grazie per la collaborazione!

Magggiori informazioni:

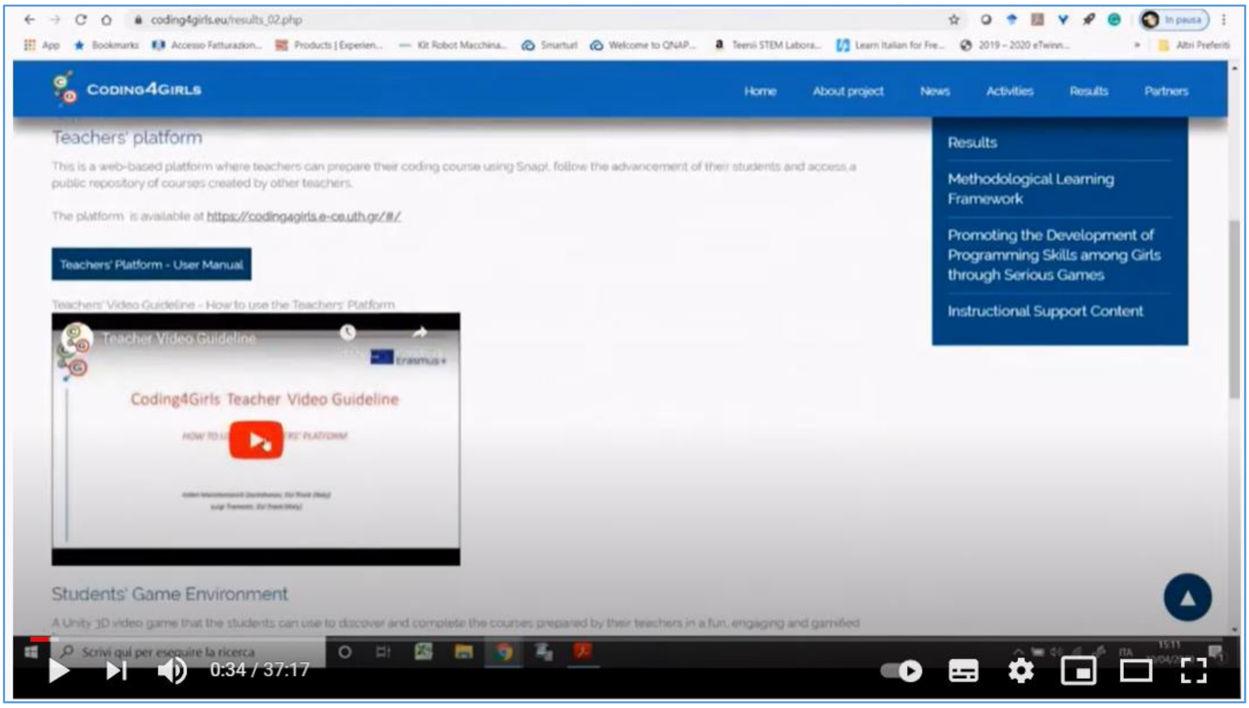
Sito web di progetto

https://www.coding4girls.eu/

Email di contatto –

m.tramonti@eu-track.eu

TEACHERS’ PLATFORM AND STUDENTS’ GAME ENVIRONMENT TUTORIAL (in Italian)



NATIONAL REPORT: PORTUGAL

TABLE OF CONTENTS

EXECUTIVE SUMMARY

The validation of the C4G approach in Portugal was concentrated in December 2020 due to the limitations introduced by COVID 19 pandemic. From March 2020 schools were closed and adopted online learning. Teachers and students remained at home and communicated through online channels – this had a tremendous impact as they had to learn new tools, to adapt to new forms of communication and learning and to manage their entire life in a completely different mode. On one side, this created logistic problems to organize the validation events even if C4G's methodology is very flexible and very suitable for online implementation, and, on the other side, teachers and students were not interested in parallel activities (like the validation of the C4G methodology) as they had to focus on the formal online education and they were quite stressed with it.

Therefore, it was only finally possible to conduct the validation, in an online model, during the Christmas holidays, when teachers and students were more relaxed from their formal online classroom duties. Even so, it was possible to gather experts, schoolteachers and students (from the Agrupamento de Escolas Carlos Amarante, a group of schools from the North of Portugal) for the C4G validation in Portugal. Different activities were then promoted according to the participants (teachers, experts, students) involved. The complementary multiplayer event organised in late December 2020 contributed to further disseminate the information about the project.

The results of the validation events showed that students were very motivated with the game-design based learning C4G methodology and participated actively in the online activities without visible gender differences. Teachers and experts were very positive on the proposed methodology but particularly on the instructor-support tools that were considered to facilitate the work of the teachers.

Considering the positive results obtained, the C4G methodology, syllabus and contents were submitted for approval by the Conselho Científico-Pedagógico da Formação Contínua, the national organ that superintends teacher training.

IMPLEMENTATION

As mentioned before, different validation activities took place in Portugal to ensure the best possible implementation and results:

- Firstly, an online workshop (3 hours) with 14 teachers was organized on the 9th of December. In this workshop, the concept, methodology and tools developed in the scope of the C4G project were presented. Then teachers were provided with all the tools so they could use them autonomously. One week later they were contacted and given feedback for doubts and questions. 5 of the teachers were interested in working with their students during the Christmas holidays (later, 2 of them were unable to do so). Some of teachers had previous experience in programming and coding (mostly using Scratch) but most of them had no previous experience. In the workshop, teachers followed the C4G game-based approach like the students would later follow. This gave them experience and confidence in the use of those tools.
- Secondly, an online meeting with 2 experts took place on the 14th of December. Once again, the main objective was to present the concept, methodology and tools developed in the scope of the C4G project. External experts expressed a first point of view regarding the proposed C4G approach. Then experts were provided with all the tools so they could use them autonomously. One week later they were contacted and gave a more extended feedback of their analysis of C4G methodology and tools.
- Finally, an online learning course took place with 14 students and 3 teachers (supported by VC staff) on the 21st and 22nd of December. Four 3-hour sessions were organized for a total of 12 hours. As mentioned before, the 3 teachers involved had been previously trained and had some previous experience in programming. One of them had a PhD in technology education and a large teaching experience in teaching informatics (to students and peers) and that facilitated the process. During the implementation, teachers and students used the Portuguese version of the learning scenarios that were developed by the project partners. In the implementation the following learning scenarios were used:

- Introduction to Snap!
- Discover Snap! : move a sprite
- Moving around the stage

- Changing costumes and turning
- Sounds of the farm
- Chameleon’s summer vacation

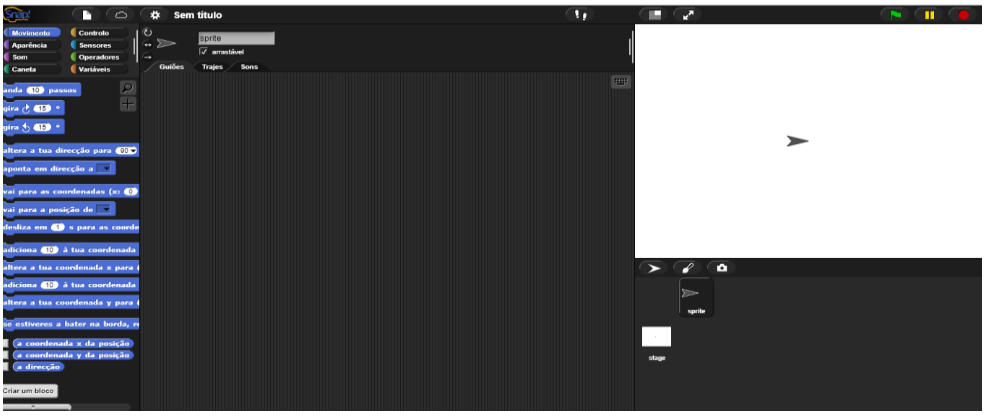


Figure 45. Snap! environment in Portuguese

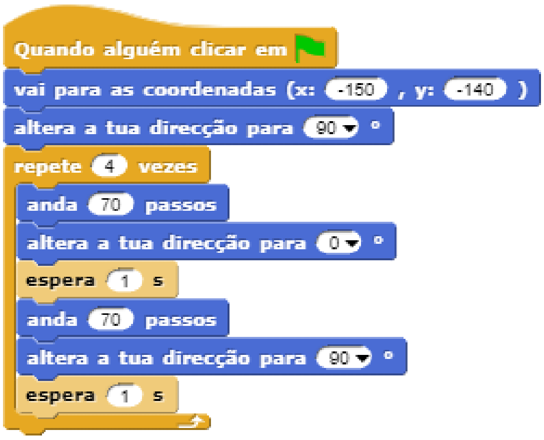


Figure 46. Snap! code blocks in Portuguese

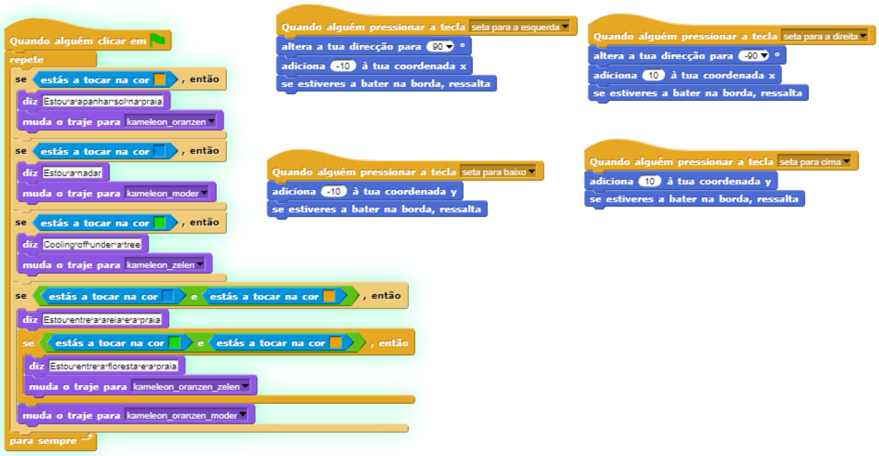


Figure 47. Portuguese code for the Chameleon scenario

Data collection tools

During the validation of C4G approach, all the data collection tools provided in the C4G validation strategy were used:

- S1 – Preliminary questionnaire (for students)
- S2 – Follow-up questionnaire (for students)
- T1 – Teacher's observations (one teacher)
- T2 – Teacher's comments
- T2A – Teacher's comments for online course
- E – Expert's comments

The student's data collection tools were translated into Portuguese. The others were used in the English versions as the teachers and experts were fluent in that language.

Teachers reported the reaction of students and their progress in building coding skills using the game-based C4G approach (T1) and their own views related to the relevance and effectiveness of the C4G methodology (T2). In the beginning of the validation with students they had to complete questionnaire S1 and after the implementation they completed questionnaire S2.

Questionnaires S1 and S2 were online, while data collection tools S3, T1, T2, and E for teachers and experts were prepared as Word documents in which they could write observations and comments. Later these filed were collected and compiled by VC staff.

RESULTS

The achieved results were the following, divided by the participants nature.

Students

According to the accepted validation strategy two online questionnaires for students were used: preliminary questionnaire about the use of digital devices and perceived level of programming and the follow-up questionnaire about satisfaction with programming and coding activities, satisfaction with the organization of the implementation, and perception on the acquired coding skills.

In both questionnaires students were asked to self-assess their current level of programming skill. Based on this question, the difference between students' self-assessed initial and final level of programming skill was calculated (the answers from the questionnaires were paired based on the code that students have entered).

A total of 14 students replied to both questionnaires.

Participants' characterization

17 students in total participated in the implementation and provided feedback through questionnaires S1 and S2.

Age

The average age of the students was 12.18 years (SD=0.38).

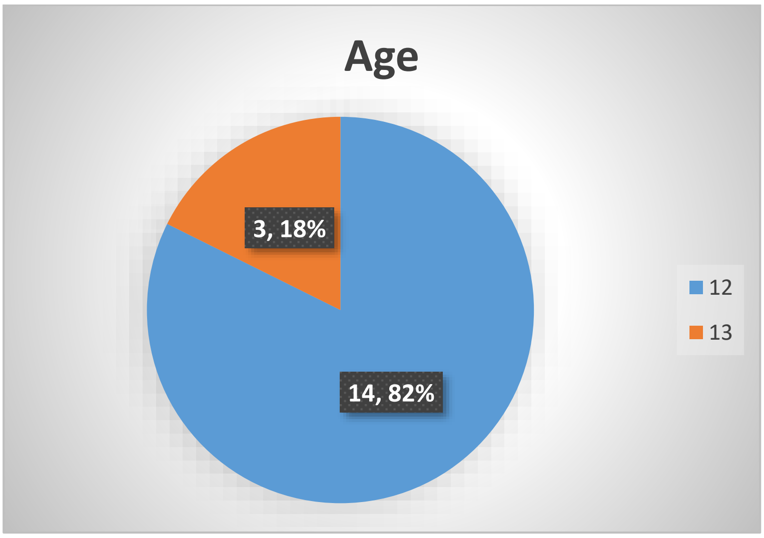


Figure 4 – Participant's age distribution

Gender

There were 6 (35%) boys and 11 (65%) girls.

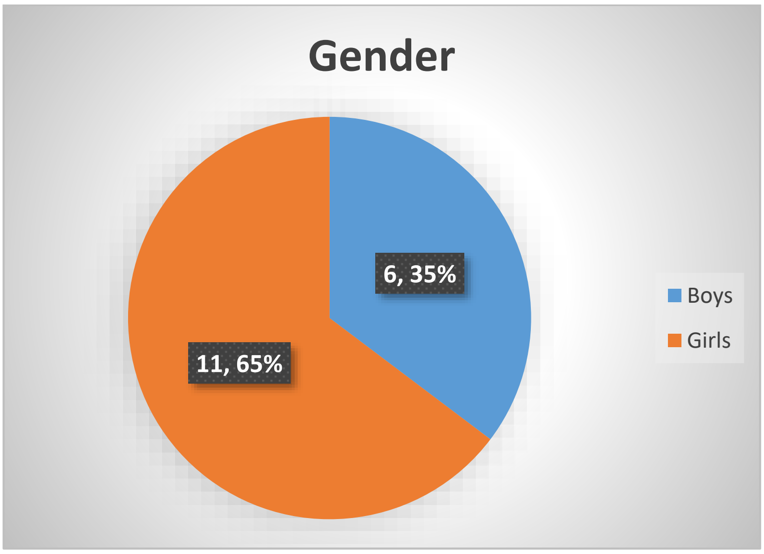


Figure 5 – Participant's gender distribution

Use of digital devices, Internet and videogames

Table 31 shows descriptive statistical analysis of participants' responses to the questions related to the use of digital devices, the internet and videogames. The comparison of the overall results by gender shows that there is no major difference between boys and girls on their use of these devices and use of the internet. Boys do spend some more time playing games.

Table 1 - The use of digital devices, the internet and video-games by gender

Question		N	Min	Max	Mean	SD
17. For how long have you been using computers, tablets or other digital devices (in years)?	Boys	6	2	7	3,5	1,71
	Girls	11	2	7	4	1,48
	Total	**17**	**2**	**7**	**3,8**	**1,58**
18. How many hours per week do you use a computer, tablet or other digital device?	Boys	6	6	16	8,67	3,45
	Girls	11	4	18	8,18	4,19
	Total	**17**	**4**	**18**	**8,35**	**3,95**
19. How many hours per week do you use the Internet?	Boys	6	4	16	7,17	4,1
	Girls	11	4	16	7,36	3,91
	Total	**17**	**4**	**16**	**7,29**	**3,98**
20. How many hours per week do you play video games?	Boys	6	3	8	4,67	1,8
	Girls	11	2	7	3,91	1,38
	Total	**17**	**2**	**8**	**4,17**	**1,58**

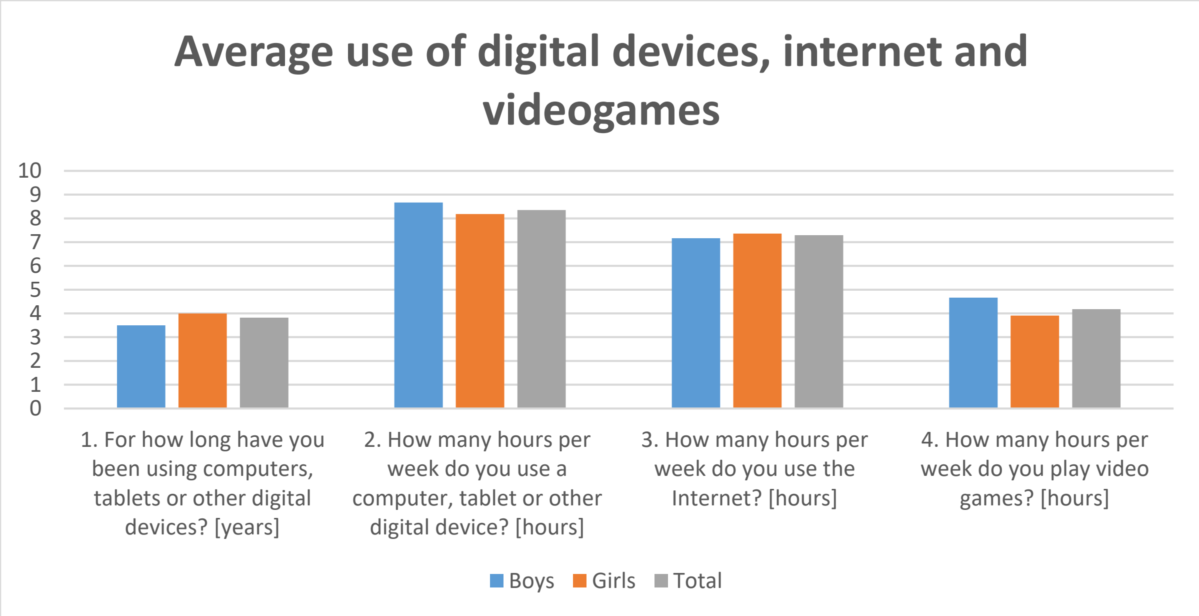


Figure 6 – Use of digital devices, internet and videogames

Motivation for learning

All the students were very motivated to learn how to code. The motivation was similar for boys and girls although boys expressed a higher desire to follow a career in informatics. Boys were also slightly more interested in solving logic problems.

Table 2 - Motivation for learning programming by grade and gender

Statement	Boys	Girls	**Total**
I'm not motivated	0%	0%	0%
I want to succeed in the programming class	66,7%	72,7%	23,1%
I want to show other students I can program	0%	27,3%	15,4%
I want to follow a career in programming	33,3%	9,1%	11,5%
I enjoy solving logic problems and puzzles	50%	36,4%	15,4%

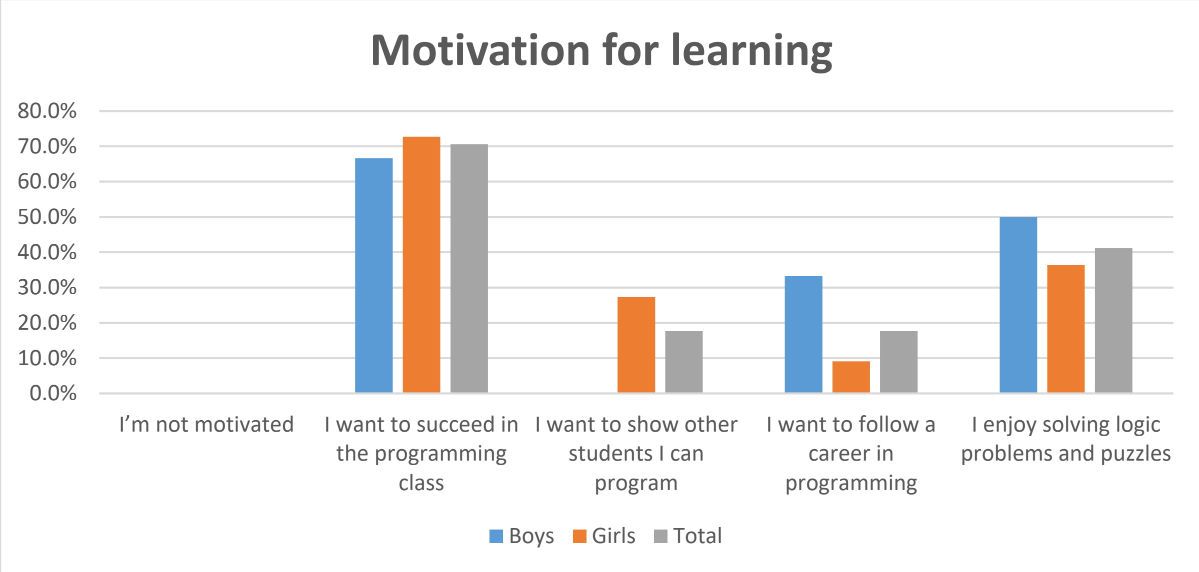


Figure 7 - Motivation for learning programming – Comparison by gender

Programming and coding analysis

Starting level of programming

The participants self-assessed the level of their programming skills on the scale from *0 - I have never coded or programmed before* to *4 - I can design a solution of a problem in the form of a program*. Results are shown in the Table 3. The majority of the students were either at level 0 – novice in programming (35,3%) or level *1 - novice programmers* (35,3%). However, girls seemed to be slightly more advanced in their knowledge than boys. None of the students were at the highest level of programming skills.

Table 3 - Self-assessment of programming skills by gender

Level of programming skills	**Boys**		**Girls**		**Total**	
0 - I have never coded or programmed before	3	50%	3	27,3%	6	35,3%
1 - I am a novice programmer (just have basic ideas)	1	16,7%	5	45,5%	6	35,3%
2 - I can code simple programs	1	16,7%	2	18,2%	3	17,6%
3 - I am fluent in programming (can create a full program)	1	16,7%	1	9,1%	2	11,8%
4 - I can design a solution of a problem in the form of a program	0	0%	0	0%	0	0%

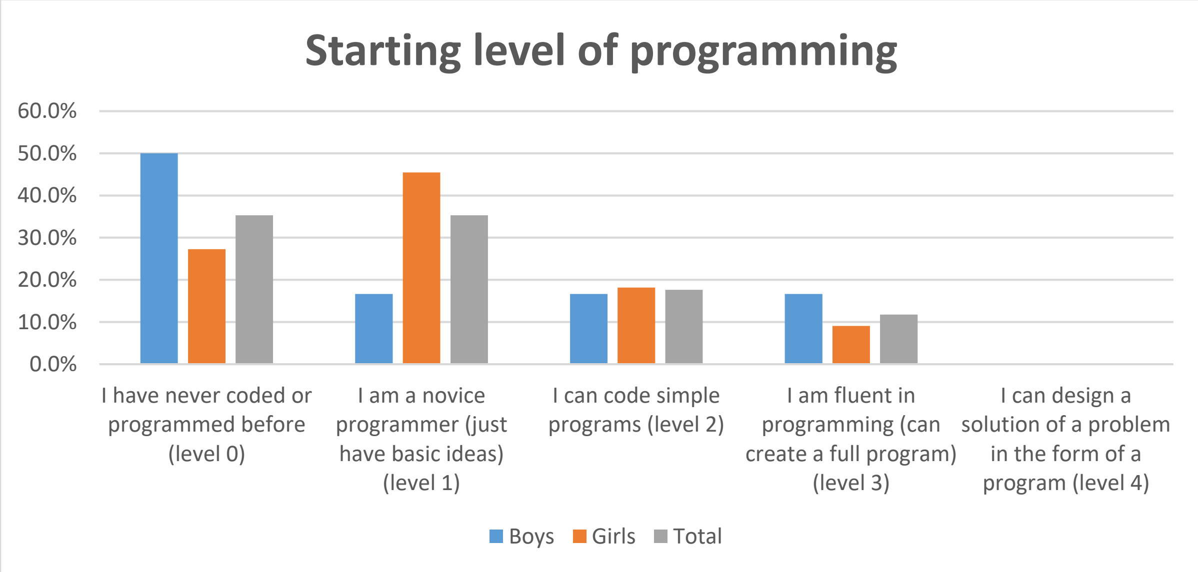


Figure 8 – Initial self-assessment of programming skills – comparison by gender

Starting experience in coding and programming

The participants that already had above level 0 also stated which programming concepts they were familiar with. The results (Table 54) show that students are mostly familiar with the variables and statements (all the students), conditionals (72,7%) and operators (54,5%) while they were least familiar with parallelism (none) and events (9,1%). The familiarity of programming concepts is very similar in both genders.

Table 4 - Familiarity with the programming concepts

Concept	Boys	Girls	Total
Loops	2	3	5
Conditionals	3	5	8
Variables	3	8	11
Statements (sounds, movement, looks, drawing)	3	8	11
Operators	2	4	6
Events	1	0	1
Parallelism	0	0	0

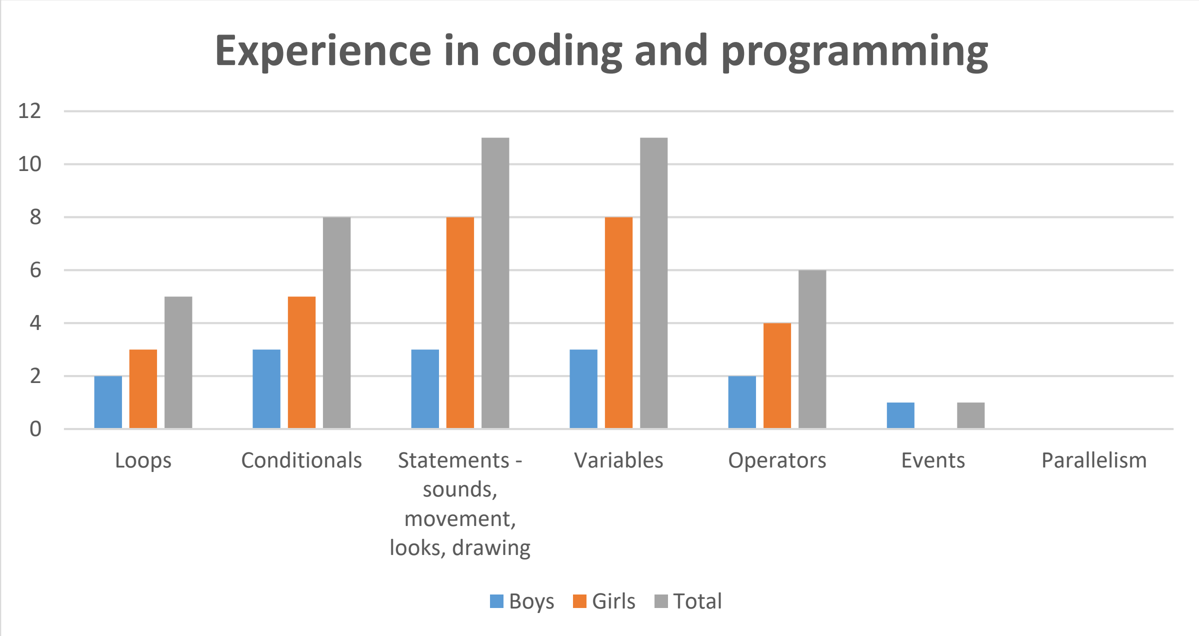


Figure 9 - Familiarity with the programming concepts – comparison by gender

Final level of programming

In the end, the participants self-assessed again the level of their programming skills on the scale from *0 - I have never coded or programmed before* to *4 - I can design a solution of a problem in the form of a program*. Results are shown in the Table 5. The majority of the students increased at least to level *1 - novice programmers* (35,3%). Results may transmit an excessive optimism from the students in relation to their recent acquired skills.

Table 5 - Self-assessment of programming skills by gender

Level of programming skills	Boys		Girls		Total	
0 - I have never coded or programmed before	0	0%	3	0%	0	0%
1 - I am a novice programmer (just have basic ideas)	3	50%	5	9,1%	4	23,5%
2 - I can code simple programs	1	16,7%	2	54,5%	7	41,2%
3 - I am fluent in programming (can create a full program)	1	16,7%	1	27,3%	4	23,5%
4 - I can design a solution of a problem in the form of a program	1	16,7%	0	9,1%	2	11,8%

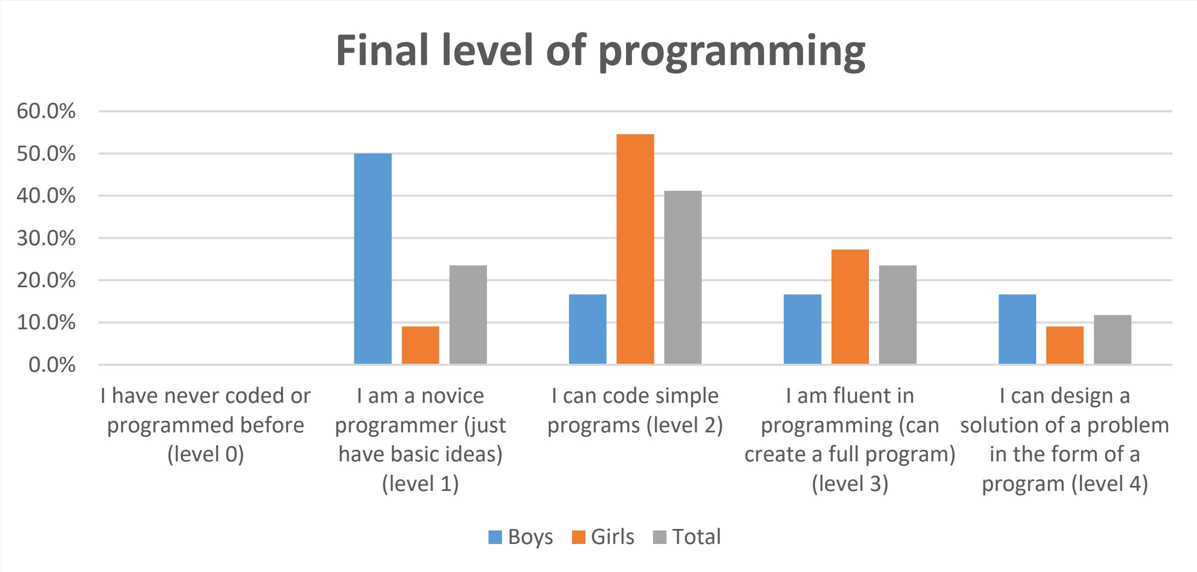


Figure 10 – Final level of programming

Programming skill comparison

Comparing the perceived level of competence before and after we have the following results, presented in Table 6.

Table 6 – Improvement in programming skill

Level of programming skills	Boys		Girls		Total	
	Before	After	Before	After	Before	After
0 - I have never coded or programmed before	3	0	3	0	6	0
1 - I am a novice programmer (just have basic ideas)	1	3	5	1	6	4
2 - I can code simple programs	1	1	2	6	3	7
3 - I am fluent in programming (can create a full program)	1	1	1	3	2	4
4 - I can design a solution of a problem in the form of a program	0	1	0	1	0	2

All the students improved their programming skill level. 3 students “jumped” 2 levels and 14 students considered to have improved one skill level. Teachers later confirmed the evolution of the students but considered that this perception was overly optimistic.

Evaluation of the C4G methodology, contents and tools

A total of 17 students (same as in the beginning) answered the set of questions in the follow-up questionnaire related with satisfaction with the organization of the implementation.

Students expressed their perception using a 5-point Likert scale (1 – strongly disagree, 2 – disagree, 3 – neutral, 4 – agree, 5 – strongly agree). According to the results (Table 5), both boys and girls felt engaged with this way of learning and think that conducted activities were relevant for learning programming. They find that learning programming in this way is fun and easy. Both groups boys and girls confirm that learned material will be helpful for their future.

Table 742 – Satisfaction with C4G learning methodology

Statement		1	2	3	4	5	Mean	SD
41. I found programming challenging.	Boys	0	0	1	4	1	4	0,63
	Girls	0	0	3	3	5	4,2	0,87
	Total	**0**	**0**	**4**	**7**	**6**	**4,12**	**0,78**
42. I found programming motivating.	Boys	0	0	1	4	1	4	0,63
	Girls	0	0	2	6	3	4,1	0,7
	Total	**0**	**0**	**3**	**10**	**4**	**2,81**	**0,66**
43. I found programming easy.	Boys	0	0	0	5	1	4,2	0,41
	Girls	0	0	3	5	3	4	0,77
	Total	**0**	**0**	**3**	**10**	**4**	**4,1**	**0,66**
44. I enjoyed programming.	Boys	0	0	1	3	2	4,2	0,75
	Girls	0	0	1	7	3	4,2	0,60
	Total	**0**	**0**	**2**	**10**	**5**	**4,2**	**0,64**
45. I understood most of programming concepts.	Boys	0	0	1	3	2	4,2	0,75
	Girls	0	0	5	2	4	3,9	0,94
	Total	**0**	**0**	**6**	**5**	**6**	**4,0**	**0,87**
46. Learning this way is fun.	Boys	0	0	0	3	3	4,5	0,55
	Girls	0	0	1	6	4	4,3	0,65
	Total	**0**	**0**	**1**	**9**	**7**	**4,4**	**0,61**
47. I felt engaged with this way of learning.	Boys	0	0	0	4	2	4,3	0,52
	Girls	0	0	0	5	6	4,5	0,52
	Total	**0**	**0**	**0**	**9**	**8**	**4,5**	**0,51**
48. The activities were relevant to learn.	Boys	0	0	0	4	2	4,3	0,52
	Girls	0	0	2	5	4	4,2	0,75
	Total	**0**	**0**	**2**	**9**	**6**	**4,2**	**0,66**
49. At any time, it was clear what I had to do.	Boys	0	1	0	4	1	3,8	0,98
	Girls	0	1	5	2	3	3,6	1,03
	Total	**0**	**2**	**5**	**6**	**4**	**3,7**	**0,99**
	Boys	0	0	4	1	1	3,5	0,84

50. What I learned will be relevant for my future.	Girls	0	1	2	5	3	3,9	0,94
	Total	**0**	**1**	**6**	**6**	**4**	**3,76**	**0,90**

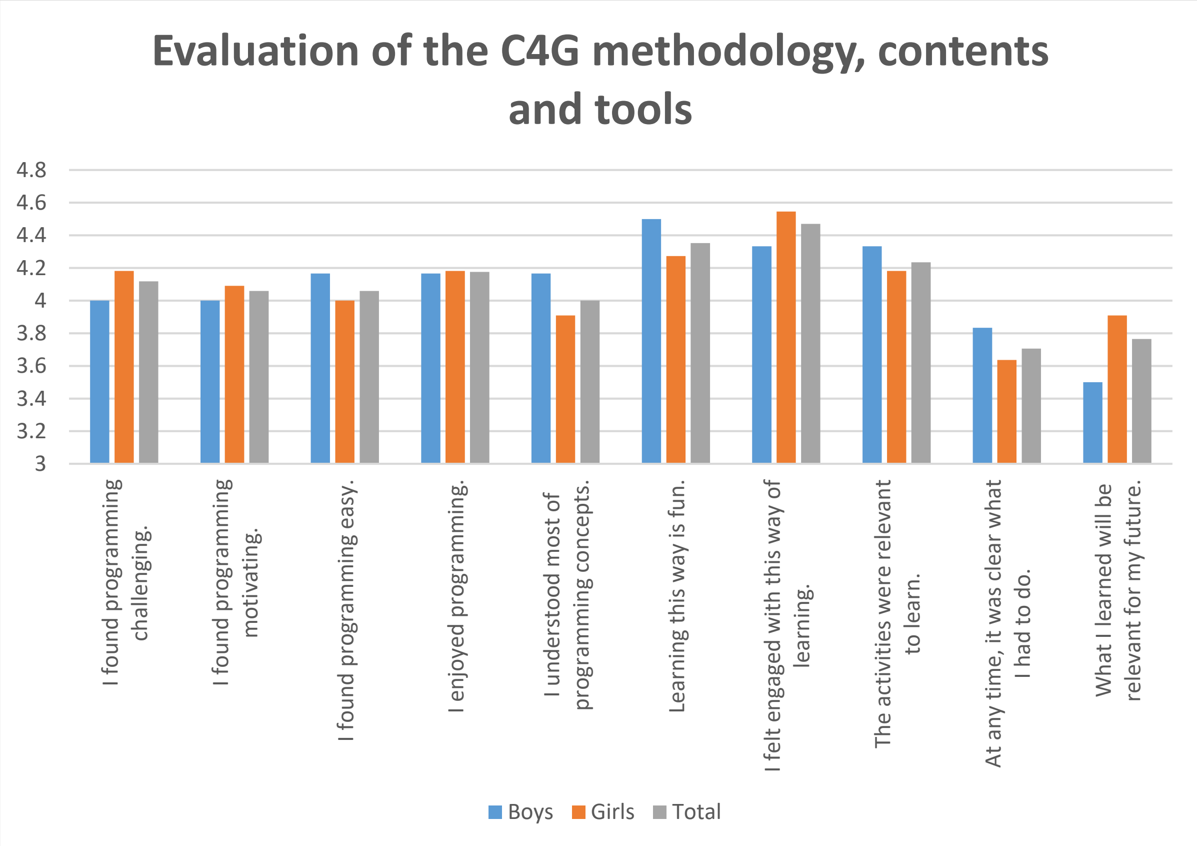


Figure 11 – Evaluation of the C4G methodology, contents and tools

Students' comments

In general, students were satisfied with the C4G approach. There were no significant differences between genres as all the participants were highly motivated and involved.

Student's perception on the overall implementation

Students did like the course and testing organization. Students mentioned that they liked doing it at home, through the computer because they were able to see and talk with the colleagues, anyway. They enjoyed coding and using Snap!.

Learning difficulties or problems

Some students who had no previous programming experience reported some difficulty understanding the organization of the code. But they mentioned that one there was a doubt there was always someone to help, teacher or colleague so they were never stopped for long. They would have liked to have a longer course and they would have not minded having the course for an entire week.

Student's views on how to improve the C4G methodology, tools and contents

As students were very positive about the course, there were not many improvement suggestions. They mentioned that they would have liked to try it in the classroom to see if it was better or worse than doing it at home. They would like to have even more exercises so they could have more options.

Teachers' observations on the student's involvement

In general, teachers reported having observed the same level of engagement and motivation that students had previously mentioned.

Students' participation and engagement, learning difficulties or problems

Students were highly motivated during the two days of the testing. Furthermore, after the testing, students continue doing challenges and asking teachers and VC staff for support and comments. During the online moments, students interacted a lot, collaborated in the development and shared the results. They really enjoyed seeing the other participants playing the games they had created. Boys were a bit competitive and always tried to be the first to finish an activity while typically girls were more reflective and more perfectionist in terms of the final result (they always tried to customize the background and objects in the scenes). Girls liked very much the stories in most of the challenges and tried to contribute also to that aspect. As students had 3 teachers available plus VC staff and some parents were also involved, they felt very supported when they had problems and could move quickly on. But they also collaborated between themselves in the process of finding bugs and problems in the challenges. There were no visible differences between girls and boys in the motivation and perceived fun.

Anything else you consider relevant

Girls and boys were equally involved in the testing. However the motivation seemed to be a little different: boys were very much interested in the coding itself and finding out about what they could do with the instructions. Girls were more reflective, liked to understand very well every aspect of a certain challenge so that they could be more creative in the solution.

Teachers

After the implementation activities, teachers were asked to express their qualitative opinions about the C4G methodology and the implementation process using the form T2.

Teachers' comments

Accomplishment of learning objectives by the students

Teachers particularly liked the clear definition of learning objectives for each challenge. They were able to observe, by asking students after each challenge, that the tasks in the challenge did in fact allow students to accomplish the learning objectives. Teachers were a bit disappointed that the length of the course limited the number of challenges/games to be developed but they mentioned that students had asked for their support to code more of the challenges that were available.

Relevance and effectiveness of GBL and C4G for building programming skills

The 3 teachers that worked with the students had previous experience on the use of learning technologies but very little practice with GBL. They participated in the training session and worked autonomously before the testing to complete the challenges themselves. Their perception was that GBL and Learning by Game Design clearly allowed students to develop programming and coding skills while being extremely motivated.

Acceptance of the proposed methodology by the students

Teachers observed that students were highly motivated by this methodological approach. They were very involved, collaborating, exchanging suggestions, asking questions throughout the entire testing process. Teacher saw no difference between boys and girls in the process.

Achieved fun by the students

As mentioned before, teachers observed the deep involvement of the students and that there was a clear fun process ongoing. Teachers mentioned that could also be due to the fact that students were on holidays, relaxed and at home so feeling less the "school environment". But teachers found also very interesting that the two parents that were involved also had (reported) a very nice and "fun" time.

Overall organization of the implementation

Teachers liked the way the testing was organized although they missed a more close contact with the students. But as reported before, that could have had positive and negative contributions. The teachers also enjoyed the way the challenges were organized, the fact that there was already a structure for the code in each challenge, that there were several support tools to help them.

Usability and acceptance of the proof-of-concept C4G approach

Teachers were enthusiastic about the whole process and were planning to use further the tools and contents in their teaching. One even commented the possibility of reorganizing the discipline he was teaching according to the proposed C4G methodology.

Experts

2 experts were asked to give their qualitative opinions regarding the accomplishment of learning objectives by the students, relevance, effectiveness, and acceptance of the proposed methodology by the students, and the overall organization of the implementation. The two experts came from the field of technology-enhanced learning and were familiar with GBL concepts, including the idea of learning by game-design.

Experts' comments

Accomplishment of learning objectives by the students

The meeting with experts took place before the actual testing with students. They were shown the C4G methodology and tools and were given some time to try them. So some answers are based on the perception and previous experience of the experts and their use of the tools and contents, rather than on the observation of the testing process with students. Experts mentioned that the learning objectives for each challenge were very clear and very well detailed and that allowed to assess that the planned tasks would allow to reach those learning objectives.

Relevance and effectiveness of GBL and C4G for building programming skills

The two experts came from the field of technology-enhanced learning and were familiar with GBL concepts, including the idea of learning by game-design. They thought that the C4G approach is a clear example on how Learning by Game Design can be used. They were also very positive on the type of challenges that was proposed to the students once they were fit to girls (no violence, the color scheme used, the narrative in the challenges). The objectives of the project (learn how to code) will be perfectly reached through the proposed methodology and tools.

Acceptance of the proposed methodology by the students

Experts could not judge this point by observation but only by their previous experience in the field which indicates that students do accept and are motivated by this methodology. The increasing level of difficulty in the activities will ensure a continuous challenge to the students while they are progressing and increasing their proficiency.

Achieved fun by the students

Like in the previous point, experts considered that students would have fun in developing the challenges, creating the games and learning to code through the C4G methodology. GBL has been widely tested and has shown that the fun component was paramount to increase the intrinsic motivation of the students.

Overall organization of the implementation

The experts' opinion was that the flexibility that the C4G methodology allowed was fundamental to ensure a high-quality level independently of the implementation conditions. Experts were referring to the fact that the planned implementation in Portugal would take place online which might create difficulties if the C4G approach was not so modular. Also the number of support tools available for the teachers was considered as a very positive aspect as it gave them confidence to guide the students in the process of learning to code.

Usability and acceptance of the proof-of-concept C4G approach

Like mentioned before, experts were very positive on the methodology, contents and tools. They recommended the consortium to try to formalize the C4G approach with the Education Ministries in the participating countries.

DISCUSSION AND CONCLUSIONS

The results from students' opinion and teacher observation show that students accepted well the C4G approach for building coding skills. Teachers confirmed the motivation and fun of the students and the relevance of the proposed approach. They mentioned that learning outcomes were correctly defined for each scenario and that the corresponding activities would, in fact, allow reaching those learning outcomes. Everything was therefore well planned to develop programming and coding skills. Most of the teachers were interested in using C4G contents and tools in their future teaching assignments.

Experts were also enthusiastic with the C4G methodology, contents and tools and congratulated the team on the details of the produced materials, mentioning that teachers could adapt existing games to their own interests.

As a conclusion, there was unanimity in accepting the suitability of the C4G methodology to help these students learn coding and programming concepts. Also this suitability applies similarly for both genders with might ensure that a larger number of female students might choose an Informatics/Computer Science career.

Acknowledgments: we would like to thank all the participants (experts, teachers and students) in the validation study of the C4G methodology. We particularly like to thank Prof. Adelina Moura for her support in finding teachers and students for the validation process and for contributing as a lead teacher to the process.

ANNEXES

A. S1. PRELIMINARY QUESTIONNAIRE FOR STUDENTS (in Portuguese)

S1. QUESTIONÁRIO PRELIMINAR PARA ESTUDANTES

Trata-se de um levantamento preliminar sobre a utilização de dispositivos digitais e experiência na programação realizada no âmbito do projeto CODING4GIRLS que visa desenvolver uma abordagem de jogo séria para a construção de competências de programação.

As suas respostas serão **anónimas** e serão usadas apenas para fins depesquisa. Obrigado pelo seu tempo e cooperação!

Primeiro, por favor, **escreva o código** recebido do seu professor.

CÓDIGO E INFORMAÇÃO GERAL

Código: __ Escola: __

Idade: __ Classe: __

Sexo: M F

O USO DE DISPOSITIVOSDIGITAIS, INTERNET E VIDEOJOGOS

11. Há quanto tempo que usa computadores, tablets ou outros dispositivos digitais?	____
12. Quantas horas por semana usas um computador, tablet ou outro dispositivo digital?	__
13. Quantas horas por semana usas a Internet?	__
14. Quantas horas por semana jogas videojogos?	__

EXPERIÊNCIA EM CODIFICAÇÃO E PROGRAMAÇÃO

15. Qual é o teu nível de programação, agora? *Circule a resposta mais apropriada.*
   u) Nunca codifiquei ou programei antes.
   v) Sou um programador novato (só tenho ideias básicas)
   w) Posso codificar programas simples
   x) Sou fluente na programação (pode criar um programa completo)
   y) Posso desenhar uma solução de um problema na forma de um programa

16. Se já codificaste, qual dos seguintes conceitos te é familiar? *Marca uma ou mais respostas.*

- ☐ Loops
- ☐ Variáveis
- ☐ Eventos
- ☐ Condicionais
- ☐ Operadores
- ☐ Paralelismo
- ☐ Declarações (sons, movimento, aparência, desenho)

17. O que te motiva a aprender a programar? *Marca uma ou mais respostas.*

- ☐ Não estou motivado.
- ☐ Quero ter sucesso na aula de programação.
- ☐ Quero mostrar a outros alunos que posso programar
- ☐ Quero seguir uma carreira na programação.
- ☐ Gosto de resolver problemas de lógica e puzzles
- ☐ Other____________________________

B. S2. FOLLOW-UP QUESTIONNAIRE FOR STUDENTS (in Portuguese)

S2. QUESTIONÁRIO DE ACOMPANHAMENTO PARA ESTUDANTES

Trata-se de um inquérito de acompanhamento sobre o atisfaction com a metodologia de aprendizagem C4G e a implementação de atividades de aquisição de competências de programação e codificação.
As suas respostas serão **anónimas** e serão usadas apenas para fins de pesquisa. Obrigado pelo seu tempo e cooperação!
PLease write under **the code** received from your teacher (itis the same code you used in the preliminary questionário).

CÓDIGO E INFORMAÇÃO GERAL

Código: __ Escola: __
Idade: __ Classe: __
Sexo: M F

METODOLOGIA DE APRENDIZAGEM C4G

18. Classificar as seguintes declarações:	*Discordo fortemente*	*Discordar*	*Neutro*	*Concordar*	*Concordo fortemente*
k) Achei a programação desafiadora.	1	2	3	4	5
l) Achei a programação motivadora.	1	2	3	4	5
m) Achei a programação fácil.	1	2	3	4	5
n) Gostei de programação.	1	2	3	4	5
o) Entendi a maioria dos conceitos de programação.	1	2	3	4	5
p) Aprender assim é divertido.	1	2	3	4	5
q) Senti-me envolvido com esta forma de aprender.	1	2	3	4	5
r) As atividades eram relevantes para aprender.	1	2	3	4	5
s) A qualquer momento, era claro o que tinha que fazer.	1	2	3	4	5
t) O que aprendi será relevante para o meu futuro.	1	2	3	4	5

NÍVEL DE PROGRAMAÇÃO PERCIEVED

19. Qual é o seu nível de programação, agora? *Circule a resposta mais apropriada.*
z) Nunca codifiquei ou programei antes.
aa) Sou um programador novato (só tenho ideias básicas)

bb) Posso codificar programas simples
cc) Sou fluente na programação (pode criar um programa completo)
dd) Posso desenhar uma solução de um problema na forma de um programa

USABILIDADE DO AMBIENTE DO JOGO

20. Classificar as seguintes declarações:	*Discordo fortemente*	*Discordar*	*Neutro*	*Concordar*	*Concordo fortemente*
k) Gostaria de usar este jogo com frequência.	1	2	3	4	5
l) Encontrei o complexo de jogos.	1	2	3	4	5
m) O jogo foi fácil de usar.	1	2	3	4	5
n) Preciso do apoio de uma pessoa técnica para poder usar este jogo.	1	2	3	4	5
o) As várias funções neste jogo foram bem integradas.	1	2	3	4	5
p) Houve muita inconsistência neste jogo.	1	2	3	4	5
q) A maioria das pessoas aprenderia a usar este jogo muito rapidamente.	1	2	3	4	5
r) O jogo foi muito complicado de usar.	1	2	3	4	5
s) Senti-me muito confiante ao usar o jogo.	1	2	3	4	5
t) Precisava de aprender muitas coisas antes de começar com este jogo.	1	2	3	4	5

EXPERIÊNCIA DE JOGO

21. Classificar as seguintes declarações:	*Discordo fortemente*	*Discordar*	*Neutro*	*Concordar*	*Concordo fortemente*
hh) Senti-me contente.	1	2	3	4	5
ii) Senti-me hábil.	1	2	3	4	5
jj) Estava interessado na história do jogo.	1	2	3	4	5
kk) Pensei que fosse divertido.	1	2	3	4	5
ll) Estava completamente ocupado com o jogo.	1	2	3	4	5
mm) Senti-me feliz.	1	2	3	4	5

nn) Deu-me mau humor.	1	2	3	4	5
oo) Pensei noutras coisas.	1	2	3	4	5
pp) Achei cansativo.	1	2	3	4	5
qq) Senti-me competente.	1	2	3	4	5
rr) Pensei que fosse difícil.	1	2	3	4	5
ss) Foi esteticamente agradável.	1	2	3	4	5
tt) Esqueci-me de tudo à minha volta.	1	2	3	4	5
uu) Senti-me bem.	1	2	3	4	5
vv) Fui bom nisso.	1	2	3	4	5
ww) Senti-me aborrecida.	1	2	3	4	5
xx) Senti-me bem sucedido.	1	2	3	4	5
yy) Senti-me imaginativo.	1	2	3	4	5
zz) Senti que podia explorar as coisas.	1	2	3	4	5
aaa) Gostei muito.	1	2	3	4	5
bbb) Fui rápido a atingir os alvos do jogo.	1	2	3	4	5
ccc) Senti-me irritado.	1	2	3	4	5
ddd) Senti-me pressionado.	1	2	3	4	5
eee) Senti-me irritado.	1	2	3	4	5
fff) Perdi a noção do tempo.	1	2	3	4	5
ggg) Senti-me desafiado.	1	2	3	4	5
hhh) Achei impressionante.	1	2	3	4	5
iii) Estava profundamente concentrado no jogo.	1	2	3	4	5
jjj) Senti-me frustrado.	1	2	3	4	5
kkk) Parecia uma experiência rica.	1	2	3	4	5
lll) Perdi a ligação com o mundo exterior.	1	2	3	4	5
mmm) Senti pressão do tempo.	1	2	3	4	5
nnn) Tive de me esforçar muito.	1	2	3	4	5

C. SYLLABUS FOR TEACHERS' QUALIFICATION COURSE

CONSELHO CIENTÍFICO-PEDAGÓGICO DA FORMAÇÃO CONTÍNUA	**An**2-B
APRESENTAÇÃO DE ACÇÃO DE FORMAÇÃO NAS MODALIDADES DE ESTÁGIO, PROJECTO, OFICINA DE FORMAÇÃO E CÍRCULO DE ESTUDOS *Formulário de preenchimento obrigatório, a anexar à ficha modelo ACC2*	N.º ________

1. DESIGNAÇÃO DA ACÇÃO DE FORMAÇÃO

Competências Básicas de Programação para Efeitos Pedagógicos

2. RAZÕES JUSTIFICATIVAS DA ACÇÃO: PROBLEMA/NECESSIDADE DE FORMAÇÃO IDENTIFICADO

O domínio das linguagens algorítmica e de programação já é reconhecido como uma das competências fundamentais para as próximas décadas. Este reconhecimento tem a ver com a maior capacidade de lidar com dispositivos digitais inerente a esse domínio mas, sobretudo, pela demonstração de um aumento substancial nas capacidades de resolução de problemas, de pensamento abstrato e lógico, de criatividade e de planeamento e organização. Estando o ensino da algoritmia e programação a ser aplicado cada vez mais cedo, torna-se absolutamente necessário que os professores também detenham esse domínio para poder ensinar e acompanhar os alunos na aplicação desses conceitos quer no âmbito de estruturas curriculares, quer fora delas.

3. DESTINATÁRIOS DA ACÇÃO

Modalidade: Oficina de Formação

3.1. Equipa que propõe (caso dos Projectos e Círculos de Estudos) (Art. 12º-3 RJFCP) (Art.33º c) RJFCP)

3.1.1 Número de proponentes: 3

3.1.2 Escola(s) a que pertence(m):

3.1.3 Ciclos/Grupos de docência a que pertencem os proponentes:

3.2. Destinatários da modalidade: (caso de Estágio ou Oficina de Formação)
Professores bibliotecários

4. EFEITOS A PRODUZIR: MUDANÇA DE PRÁTICAS, PROCEDIMENTOS OU MATERIAIS DIDÁCTICOS

1. Estimular o uso de estratégias pedagógicas e metodologias inovadoras, capazes de contribuírem para o sucesso escolar, integrando as potencialidades da biblioteca escolar.
2. Sensibilizar os educadores e professores para a importância da algoritmia e programação
3. Formar os educadores e professores nos conceitos fundamentais de algoritmia e programação e na utilização de ferramntas pedagógicas nessa área
4. Valorizar a biblioteca escolar como espaço de partilha de recursos e equipamentos no âmbito da algoritmia e programação
5. Produzir recursos educativos relacionados com a algoritmia e programação, potenciadores de novas situações de aprendizagem.

5. CONTEÚDOS DA ACÇÃO (Práticas Pedagógicas e Didácticas em exclusivo, quando a acção de formação decorre na modalidade de Estágio ou Oficina de Formação)

1ª Sessão: Conceitos fundamentais de algoritmia e programação (3 horas)

- Apresentação dos formandos. Conteúdos, metodologia e avaliação dos formandos. Familiarização com a plataforma digital.
- O que é a algoritmia? O que é a programação
- A plataforma Snap!

2ª Sessão: Primeiros passos em algoritmia e programação (3 horas)

- Instruções e blocos de código
- Sequenciação de instruções e blocos de código
- Tipos de dados
- Variáveis e constantes, operadores
- Elementos de media: sprites, desenhos e sons

3ª Sessão: Controle de execução de algoritmos (3 horas)

- Instruções condicionais
- Eventos e estados de jogo
- Instruções de ciclo

4ª Sessão: Codificação de instruções mais complexas (3 horas)

- Operadores lógicos em instruções
- Manipulação de strings
- Valores aleatórios
- Input de dados

5ª Sessão: Construção avançada de programas (3 horas)

- Módularização do código
- Conceção de programas complexos
- Avaliação da ação

6. METODOLOGIAS DE REALIZAÇÃO DA ACÇÃO

6.1. Passos Metodológicos

A oficina de formação Formar leitores com o apoio da biblioteca escolar terá a duração de 15 horas, em regime presencial, e 15 horas de trabalho individual, realizadas de forma intercalada.

O trabalho autónomo desenvolve-se do seguinte modo:

1ª Sessão: Conceitos fundamentais de algoritmia e programação (3 horas)

- Utilização da plataforma Snap! para a realização de dois exercícios tutoriais

2ª Sessão: Primeiros passos em algoritmia e programação (3 horas)

- Utilização da plataforma Snap! para a realização de três exercícios tutoriais

3ª Sessão: Controle de execução de algoritmos (3 horas)

- Utilização da plataforma Snap! para a realização de três exercícios tutoriais

4ª Sessão: Codificação de instruções mais complexas (3 horas)

- Utilização da plataforma Snap! para a realização de três exercícios tutoriais

5ª Sessão: Construção avançada de programas (3 horas)

- Utilização da plataforma Snap! para a realização de um projeto tutorial

6.2. Calendarização

6.2.1. Período de realização da acção durante o mesmo ano escolar:

Entre os meses de: e

6.2.2. Número de sessões previstas por mês:

6.2.3. Número de horas previstas por cada tipo de sessões:

Sessões presenciais conjuntas:

Sessões de trabalho autónomo:

7. APROVAÇÃO DO ÓRGÃO DE GESTÃO E ADMINISTRAÇÃO DA ESCOLA:

(Caso da Modalidade do Projecto) (Art. 7º, RJFCP)

Data: ___/___/___ Cargo:

____

Assinatura:

____

8. CONSULTOR CIENTÍFICO-PEDAGÓOGICO OU ESPECIALISTA NA MATÉRIA

(Art.25º-A,2 c) RJFCO)

Nome:

(Modalidade de Projecto e Círculo de Estudos) delegação de competências do Conselho Científico-Pedagógico da

Formação Contínua (Art. 37º f) RJFCP

Sim		Não		N.º de acreditação do consultor							/		

9. REGIME DE AVALIAÇÃO DOS FORMANDOS

A avaliação será expressa nos termos dos números 5 e 6 do artigo 4.º, do Despacho n.º 4595/2015, tendo em consideração todos os dispositivos legais da avaliação contínua.

1. Participação/contributo nas sessões: 40%
   - Dinâmica da participação e qualidade das intervenções – 20%
   - Competências e capacidades (rigor científico, coerência, pertinência, …) – 20%
2. Trabalho de aplicação dos conteúdos: 60%
   - Qualidade do trabalho - 20%
   - Relevância pedagógica para a prática - 20%
   - Reflexão crítica - 20%

10. FORMA DE AVALIAÇÃO DA ACÇÃO

- Relatório dos formadores
- Questionários de avaliação preenchidos online pelos formandos
- Questionário de avaliação preenchido online pelos formadores

11. BIBLIOGRAFIA FUNDAMENTAL

- Guiões e vídeos de apoio fornecidos pelos formadores
- Bem-vindo ao Snap! (https://snap.berkeley.edu/)
- Manual de Referência Snap! (https://snap.berkeley.edu/snap/help/SnapManual.pdf)
- HobbyPress (2017). *Introduction to Block Based Programming with Snap: 2017 Edition*, Paperback – Large Print
- Abhay B Joshi (2018). *Learn CS Concepts with Snap!: Create exciting games and interactive animation in Snap! and learn computer science principles*, Independently published, ISBN-13 : 978-1728921716

NATIONAL REPORT: SLOVENIA

TABLE OF CONTENTS

EXECUTIVE SUMMARY

The report describes the validation phase of testing the C4G approach in Slovenia, presents the evaluation tools used and the results obtained by students, teachers and external experts. The method of test implementation and data collection is described. The results were obtained in the one-week winter school, one course and two workshops. The analysis is quantitative and qualitative and shows the suitability of the developed C4G approach for learning programming through designing games.

The implementation of the C4G approach in Slovenia took place from February to August 2020 as a one-week winter school, one course and two workshops. Due to the pandemic COVID -19 the course was moved to the virtual classroom. All other activities took place in the classroom.

Teachers (N_T=5) from the UL project team participated in the validation study and organized game-based learning activities with primary school students (N_S=50). Activities from C4G learning scenarios were used in the testing. The initial lessons were guided, and later students worked individually or in pairs using prepared instructions for students, with teacher assistance and further explanation of individual programming concepts if necessary. The prepared instructions were also given to the students in the virtual classroom, they could write questions in the forum or ask the teacher "live" via video conference.

Data were collected using prepared tools developed within the C4G project. Students and teachers gave their opinions and observations, and an external expert was also involved in the testing (N_E=1).

The results were very positive and indicate that the game-based C4G methodology with learning by designing games was well accepted by the students. They were very motivated to solve the tasks and had a lot of fun doing them. They enjoyed learning programming concepts, collaborating with their classmates, and exploring the Snap! environment. They tried to solve the activities individually and also improved their games. Teachers and external expert also see the approach as an appropriate way to learn programming for students ages 10 to 16. During implementation, we found that some activities were too easy for some students, so we added additional tasks to each activity and left the possibility to upgrade them at their own will.

IMPLEMENTATION

Data collection tools

The validation of the C4G approach used all data collection tools provided in the C4G validation strategy:

- S1 – Preliminary questionnaire (for students)
- S2 – Follow-up questionnaire (for students)
- S3 – Student's comments
- T1 – Teacher's observations
- T2 – Teacher's comments
- E – Expert's comments

First, all questionnaires were made and distributed to participants as Word documents, and later we used Google Forms for questionnaires S1 and S2 for students.

Initially, all questionnaires were prepared as Word documents and distributed to participants, later Google Forms for S1 and S2 questionnaires for students was used.

Materials

Learning scenarios and instructions for students were used during the implementation. A 3D platform with elements of gamification was not used because too few hours were available for testing.

The following scenarios were used in the testing:

1. Introduction to Snap! interface
2. Time to bring your sprite to life
3. Moving around the stage
4. Changing costumes and turning
5. Sounds of the farm
6. Chameleon's summer vacation
7. Helping Prince and Princess to find their animals
8. Drawing with a chalk
9. Picking up trash and cleaning the park
10. Feeding the cats

11. Guessing the number of cats in a shelter
12. Catching healthy food
13. Storytelling
14. Catch the mouse
15. Buying food for a picnic
16. Recycling
17. Play a piano 2

With selected activities, students learn all the basic programming concepts (loops, conditionals, variables, statements, operators, events, parallelism). With initial, simpler activities, students learned one programming concept, and in more challenging activities, multiple programming concepts were linked together. All scenarios and instructions for the students were translated into Slovenian before implementation.

Additional instructions (instructions for students) were prepared additionally, because after the first lesson in the course (the course was held once a week) we found that the students need some guidance to work individually.

Setup model and procedure

For the purpose of testing the C4G approach, a one-week winter school was organized, which took place during the school holidays in Ljubljana in February 2020. The winter school was attended only by girls aged between 10 and 14 years. The initial lessons were guided, after which the students solved the tasks individually or in pairs with the help of the instructions for the students. In case of problems they turned to the teachers. At the beginning of the winter school, students answered the preliminary questionnaire (S1), and at the end, students answered the follow-up questionnaire (S2). In order to compare the pretest and posttest results, students wrote a code on the questionnaires. We also collected their responses orally (S3), where they responded to our additional questions. The teachers reported on the students' participation and engagement and their learning difficulties during the implementation (T1) and on the accomplishment of the learning objectives, the relevance and effectiveness of the game-based learning, the acceptance of the proposed methodology, the fun achieved and the overall organization of the implementation (T2). The external expert also gave her qualitative opinion regarding the accomplishment of the learning objectives, the relevance and effectiveness of the game-based learning, the acceptance of the proposed methodology, the fun achieved and the overall organization of the implementation (E).

The course started at the beginning of February 2020 in the primary school in Ljubljana and was moved to the virtual classroom in mid-March due to the pandemic COVID -19. The course was held once a week for two school hours. It was attended by students aged 10 to 14 years, who gave their answers through the S1 and S2 questionnaires.

In June and August, two one-day workshops were organized in Nova Gorica, attended by students aged 11 to 14 years who also gave their answers through the S1 and S2 questionnaires.

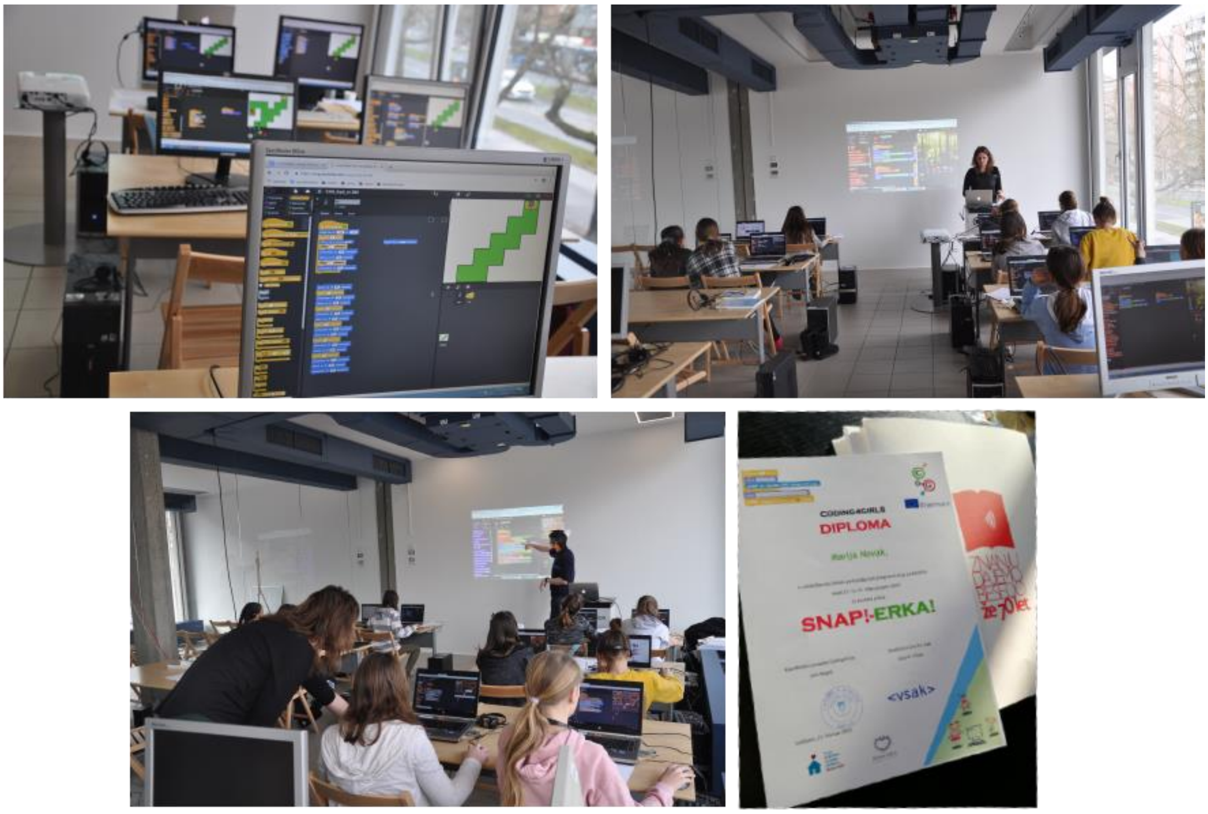


Figure 48 Testing in winter school

Participants

The project team at UL consists of researchers and teachers (N_{PT}=5) in the field of game-based learning, programming, and didactics of informatics. The whole team was actively involved in the preparation and evaluation of the activities.

The C4G approach for building programming skills was used in a one-week winter school, a course and two workshops. All testing was conducted by the UL project team. A total of 50 students aged 10 to 14 (4th to 9th grade of primary school) participated in the tests. Computer science is an elective subject in all classes. Table 43 shows the number of students-participants in the study by age/grade. Most of the students were from the 6th grade (Figure 49).

Table 43 Number of students by age/grade

Years of age	Grade	Number of students
10	4	1
10-11	5	2
11-12	6	20
12-13	7	8
13-14	8	15
14	9	4
	Total	**50**

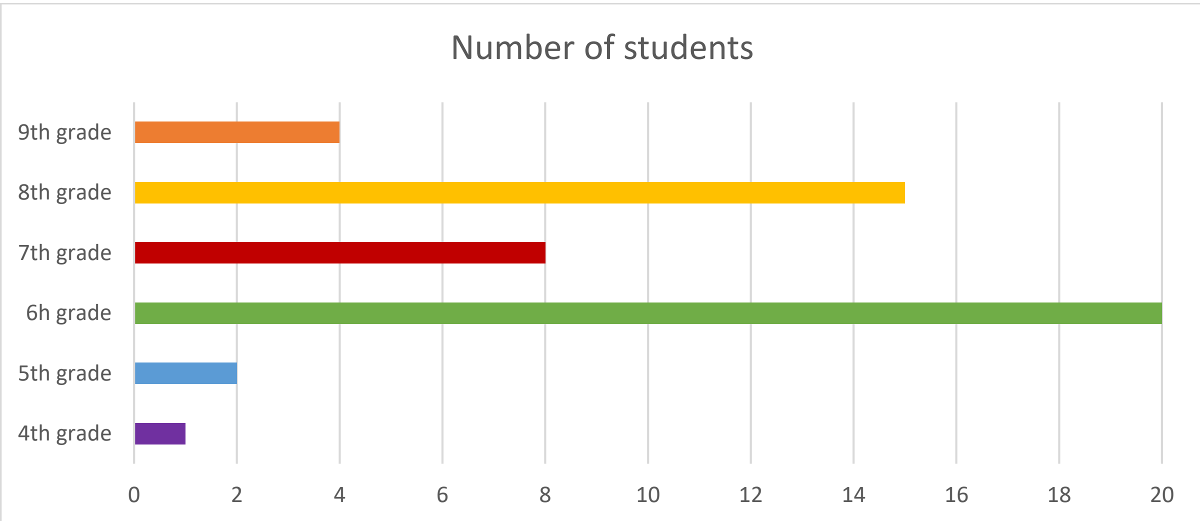


Figure 49 Number of students by grade

One external expert (N_E=1) was selected for the validation activities because of her expertise. She works as an executive director and conducts various programming workshops for primary school students.

RESULTS

Results of questionnaires for students

Students solved two questionnaires:

1. Preliminary questionnaire about digital device use and programming experience, and experience in programming, and
2. Follow-up questionnaire about satisfaction with the C4G learning methodology and the implementation of activities to acquire programming and coding skills.

In both questionnaires, students self-assessed their current level of programming skills. The results were later compared based on the students' codes.

The preliminary questionnaire was solved by 50 students (100%), while the follow-up questionnaire was solved by 43 students (86%). Self-assessment results were compared for students who solved both questionnaires - 43 students (86%).

S1 - Preliminary questionnaire

A total of 50 students solved the preliminary questionnaire about the use of digital devices and perceived level of programming. The average age of the students was 12.38 years (SD =1.260). Table 44 shows the number of students who solved S1 by gender and grade level. Slightly more girls (54%) responded to the questionnaire than boys (46%) (Figure 50).

Table 44 Number of students who solved S1 - Preliminary questionnaire by gender and grade

	4th grade	**5th grade**	**6th grade**	**7th grade**	**8th grade**	**9th grade**	**Total**
Boys	1	0	5	2	12	3	23
Girls	0	2	15	6	3	1	27
Total	**1**	**2**	**20**	**8**	**15**	**4**	**50**
Response rate	100%	100%	100%	100%	100%	100%	100%

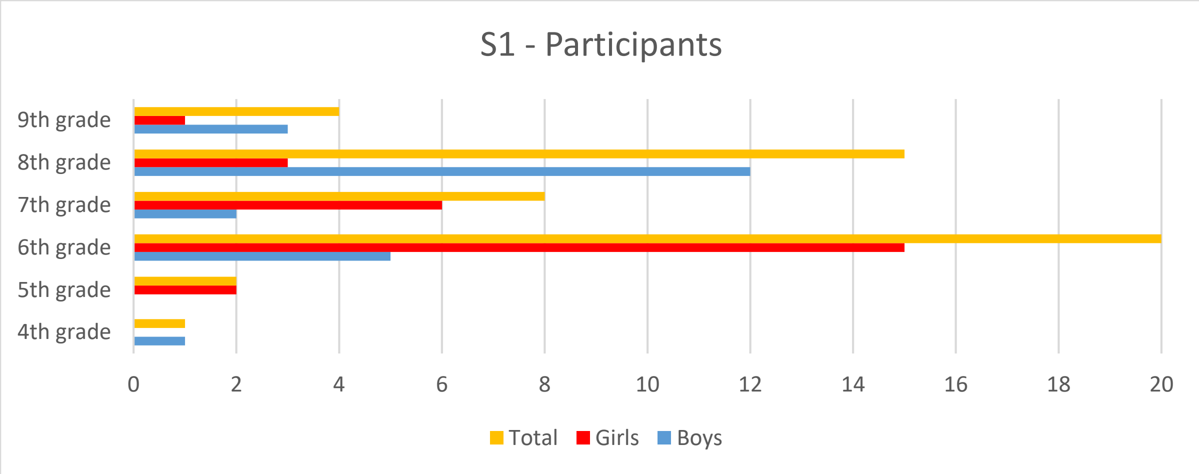


Figure 50 Distribution of students who solved S1 - Preliminary questionnaire by gender and grade

Table 45 shows the descriptive statistical analysis of the participants' responses to the questions related to the use of digital devices, internet and video games.

The standard deviation shows large deviations from the mean for some questions. Comparison of the overall mean scores by gender (Figure 51) shows that girls and boys have been using digital devices for about the same length of time, similarly is with the average hours spent using digital devices and the Internet per week. There is a slightly bigger difference when it comes to playing video games, as boys spend an average of 13 hours per week playing video games, while girls spend only 3 hours.

Table 45 The use of digital devices, the internet and video-games by gender

Question		**N**	**Min**	**Max**	**Mean**	**SD**
1. For how long have you been using computers, tablets or other digital devices (in years)?	Boys	23	1	9	5.91	2.31
	Girls	27	1	10	5.33	2.85
	Total	**50**	**1**	**10**	**5.60**	**2.61**
2. How many hours per week do you use a computer, tablet or other digital device?	Boys	23	0.5	84	19.89	23.6
	Girls	27	2	105	18.17	21.67
	Total	**50**	**0.5**	**105**	**18.96**	**22.36**
3. How many hours per week do you use the Internet?	Boys	23	0	84	18.08	24.38
	Girls	27	0	105	13.65	22.48
	Total	**50**	**0**	**105**	**15.69**	**23.24**
4. How many hours per week do you play video games?	Boys	23	0	84	13.09	19.58
	Girls	27	0	21	3.07	4.94
	Total	**50**	**0**	**84**	**7.68**	**14.51**

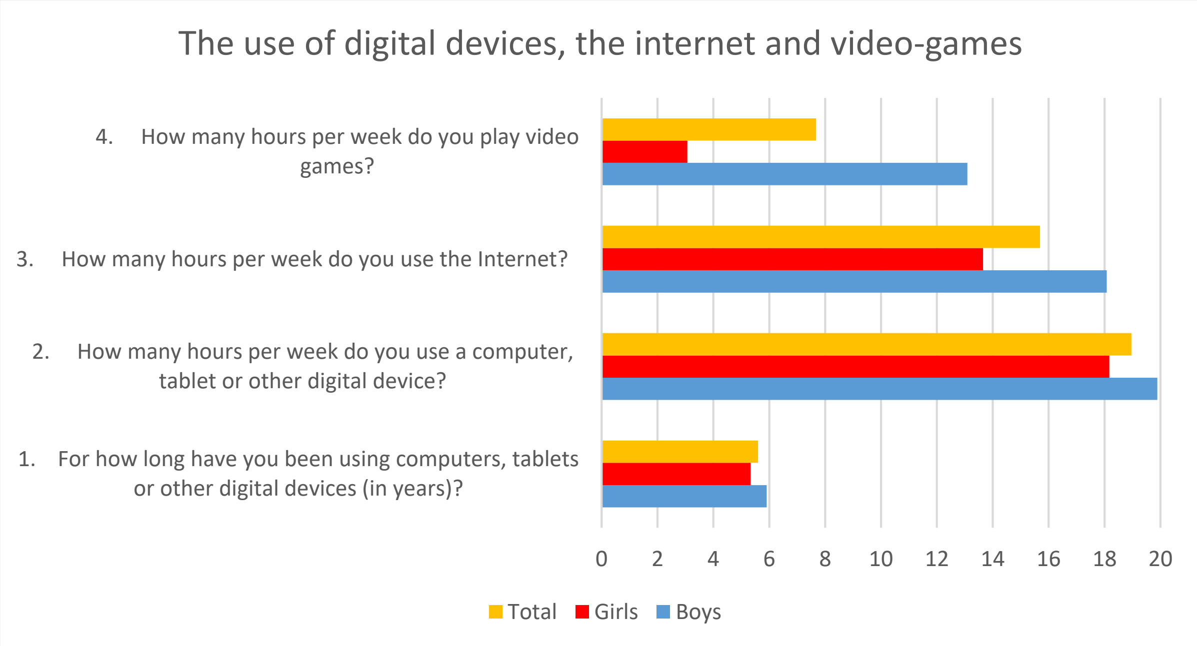


Figure 51 The use of digital devices, the internet and video-games – comparison by gender

Comparing the results by gender (Table 46), we can see that students in the upper grades (7th to 9th grade) have been using digital devices for more years, which is to be expected. When asked about the number of hours per week spent using digital devices and the Internet, we see a large variation in the standard deviation, which is due to the fact that some students answered with high values (84 hours per week by boys and 105 by girls, as can be seen in Table 45). It is also interesting to note that 8th graders spend fewer hours behind digital devices than 7th graders and most 9th graders, as expected. The standard deviation is also high for playing video games, which is also due to the high value entered by boys - 84 hours per week (Table 45).

Table 46 The use of digital devices, the internet and video-games by grade and gender

Question		**4th grade**	**5th grade**	**6th grade**	**7th grade**	**8th grade**	**9th grade**
1. For how long have you been using computers. tablets or other digital devices (in years)?	Boys	5.00	0.00	5.2	6.0	6.17	6.33
	Girls	0.00	2.75	5.00	6.25	6.67	6.00
	Total	**5.00**	**2.75**	**5.05**	**6.19**	**6.27**	**6.25**
2. How many hours per week do you use a computer. tablet or other digital device?	Boys	9.00	0.00	8.20	11.0	23.5	34.50
	Girls	0.00	2.25	21.80	8.17	23.33	40.00
	Total	**9.00**	**2.25**	**18.40**	**8.88**	**23.47**	**35.88**
3. How many hours per week do you use the Internet?	Boys	4.00	0.00	2.68	2.5	24.28	34.00
	Girls	0.00	0.75	14.17	7.42	23.33	40.00

	Total	**4.00**	**0.75**	**11.30**	**6.19**	**24.09**	**35.50**
4. How many hours per week do you play video games?	Boys	5.00	0.00	8.0	3.50	15.67	20.33
	Girls	0.00	1.25	2.43	2.27	10.33	0.00
	Total	**5.00**	**1.25**	**3.83**	**2.50**	**14.60**	**15.25**

The participants (N=50, 27 girls and 23 boys) answered a question about their programming skills, choosing the appropriate statement on a 5-point scale. The results are presented in Table 47. For both girls (37.04%) and boys (43.48%), the most common response was 2 - I can code simple programs, and none of the respondents rated their knowledge with the highest score.

Table 47 Self-assessment of programming skills by gender

Level of programming skills	**Boys**	**Girls**	**Total**
0 - I have never coded or programmed before	13.04%	29.63%	22.00%
1 - I am a novice programmer (just have basic ideas)	30.43%	25.93%	28.00%
2 - I can code simple programs	43.48%	37.04%	40.00%
3 - I am fluent in programming (can create a full program)	13.04%	7.41%	10.00%
4 - I can design a solution of a problem in the form of a program	0.00%	0.00%	0.00%

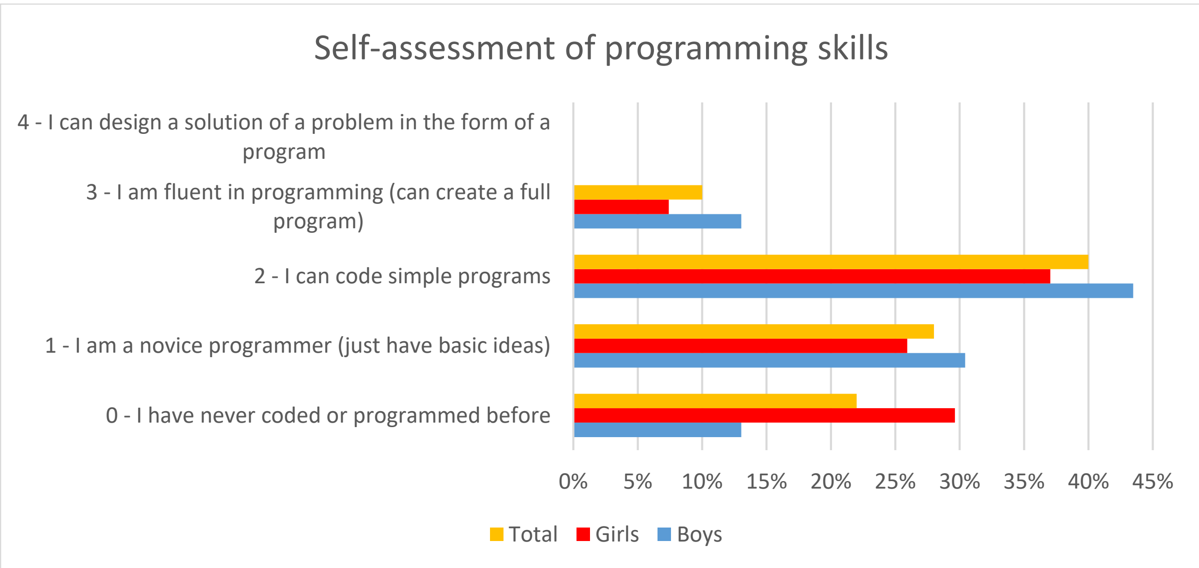


Figure 52 Self-assessment of programming skills – comparison by gender

The analysis by grades (*Table 48*) shows that the largest number of students who have never coded (level 0) is from 5th grade and not 4th, but it is worth highlighting that there were only 3 students in both grades combined. It is also interesting to note that 7th graders rated themselves the highest on the scale (level 3, as there were no responses at level 4).

Table 48 Self-assessment of programming skills by grade and gender

Level of programming skills		4th grade	5th grade	6th grade	7th grade	8th grade	9th grade
0 - I have never coded or programmed before	Boys	0.00%	0.00%	0.00%	0.00%	25.00%	0.00%
	Girls	0.00%	50.00%	26.67%	33.33%	33.33%	0.00%
	Total	**0.00%**	**50.00%**	**20.00%**	**25.00%**	**26.67%**	**0.00%**
1 - I am a novice programmer (just have basic ideas)	Boys	0.00%	0.00%	40.00%	50.00%	33.33%	0.00%
	Girls	0.00%	50.00%	20.00%	16.67%	33.33%	100.00%
	Total	**0.00%**	**50.00%**	**25.00%**	**25.00%**	**33.33%**	**25.00%**
2 - I can code simple programs	Boys	100.00 %	0.00%	0.00%	50.00%	41.67%	100.00%
	Girls	0.00%	0.00%	53.33%	16.67%	33.33%	0.00%
	Total	**100.00 %**	**0.00%**	**40.00%**	**25.00%**	**40.00%**	**75.00%**
3 - I am fluent in programming (can create a full program)	Boys	0.00%	0.00%	60.00%	0.00%	0.00%	0.00%
	Girls	0.00%	0.00%	0.00%	33.33%	0.00%	0,00%
	Total	**0.00%**	**0.00%**	**15.00%**	**25.00%**	**0,00%**	**0.00%**
4 - I can design a solution of a problem in the form of a program	Boys	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	Girls	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	Total	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**

The participants also stated which programming concepts they were familiar with. The results (Table 49) show that students are most familiar with *variables* (42.00%) and *loops* (38.00%) and least familiar with *parallelism* (4.00%). According to the results (Figure 53), there is not much difference in familiarity with programming concepts between genders except for the concept *conditionals* where 39.13% of boys stated that they are familiar with this concept while only 11.11% of girls stated the same.

Table 49 Familiarity with the programming concepts

Concept	Boys	Girls	Total
Loops	43.48%	33.33%	38.00%
Conditionals	39.13%	11.11%	24.00%
Variables	39.13%	44.44%	42.00%
Statements (sounds, movement, looks, drawing)	34.78%	29.63%	32.00%
Operators	17.39%	18.52%	18.00%

Events	39.13%	33.33%	36.00%
Parallelism	4.35%	3.70%	4.00%

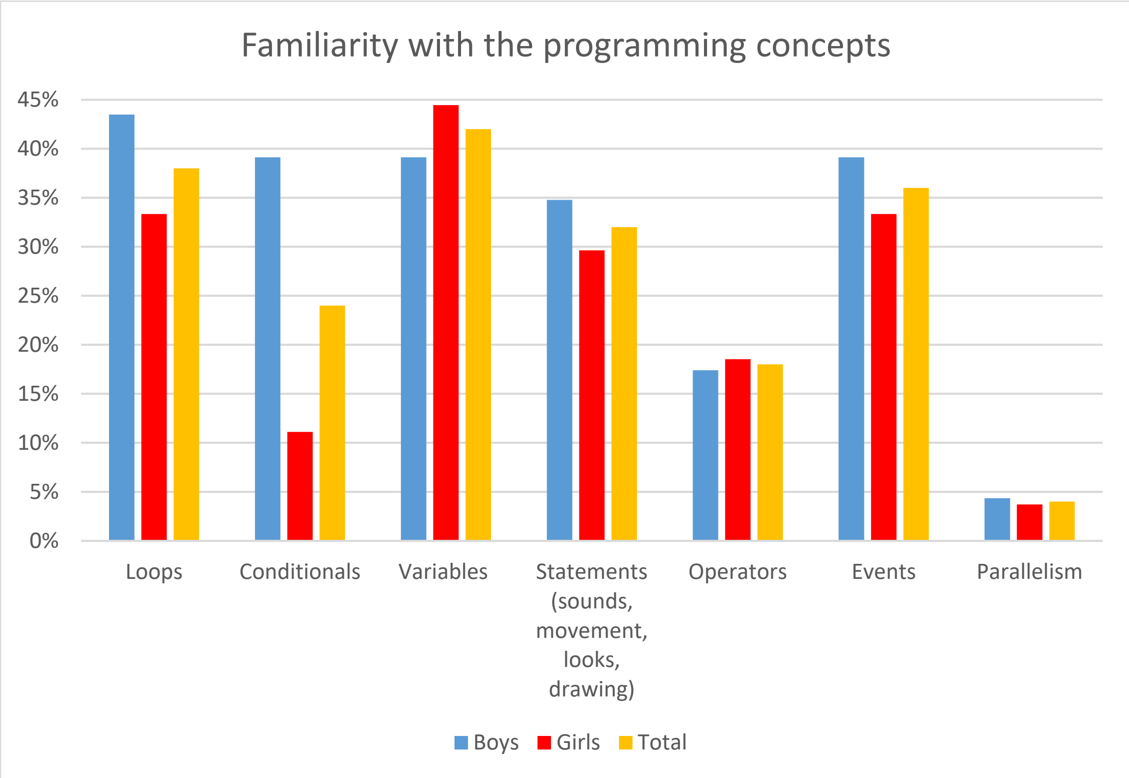


Figure 53 Familiarity with the programming concepts – comparison by gender

Comparison of the results (**Table 21**)[8] shows that 7th (50.00%), 8th (46.67%) and 9th (75%) graders are most familiar with *loops*, while 6th graders are most familiar with *variables* (50%).

Table 50 Familiarity with the programming concepts by grade and gender

Concept		4th grade	5th grade	6th grade	7th grade	8th grade	9th grade
Loops	Boys	100.00%	0.00%	0.00%	50.00%	41.7%	100.00%
	Girls	0.00%	50.00%	20.00%	50.00%	66.67%	0.00%
	Total	**100.00%**	**50.00%**	**15.00%**	**50.00%**	**46.67%**	**75.00%**
Conditionals	Boys	100.00%	0.00%	20.00%	0.00%	33.33%	100.00%
	Girls	0.00%	0.00%	0.00%	33.33%	33.33%	0.00%
	Total	**100.00%**	**0.00%**	**5.00%**	**25.00%**	**33.33%**	**75.00%**
Variables	Boys	100,00%	0.00%	60.00%	0.00%	33.33%	33.33%
	Girls	0.00%	0.00%	46.67%	33.33%	66.67%	100.00%
	Total	**100.00%**	**0.00%**	**50.00%**	**25.00%**	**40.00%**	**50.00%**

[8] For the same reason as in Table 48 we took into account only results from 6th to 9th grade.

Statements (sounds, movement, looks, drawing)	Boys	100.00%	0.00%	40.00%	0.00%	33.33%	33.33%
	Girls	0.00%	0.00%	26.67%	50.00%	33.33%	0.00%
	Total	**100.00%**	**0.00%**	**30.00%**	**37.50%**	**33.33%**	**25.00%**
Operators	Boys	0.00%	0.00%	60.00%	0.00%	8.33%	0.00%
	Girls	0.00%	0.00%	20.00%	16.67%	33.33%	0.00%
	Total	**0.00%**	**0.00%**	**30.00%**	**12.50%**	**13.33%**	**0.00%**
Events	Boys	100.00%	0.00%	80.00%	0.00%	33.33%	0.00%
	Girls	0.00%	0.00%	26.67%	50.00%	66.67%	0.00%
	Total	**100.00%**	**0.00%**	**40.00%**	**37.50%**	**40.00%**	**0.00%**
Parallelism	Boys	0.00%	0.00%	0.00%	0.00%	8.33%	0.00%
	Girls	0.00%	0.00%	6.67%	0.00%	0.00%	0.00%
	Total	**0.00%**	**0.00%**	**5.00%**	**0.00%**	**6.67%**	**0.00%**

The results show that 9th graders are most familiar with loops, conditionals and variables, 8th and 6th graders with events, 7th graders with statements and 6th graders with operators.

Table 51 shows participants' responses regarding their motivation for learning programming, where they had to select one or more answers. Most students enjoy solving logic problems and puzzles (44.00%). This was also the main motivating factor for girls (48.15%), while 39.13% of boys agreed. The main motivating factor for boys was that they want to follow a career in programming (43.48%), while only 14.81% of girls agreed with them.

Table 51 Motivation for learning programming

Response	**Boys**	**Girls**	**Total**
I'm not motivated	0.00%	3.70%	2.00%
I want to succeed in the programming class	34.78%	33.33%	34.00%
I want to show other students I can program	13.04%	3.70%	8.00%
I want to follow a career in programming	43.48%	14.81%	28.00%
I enjoy solving logic problems and puzzles	39.13%	48.15%	44.00%

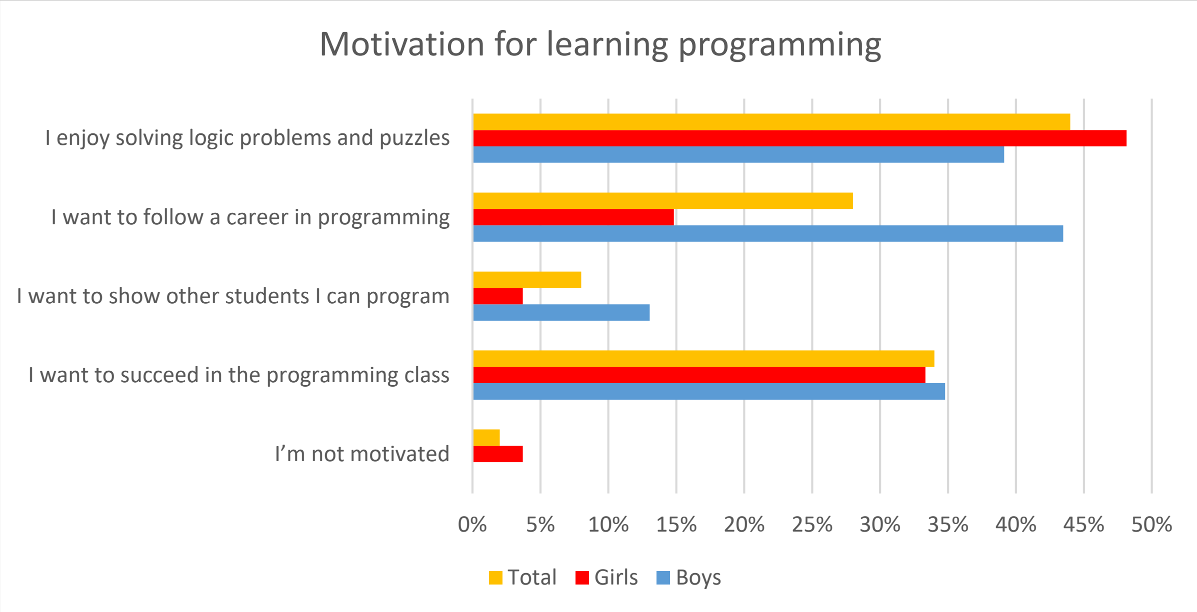


Figure 54 Motivation for learning programming – Comparison by gender

Comparison by grade (Table 52) show that 9th graders enjoy solving logic problems and puzzles the most, 8th graders want to follow a career in programming, while 6th and 7th graders want to succeed in programming class and also enjoy solving logic problems and puzzles.

Table 52 Motivation for learning programming by grade and gender

Statement		**4th grade**	**5th grade**	**6th grade**	**7th grade**	**8th grade**	**9th grade**
I'm not motivated	Boys	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	Girls	0.00%	0.00%	0.00%	16.67%	0.00%	0.00%
	Total	**0.00%**	**0.00%**	**0.00%**	**12.50%**	**0.00%**	**0.00%**
I want to succeed in the programming class	Boys	0.00%	0.00%	40.00%	100,00%	33.33%	0.00%
	Girls	0.00%	50.00%	40.00%	33.33%	0.00%	0.00%
	Total	**0.00%**	**50.00%**	**40.00%**	**50.00%**	**26.67%**	**0.00%**
I want to show other students I can program	Boys	0.00%	0.00%	60.00%	0.00%	0.00%	0.00%
	Girls	0.00%	0.00%	0.00%	16.67%	0.00%	0.00%
	Total	**0.00%**	**0.00%**	**15.00%**	**12.50%**	**0.00%**	**0.00%**
I want to follow a career in programming	Boys	0.00%	0.00%	40.00%	0.00%	58.33%	33.33%
	Girls	0.00%	0.00%	6.67%	16.67%	66.67%	0.00%
	Total	**0.00%**	**0.00%**	**15.00%**	**12.50%**	**60.00%**	**25.00%**
I enjoy solving logic problems and puzzles	Boys	100.00%	0.00%	60.00%	0.00%	16.67%	100.00%
	Girls	0.00%	50.00%	46.67%	66.67%	33.33%	0.00%
	Total	**100.00%**	**50.00%**	**50.00%**	**50.00%**	**20.00%**	**75.00%**

Participants also had the opportunity to write what else motivates them to learn programming. They stated: "*I like programming because it is fun*", "*Programming relaxes me*", "*I want to design my own game*", "*I want to see if this profession is right for me*".

S2 – Follow-up questionnaire

A total of 43 students solved the follow-up questionnaire about satisfaction with programming and coding activities, satisfaction with the organization of the implementation, and perception on the acquired coding skills. The mean age of students was 12.49 years (SD=1.222). Table 53 shows the number of students who solved the S2 questionnaire by gender and grades. The number of girls and boys who solved the questionnaire is about the same in overall, but there are big differences by each grade, as can be seen in Table 53 and Figure 55.

Table 53 Number of students who solved S2 - Follow-up questionnaire by gender and grades

	5th grade	**6th grade**	**7th grade**	**8th grade**	**9th grade**	**Total**
Boys	0	4	2	12	3	21
Girls	1	14	5	2	0	22
Total	**1**	**18**	**7**	**14**	**3**	**43**
Response rate	50%	90%	86%	93%	75%	86%

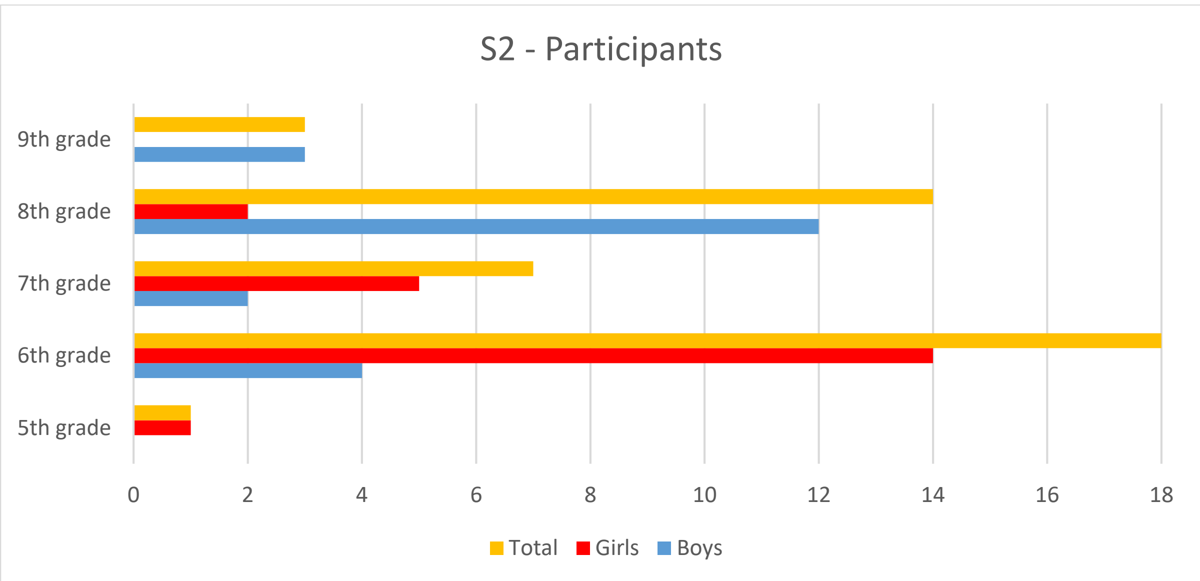


Figure 55 Distribution of students who solved S2 - Follow-up questionnaire by gender and grades

In the follow-up questionnaire, participants expressed their attitudes towards the C4G learning methodology and the implementation of the activities using the 5-point Likert scale (1 - strongly disagree, 2 - disagree, 3 - neutral, 4 - agree, 5 - strongly agree). According to the results (**Table 8**), both girls and boys enjoyed programming (mean response 4.58), felt engaged with this type of learning (4.35), and indicated that this type of learning was fun (4.30).

Table 54 Satisfaction with C4G learning methodology

Statement		1	2	3	4	5	AVG	SD
1. I found programming challenging.	Boys	9.52%	9.52%	19.05%	47.62%	14.29%	3.48	1.17
	Girls	4.55%	22.73%	13.64%	31.82%	27.27%	3.55	1.26
	Total	**6.98%**	**16.28%**	**16.28%**	**39.53%**	**20.93%**	**3.51**	**1.20**
2. I found programming motivating.	Boys	0.00%	0.00%	4.76%	61.90%	33.33%	4.29	0.56
	Girls	0.00%	0.00%	9.09%	72.73%	18.18%	4.09	0.53
	Total	**0.00%**	**0.00%**	**6.98%**	**67.44%**	**25.58%**	**4.19**	**0.55**
3. I found programming easy.	Boys	0.00%	9.52%	33.33%	47.62%	9.52%	3.57	0.81
	Girls	0.00%	9.52%	42.86%	38.10%	9.52%	3.48	0.80
	Total	**0.00%**	**9.52%**	**38.10%**	**42.86%**	**9.52%**	**3.52**	**0.80**
4. I enjoyed programming.	Boys	0.00%	0.00%	4.76%	28.57%	66.67%	4.62	0.59
	Girls	0.00%	0.00%	4.55%	36.36%	59.09%	4.55	0.60
	Total	**0.00%**	**0.00%**	**4.65%**	**32.56%**	**62.79%**	**4.58**	**0.59**
5. I understood most of programming concepts.	Boys	0.00%	4.76%	14.29%	33.33%	47.62%	4.24	0.89
	Girls	0.00%	0.00%	27.27%	40.91%	31.82%	4.05	0.79
	Total	**0.00%**	**2.33%**	**20.93%**	**37.21%**	**47.62%**	**4.14**	**0.60**
6. Learning this way is fun.	Boys	0.00%	4.76%	14.29%	33.33%	47.62%	4.24	0.60
	Girls	0.00%	0.00%	9.09%	45.45%	45.45%	4.36	0.66
	Total	**0.00%**	**2.33%**	**11.63%**	**39.53%**	**46.51%**	**4.30**	**0.62**
7. I felt engaged with this way of learning.	Boys	0.00%	0.00%	4.76%	52.38%	42.86%	4.38	0.59
	Girls	0.00%	0.00%	9.09%	50.00%	40.91%	4.32	0.65
	Total	**0.00%**	**0.00%**	**6.98%**	**51.16%**	**41.86%**	**4.35**	**0.61**
8. The activities were	Boys	0.00%	0.00%	14.29%	28.57%	57.14%	4.43	0.75
	Girls	0.00%	0.00%	18.18%	45.45%	36.36%	4.18	0.73

relevant to learn.	**Total**	**0.00%**	**0.00%**	**16.28%**	**37.21%**	**46.51%**	**4.30**	**0.74**
9. At any time, it was clear what I had to do.	Boys	0.00%	4.76%	33.33%	47.62%	14.29%	3.71	0.78
	Girls	0.00%	9.09%	40.91%	45.45%	4.55%	3.45	0.74
	Total	**0.00%**	**6.98%**	**37.21%**	**46.51%**	**9.30%**	**3.58**	**0.76**
10. What I learned will be relevant for my future.	Boys	0.00%	0.00%	9.52%	42.86%	47.62%	4.38	0.67
	Girls	0.00%	9.09%	22.73%	45.45%	22.73%	3.82	0.91
	Total	**0.00%**	**4.65%**	**16.28%**	**44.19%**	**34.88%**	**4.09**	**0.84**

Participants again self-assessed their programming skills on a scale from 0 - *I have never coded or programmed before* to 4 - *I can design a solution of a problem in the form of a program*. A total of 43 students (22 girls and 21 boys) completed the preliminary and the follow-up questionnaire so their self-assessment results were compared. Table 55 shows the difference on their initial and final level of programming skills. 75% of students reported that they had made progress, most of them (49%) for 1 level and 27% of them for 2 levels, while 26% of students remained at the same level. A comparison by gender shows that girls made more than boys (8% more girls have progressed for 1 level and 3% for 2 levels), while 15% more boys remained at the same level. None of the students indicated that they had regressed in their programming skills.

Table 55 - The difference between the self-assessed levels of programming skill

	Difference		
	0	**1**	**2**
Boys	33%	43%	24%
Girls	18%	55%	27%
Total	**26%**	**49%**	**26%**

A Wilcoxon's signed rank test for paired samples with Exact test showed that students self-assessed their programming skill significantly higher after the C4G activities compared to self-assessment before the C4G activities (Table 56).

The effect size is calculated with formula r=$\frac{Z}{\sqrt{n}}$, where Z is z- statistics obtained from Wilcoxon signed rank test (SPSS), n is number of observations. The results show large effect size overall and by gender.

Table 56 Comparison of self-assessment of programming skill

		Descriptive statistics					Wilcoxon's signed rank test results		
		N	MIN	MAX	MEAN	SD	Z	p	Effect size
Boys	S1	21	0	3	1.48	.873	-3,416	.000 (exact sig. 0,000)	-0,74543
	S2	21	1	4	2.38	.921			
Girls	S1	22	0	3	1.23	.922	-3,874	.000 (exact sig. 0,000)	-0,82594
	S2	22	1	4	2,32	.945			
Total	**S1**	**43**	**0**	**3**	**1.35**	**.897**	**-5.138**	.000 (exact sig. 0,000)	. -0.78354
	S2	**43**	**1**	**4**	**2.35**	**.923**			

Students' comments

Students in their comments stated that they liked this way of learning a lot and that it was really fun and interesting. They enjoyed in designing games and found gathered knowledge very useful. Learning by designing games was fun, interesting and "*much more fun than traditional learning*".

The students liked the methodology and most would not change anything. Some said it would be fun if they could choose a theme for the game by themselves.

Teachers' observations and comments

After the implementation, the teachers presented their observations and comments in a qualitative way through open-ended questions.

Teachers' observations

Using the T1 form teachers (NT=5) reported on students' participation and engagement and their learning difficulties during the implementation.

All teacher stated that students were actively involved in the activities. They were motivated for work, discuss, collaborate and help each other while participating in the activities. They had a lot of fun developing games. Some students which had some previous experience in programming were more independent and often did even more than excepted. They were all motivated to learn new functionalities to implement them in the game. They also enjoyed playing the finished games and participating in them.

Novice programmers with no previous experience needed more support in the beginning, but with some assistance and hints from teachers, they were able to quickly start programming and experimenting in the Snap environment. Other problems at the beginning were mostly due to not listening to the teacher and not reading the instructions on the worksheets. In both cases, they felt comfortable asking for support when they could not solve the situation with their colleagues or on their own.

Students were very interested and motivated to learn programming. They enjoyed programming their games. The first lessons (1-4) were not so interesting for the students who already knew Scratch, but later, when they started creating real games, they said it was awesome and really interesting.

Teachers' comments

Using the T2 form, teachers (N_T=5) reported on accomplishment of learning objectives, relevance and effectiveness of game-based learning, acceptance of the proposed methodology, achieved fun, and the overall organization of the implementation.

In a 5-day winter school students achieved all the objectives that were planned for course: Adding a new sprite, adding a costume to a sprite and edit it, Adding a new background and edit it, Moving a sprite, Making sprite say something, Using loop repeat, Changing sprite's costume, Adding sound, Using events, Using if sentence, Drawing, Changing background, Using variables, Random numbers, String concatenation Operators, Input, and Broadcast.

All teachers indicated that the working methods and materials were well prepared. It was found that the learning approach had a great influence on the motivation of the students and therefore on the competences achieved. As they were designing a game, they were able to consider the concepts in the appropriate context. They were motivated to improve the original game by adding functionalities that went beyond the expected skill level simply because they wanted to make their game better and have more fun playing it. Suddenly, relatively complex concepts were no longer difficult to understand, and that is the biggest benefit of this approach. Specific adaptations of teaching materials and working methods for girls also proved successful.

The students accepted and enjoyed working with the proposed methodology. They were very engaged, focused and motivated. They love playing games and this approach gave them the opportunity to design their own simple game. The relatively complex learning content of programming, which is often perceived as difficult and boring, was presented in a fun and meaningful way that the students enjoyed.

Students enjoyed active learning and collaborating with their peers and had fun. Most importantly, even though they had fun, they achieved great results and learned many new concepts.

The organization of the implementation was carefully prepared. The complexity of the learning content and programming tasks in the course gradually increases so that students can effectively progress in the learning process. The games they program become more and more interesting and present a real challenge for students who spend most of their time in the zone of proximal development.

Teachers' and students' comments on the appropriateness of prepared learning materials for girls

At our multiplier event we asked teachers (N_{Tme}=9) and students (N_{Sme}=4) about the appropriateness of the prepared scenarios for girls. All agreed that the topics of the prepared activities in Snap! were appropriate and motivating for girls.

Experts' comments

External validator - expert (N_E=1) was also asked to give her qualitative opinion regarding the accomplishment of learning objectives, relevance and effectiveness of game-based learning, acceptance of the proposed methodology, achieved fun, and the overall organization of the implementation.

External expert stated that the implementation offered involving exercises and was well accepted by the students. Students have learned the basic programming concepts in a fun way with teachers who were positive and made a great connection with the group. Majority of the teachers were women (as well as students were all girls in this course) which is very important for girls, so they could identify with them as their role-models.

External expert noted that the implementation involved exercises and was well accepted by the students. Students learned basic programming concepts in a fun way with teachers who were positive and connected well with the group. The majority of the teachers were women (as the students in this course were all girls), which is very important for girls to identify with as role models.

Her estimation is that the students very well accepted the proposed methodology, perhaps even more so the youngest among them. Some of the games they designed could have been less appealing for the oldest students. She would recommend diversifying the learning materials for students older than 13 and creating other stories/scenarios for them where there is less talk about designing games and more focus on solving a problem.

The students definitely enjoyed learning the programming concepts. They were very often motivated to understand and learn the concepts so they could solve/program the solutions of the activities. The learning materials are well designed and excellently presented to the participating students.

The design thinking educational framework is probably the best approach in different learning situations, especially when you have the opportunity to teach in a learning-by-doing situation. Using the design thinking approach, important social/cultural/environmental issues and problems can be observed, discussed and reflected upon in terms of the impact of the solutions created on their users and society.

This C4G program is a well needed for two reasons: it targets girls who are not typically encouraged in their socialization to use and explore technology creatively; learning scenarios that call for solutions to a problem or people or animals in need of help. In this way, they could be further developed and linked to different subjects and topics from the technical or social sciences.

DISCUSSION AND CONCLUSIONS

The results of the preliminary questionnaire (S1) show that girls and boys use digital devices and the Internet a few hours a day and have experience in them between 5 and 6 years. A greater difference between the genders is shown when it comes to playing video games, where boys play 2 hours per day while girls only one hour. High values in the use of digital devices and internet can also be attributed to the pandemic, as responses after the pandemic are 60% higher in digital device use, 45% higher in internet use, and 43% higher in playing video games than before. Due to the lower interest of girls in video games, it is even more important that we motivate them well to play and also to design games, which we definitely achieved with the C4G approach.

The results show that almost all students are motivated to learn programming, which is expected of our participants since they all participated in testing in their free time. The girls are most motivated by solving logic problems and puzzles, while the biggest motivating factor for the boys is the desire to make a career in programming. This answer showed the largest gender gap, which is in line with the picture in the world, as only a small percentage of women are employed in the field of computer science. Therefore, such an approach is recommended to get girls interested in programming and show them that they too can be successful in the field of computer science.

In the preliminary questionnaire, most students rated their programming skills as level 1 (they are novice programmers) and level 2 (they can code simple programs). None of the participants rated their knowledge at the maximum level 4 (they can design a solution of a problem in the form of a program). The answers are also consistent with the results related to knowledge of programming concepts, where all concepts were rated quite low (most students know variables - 42%, followed by loops - 38%, statements - 33%, etc.).

The teachers and an external expert also gave their opinion on the implementation. All of them agreed that the students learned a lot, were very motivated in their learning and had a lot of fun. At the online (multiplier) event we also showed the prepared activities to a wide audience of teachers and students all over Slovenia, who were enthusiastic about the activities and will be happy to use them in their lessons.

Comparisons between students' responses regarding their knowledge of programming skills before and after implementation also show that almost half of the students (49%) progressed by one level, while just over a quarter (26%) progressed by two levels or stayed at the same level, and no one regressed.

Similar to the teachers and external expert, the approach was also very well received by the students. During the implementation there was a sense of collaboration, interest and motivation among the students to design games, many students also added their own ideas and were happy to help their classmates.

The C4G methodology has proved very useful and is well received by students aged 10 to 16. Of course, the methodology still leaves room for improvement, such as more challenging tasks for more able students, adding activities and bringing the tasks even closer to real-life problems.

ANNEXES

S1. PRELIMINARY QUESTIONNAIRE FOR STUDENTS (in Slovenian)

S1. VPRAŠALNIK ZA UČENCE pred izvajanjem tečaja

To je začetni vprašalnik o uporabi digitalnih naprav in izkušnjami iz programiranja. Raziskava je izvedena v okviru projekta CODING4GIRLS, katerega namen je uporabiti pristop učenja z igrami za spodbujanje razvoja veščin programiranja pri učencih.
Tvoji odgovori bodo **anonimni** in bodo uporabljeni le v raziskovalne namene. Hvala za tvoj čas in sodelovanje!
Najprej **napiši kodo**, ki si jo prejel od učitelja!

KODA IN SPLOŠNE INFORMACIJE

Koda: ______________ Šola: ______________
Starost: ______________ Razred: ______________
Spol: M Ž

UPORABA DIGITALNIH NAPRAV, INTERNETA IN VIDEO IGER

22. Koliko let že uporabljaš računalnik, tablico ali druge digitalne naprave?	_________ let
23. Koliko ur na teden uporabljaš računalnik, tablico ali druge digitalne naprave?	_________ ur
24. Koliko ur na teden uporabljaš internet?	_________ ur
25. Koliko ur na teden igraš video igre?	_________ ur

IZKUŠNJE V PISANJU KODE IN PROGRAMIRANJU

26. Kakšen je tvoj nivo znanja iz programiranja? *Obkroži najbolj primeren odgovor.*
    - ee) Nikoli še nisem pisal/a kode oz. programiral/a
    - ff) Sem novinec/ka pri programiranju (imam le osnovne ideje)
    - gg) Napisati znam preproste programe
    - hh) Napisati znam zahtevnejše programe (znam napisati celoten program)
    - ii) Znam oblikovati rešitev in jo zapisati v obliki programa

27. Če si se že srečal/a s programiranjem, kateri od spodnjih konceptov so ti poznani? *Obkrožiš lahko več odgovorov.*

☐ Zanke (Loops) ☐ Spremenljivke (Variables) ☐ Dogodki (Events)
☐ Pogojni stavki (Conditionals) ☐ Operatorji (Operators) ☐ Vzporednost (Parallelism)
☐ Ukazi za zvok, premikanje, izgled, risanje (Statements - sounds, movement, looks, drawing)

28. Kaj te motivira za učenje programiranja? *Obkrožiš lahko ve odgovorov.*

- ☐ Nisem motiviran/a
- ☐ Želim uspeti pri pouku programiranja
- ☐ Drugim učencem želim pokazati, da znam programirati
- ☐ Želim si nadaljevati poklicno pot na področju programiranja
- ☐ Uživam v reševanju logičnih problemov in ugank
- ☐ Drugo ______________________________

S2. FOLLOW-UP QUESTIONNAIRE FOR STUDENTS (in Slovenian)

S2. VPRAŠALNIK ZA UČENCE po končanem tečaju

To je vprašalnik o zadovoljstvu s C4G učno metodologijo in izvajanjem aktivnosti za pridobivanje veščin programiranja in kodiranja.
Tvoji odgovori so **anonimni** in bodo uporabljeni le v raziskovalne namene. Hvala za tvoj čas in sodelovanje!
Spodaj napiši **kodo**, ki si jo prejel/a od učitelja (to je ista koda, kot si jo dobil/a na začetku).

KODA IN SPLOŠNE INFORMACIJE

Koda: ______________ Šola: ______________
Starost: ______________ Razred: ______________
Spol: M Ž

C4G UČNA METODOLOGIJA

1. Označi stopnjo strinjanja za vsako izmed spodnjih trditev:	*Sploh se ne strinjam*	*Ne strinjam se*	*Niti se strinjam, niti se ne strinjam*	*Strinjam se*	*Popolnoma se strinjam*
u) Programiranje mi predstavlja izziv.	1	2	3	4	5
v) Programiranje me motivira.	1	2	3	4	5
w) Programiranje se mi zdi enostavno.	1	2	3	4	5
x) Užival/a sem v programiranju.	1	2	3	4	5
y) Razumel/a sem večino konceptov programiranja.	1	2	3	4	5
z) Učenje na takšen način je zabavno.	1	2	3	4	5
aa) Takšen način učenja me je pritegnil.	1	2	3	4	5
bb) Naloge so bile uporabne.	1	2	3	4	5
cc) Vedno sem vedel/a, kaj moram narediti.	1	2	3	4	5
dd) Pridobljeno znanje je pomembno za mojo prihodnost.	1	2	3	4	5

NIVO ZNANJA IZ PROGRAMIRANJA

2. Kakšen je sedaj tvoj nivo znanja iz programiranja? *Obkroži najustreznejši odgovor.*
   jj) Nikoli še nisem pisal/a kode oz. programiral/a
   kk) Sem novinec pri programiranju (imam le osnovne ideje)
   ll) Napisati znam preproste programe
   mm) Napisati znam zahtevnejše programe (znam napisati celoten program)
   nn) Znam oblikovati rešitev in jo zapisati v obliki programa

S3. STUDENT'S COMMENTS (in Slovenian)

S3. KOMENTARJI UČENCEV

Prosimo učitelje, da po izvedbi učnih aktivnosti za usvajanje programerskih veščin, ki temelji na metodi učenja z izdelavo iger in smo ga razvili v okviru projekta Coding for Girls (C4G), od učencev s skupinskim intervjujem pridobite njihova mnenja in komentarje.
Učence povprašajte o vidikih, ki so navedeni spodaj, in jih vnesite v obrazec.
Hvala za vaš čas in sodelovanje!

SPLOŠNE INFORMACIJE

Učitelj: ______________________ Razred: _______________
Šola: ______________________ Datum: _______________

SPLOŠNA ORGANIZACIJA IN DOJEMANJE UČENCEV

Učence lahko vprašate o celotni izvedbi dela predmeta, njihovem dojemanju pridobljenega znanja, učinkovitosti učenja z igrami, zabavnosti ipd.

Primer:
Kaj si se naučil/a?
Kakšno se ti je zdelo učenje z izdelavo iger?
Ali je bilo izdelovanje iger zabavno?

UČNE TEŽAVE

Učence vprašajte o i učnih ali drugih težavah, s katerimi so se srečevali med izvedbo, in o tem, kaj so storili, ko so naleteli na težave.

Primer:
Ali si imel/a težave pri izdelovanju iger?
Kaj si naredil/a,če si imel/a težave?

PREDLOGI UČENCEV KAKO IZBOLJŠATI C4G METODOLOGIJO, ORODJE IN VSEBINO

Primer:
Imaš kakšen predlog, kako bi izboljšal/a takšen način učenja (z igrami)?
Kaj bi dodal/a, kaj bi spremenil/a?

KARKOLI DRUGEGA, KAR SE JIM ZDI POMEMBNO

Primer:
Bi dodal/a kakšno drugo tematiko za igre?
Imaš kakšne druge predloge glede izvedbe take oblike učenja?

T1. TEACHER'S OBSERVATIONS (in Slovenian)

T1. UČITELJEVA OPAŽANJA IN UGOTOVITVE	
Med izvedbo učnih ur ste učitelji opazovali in dokumentirali odzive ter napredek učencev pri pridobivanju programerskih veščin z uporabo "C4G pristopa učenja z izdelavo iger". Prosimo vas, da navedete svoja opažanja glede spodaj navedenih vidikov. Hvala za vaš čas in sodelovanje!	
SPLOŠNE INFORMACIJE	
Učitelj/ica: ____________________ Šola: ____________________	Razred: ________________ Datum (od-do): ________________
SODELOVANJE IN VKLJUČENOST UČENCEV	
So bili učenci med učno uro aktivni? So sodelovali z učiteljem in med sabo? So se zabavali? Ipd.	
UČNE TEŽAVE	
Imajo učenci težave pri učenju in / ali z uporabljeno tehnologijo? Ali so vas prosili za pomoč? Ipd.	
DRUGA OPAŽANJA, KI SE VAM ZDIJO POMEMBNA	

T2. TEACHER'S COMMENTS (in Slovenian)

T2. UČITELJEVI KOMENTARJI
Po izvedbi učnih ur na osnovi »C4G pristopa za usvajenje programerskih veščin« zbiramo mnenja in komentarje učiteljev. Prosimo, da izpolnete vprašalnik in podate svoje mnenje o spodaj navedenih vidikih. Hvala za vaš čas in sodelovanje!
SPLOŠNE INFORMACIJE
Učitelj/ica: ______________________ Razred: ___________ Šola: ______________________ Datum: ___________
DOSEGANJE UČNIH CILJEV S STRANI UČENCEV
USTREZNOST IN UČINKOVITOST UČENJA Z UPORABO IGER ZA GRADNJO VEŠČIN PROGRAMIRANJA IN SPRECIFIČNEGA CODING4GIRLS UČNEGA PRISTOPA
SPREJEMANJE PREDLAGANE METODE UČENJA S STRANI UČENCEV
DOSEŽENA STOPNJA ZABAVNOSTI PRI UČENCIH

VAŠE MNENJE O IZVEDBI UČNIH UR
UPORANOST IN SPREJEMANJE PRISTOPA UČENJA S SNOVANJEM IZOBRAŽEVALNIH IGER (povezano s CODING4GIRLS pristopom učenja z izobraževalnimi igrami, snovalskim mišljenjem)
DRUGO

E. EXPERT'S COMMENTS (in Slovenian)

E. KOMENTARJI STROKOVNJAKA
Po izvedbi učnih ur na osnovi »C4G pristopa za usvajenje programerskih veščin« zbiramo mnenja in komentarje izkušenih učiteljev in strokovnjakov oz. raziskovalcev s področja didaktike. Prosimo, da izpolnete vprašalnik in podate svoje mnenje o spodaj navedenih vidikih. Hvala za vaš čas in sodelovanje!
SPLOŠNE INFORMACIJE
Ime in priimek: ______________________ Položaj: ___________ Datum: ___________ Ustanova: ______________________
DOSEGANJE UČNIH CILJEV S STRANI UČENCEV
USTREZNOST IN UČINKOVITOST UČENJA Z UPORABO IGER ZA GRADNJO VEŠČIN PROGRAMIRANJA IN SPRECIFIČNEGA CODING4GIRLS UČNEGA PRISTOPA
SPREJEMANJE PREDLAGANE METODE UČENJA S STRANI UČENCEV
DOSEŽENA STOPNJA ZABAVNOSTI PRI UČENCIH

VAŠE MNENJE O IZVEDBI UČNIH UR
UPORANOST IN SPREJEMANJE PRISTOPA UČENJA S SNOVANJEM IZOBRAŽEVALNIH IGER (povezano s CODING4GIRLS pristopom učenja z izobraževalnimi igrami, snovalskim mišljenjem)
DRUGO

NATIONAL REPORT: TURKEY

TABLE OF CONTENTS

EXECUTIVE SUMMARY

In this publication, the results of the validation test in Turkey presented. Governorship of Istanbul has implemented the validation test for the proposed learning framework through the design and development of awareness raising serious games in Turkey with the participation of students and teachers.

The validation procedures of the Coding4Girls approach were implemented in Turkey between June and November 2020. Since the schools were closed due to the pandemic, the implementation of the testing was done online for both students and teachers.

The teachers from 14 schools (Primary, secondary and vocational) were invited to the testing activity and 72 girls from the 9th grade (aged 13-15) of Hasbahçe Religious High School had participated to the online testing activities in Turkey. All implementation activities were based on the selected C4G learning scenarios and instructions for students and assumed independent work of students under the guidance of their teachers in virtual classrooms.

Using developed data collection tools annexed in this publication, teachers' and students' attitudes, observations and comments regarding the game-based C4G methodology for building programming skills were collected.

Results showed that students liked the game-based C4G methodology. Conducted activities enabled them to develop their programming skills in a fun and creative way. Although the participating students did not possess the skills related to coding and programming, their motivation towards coding skills are enhanced after the activity. Teachers who participated to the validation activities consider the C4G approach as suitable and efficient way of acquiring programming skills that is applicable and appropriate for the students.

IMPLEMENTATION

Data collection tools

During the validation of Coding4Girls (C4G) approach, all the data collection tools provided in the C4G validation strategy were used:

- S1 – Preliminary questionnaire (for students)
- S2 – Follow-up questionnaire (for students)
- S3 – Student's comments
- T1 – Teacher's observations
- T2 – Teacher's comments

The data collection tools were before validation activities translated into the Turkish language.

Questionnaires S1 and S2 were created using Google Forms while data collection tools S3, T1 and T2 for teachers were prepared as Google Forms in which they could write observations and comments.

Materials

The experts form the Governorship of Istanbul used the 3D game environment developed within the framework of the C4G project and the learning scenarios for students. For the validation event with teachers, the experts used the learning scenarios with instructions. Since the event was done in online environment, the participants were informed to install the 3D game before the event.

The second learning activity which is "Discover Snap! Move a sprite -Time to bring your sprite to life" was chosen for the teachers. The activity contains basic programming concepts that are in the focus of the C4G approach such as dialogs and movement. These learning scenarios enable users to learn one or multiple programming concepts by creating a game that addresses real-world problem. To further motivate girls to learn programming, the topics of real-world problems are chosen to be attractive to girls. All resourced were translated into the Turkish language prior to implementation.

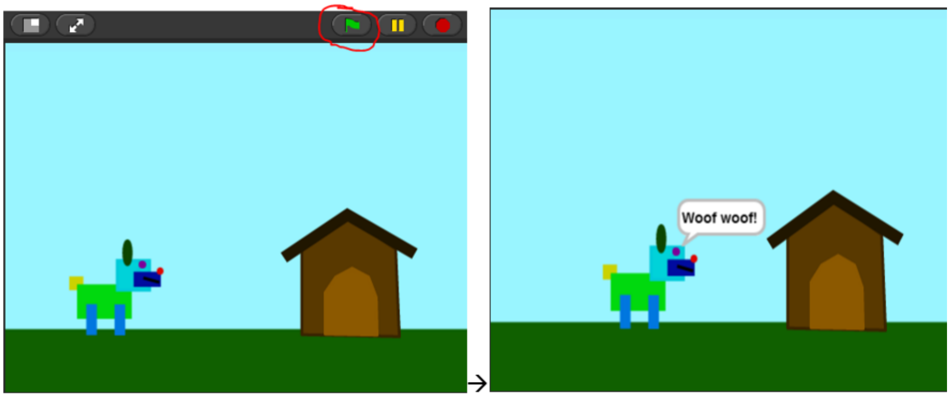


Figure 1 – "Discover Snap!: Moving a Spirite" learning activity."

As for the activity with the students, the following two games were introduced to the students;

1. Game

Mini Game Category

-Looks

Mini Game

-Snake Game

2. Game

Mini Game Category

-Trigonometry

Mini Game

-Pattern Matching Game

Operation family

-Basic Operations

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

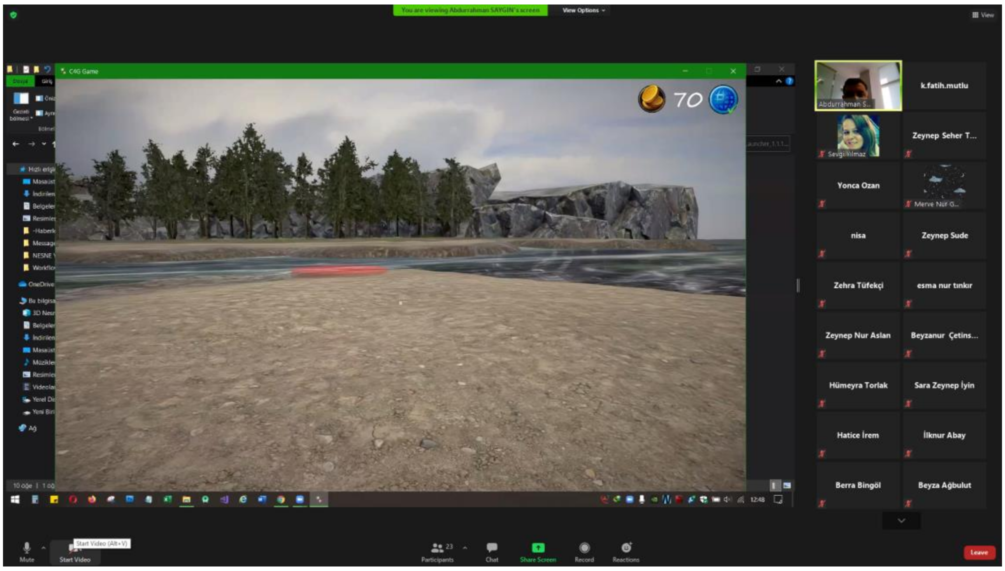


Figure 2 – "Basic Calculation in Trigonometry" activity.

Setup model and procedure

The validation events were implemented under the shadow of COVID-19 pandemic. Therefore, all activities were online. The first step for the event with teacher was to inform them about the project and its results. The participants were provided with the 3D games and learning scenarios before the actual event starts. In total, 14 IT and Computer teachers from secondary and high school levels were invited. The experts from Governorship of Istanbul presented the project, learning scenarios and the 3D games briefly to the participants and the second learning scenario was implemented online with the teachers. After the activity, the formal feedbacks from the teachers were gathered online.

Sessions for building programming skills using the C4G approach were organized online with the participation of 72 high school students from the 9th grade (aged between 13-15) due to COVID-19 pandemic. Although the subject is compulsory at the high schools, it is not thought during the online education. The students were provided with the link of the 3D games and the S1 test before the event. They were divide into 3 classes and the activity took 2 hours on Zoom. The experts form GOI first organized sessions in order to introduce coding concepts. Students could practice those concepts using exercises and then they were expected to create a serious game using the learnt coding concepts. During the sessions, experts provided guidance and help to the students with the given tasks. After the implementation, in the last session, students answered the follow-up questionnaire (S2) about their perception and views on the C4G learning approach. They were required to write the anonymised code received from the teacher to ensure comparison of results regarding the self-assessment of their programming skill. The experts and teachers from the school collected students' qualitative opinions and comments through a group discussion in virtual classrooms (S3).

Participants

The validation event for students took place online with the female students from Hasbahçe Religious School. All 72 students were from the 9th grade whose ages varies between 13 and 15. Their previous experiences with coding and programing is very low however they have the basic skills on the use of computer and basic software such as Ms Windows and Office. The 14 teachers selected for the validation are Computer teachers with at least 10 years of experience in teaching informatics. Although they have all necessary skills in teaching coding and programming, they do not teach coding at the schools since it is not in their curriculum at schools.

Years of age	Grade	Number of students
13	9	10
14	9	55
15	9	7
Total		**72**

Table 1 - Number of students by age/grade

RESULTS

Results of questionnaires for students

Two questionnaires for students were used: preliminary questionnaire about the use of digital devices and perceived level of programming and the follow-up questionnaire about satisfaction with programming and coding activities, satisfaction with the organization of the implementation, and perception on the acquired coding skills.

In both questionnaires students were asked to self-assess their current level of programming skills. Based on this question, the difference between students' self-assessed initial and final level of programming skill was calculated (the answers from the questionnaires were paired based on the code that students have entered).

All students who participated in C4G activities solved preliminary questionnaire and the follow-up questionnaire.

S1 - Preliminary questionnaire

A total of 72 students solved the preliminary questionnaire about the use of digital devices and perceived level of programming. The mean age of students was 13.94 years. Table 3 shows descriptive statistical analysis of participants' responses to the questions related to the use of digital devices, the internet and video-games. Since the formal face-to-face education is transformed to online education due to Covid-19 pandemic, the use of computer, tablet and other digital devices is probably higher than its value before the pandemic. The use of internet is more than 4 hours among the participants. This can also be based to the online education. The results also show that the average age for girls to start using digital devices is 9 and their average playtime with digital games is around an hour per day.

Question	Averages
1. For how long have you been using computers, tablets or other digital devices (in years)?	4,89 years
2. How many hours per week do you use a computer, tablet or other digital device?	30,13 hours

3. How many hours per week do you use the Internet?	29,73 hours
4. How many hours per week do you play video games?	6,47 hours

Table 2 - The use of digital devices, the internet and video-games by gender

The participants self-assessed the level of their programming skills on the scale from *0 - I have never coded or programmed before* to *4 - I can design a solution of a problem in the form of a program*. Results are shown in the Table 3. Most of the students stated for themselves that they are at level *0 - Never coded or programmed before* (76.39%) or on level *1 – Novice Programmer* (9.72%). The percentage of 3- Simple Programmer is 13,89%.

Level of programming skills	Frequency	Percentage
0 - I have never coded or programmed before	55	76.39%
1 - I am a novice programmer (just have basic ideas)	7	9.72%
2 - I can code simple programs	10	13.89%
3 - I am fluent in programming (can create a full program)	0	0%
4 - I can design a solution of a problem in the form of a program	0	0%

Table 3 - Self-assessment of programming skills

In the preliminary questionnaire the participants also stated which programming concepts are they familiar with. The results (Table 4) show that students are not familiar with the concept related to programming which makes the findings in the previous section consistent. The students with the knowledge on programing are mostly familiar with the *statements* (13 students) and operators (12 students) while only 11% of them are familiar with conditionals and variables.

Concept	Frequency
Loops	6
Conditionals	8
Variables	8
Statements (sounds, movement, looks, drawing)	13
Operators	12
Events	7
Parallelism	5

Table 4 - Familiarity with the programming concepts

Table - 5 shows students' responses about what motivates them to learn to program (students could choose one or more responses). The most of the students are motivated by the jot they have during solving problems (23,61%). The second highest option is the success in the programming class (22.22%). On the other hand, 23.61 % of the students do not feel themselves motivated for learning coding or programming.

Response	Frequency	Percentage
I'm not motivated	17	23.61%
I want to succeed in the programming class	16	22.22%
I want to show other students I can program	0	0%
I want to follow a career in programming	9	12.50%
I enjoy solving logic problems and puzzles	18	25.00%
Other	11	15.27%

Table 5 - Motivation for learning programming

S2 – Follow-up questionnaire

A total of 72 students answered the follow-up questionnaire about satisfaction with programming and coding activities, satisfaction with the organization of the implementation, and perception on the acquired coding skills. Since all students who responded to the preliminary questions also participated in the follow-up part the demographics of the students are the same.

In the follow-up questionnaire, students expressed their attitudes regarding the C4G learning methodology and the implementation of activities using the 5-point Likert scale (1 – strongly disagree, 2 – disagree, 3 – neutral, 4 – agree, 5 – strongly agree). According to the results (Table - 6), students find programming motivating and not challenging but not easy.

They have fun with the programming activities and find that activities are relevant for learning programming. They understand presented concepts and had fun during conducted activities.

Statement	1 -Strongly Disagree	2- Disagree	3- Neutral	4- Agree	5- Strongly Agree	Average Out of 5
1. I found programming challenging.	9,86%	19,72%	52,11%	14,08%	4,23%	2.83
2. I found programming motivating.	1,41%	14,08%	45,07%	38,03%	1,41%	3.24
3. I found programming easy.	5,63%	26,76%	46,48%	15,49%	5,63%	2.88
4. I enjoyed programming.	0,00%	8,45%	29,58%	52,11%	9,86%	3.63
5. I understood most of programming concepts.	8,45%	28,17%	39,44%	22,54%	1,41%	2.80
6. Learning this way is fun.	4,23%	7,04%	23,94%	49,30%	15,49%	3.64
7. I felt engaged with this way of learning.	5,63%	7,04%	30,99%	46,48%	9,86%	3.47
8. The activities were relevant to learn.	0,00%	4,23%	15,49%	64,79%	15,49%	3.91
9. At any time, it was clear what I had to do.	1,41%	5,63%	66,20%	25,35%	1,41%	3.19
10. What I learned will be relevant for my future.	4,23%	11,27%	36,62%	33,80%	14,08%	3.42

Table 6 – Satisfaction with C4G learning methodology

The participants again self-assessed the level of their programming skills on the scale from *0 - I have never coded or programmed before* to *4 - I can design a solution of a problem in the form of a program*. A total of 72 students solved the preliminary and the follow-up questionnaire so their self-assessment results were compared. Table-7 shows data on the difference between the self-assessed initial level and the self-assessed final level of programming skill. The number of statements for never coded before is decreased by 26.38% and number of novice programmer increased by 15.27%. According to the results, most of students self-assessed their programming skill level higher before participating in C4G activities. The analysis showed that the effect of C4G approach on coding and programming skills is supportive for students.

Level of programming skills	Preliminary Frequency	Follow-Up Frequency	Change in Percentage
0 - I have never coded or programmed before	55	36	-26.38%
1 - I am a novice programmer (just have basic ideas)	7	18	+15.27%
2 - I can code simple programs	10	11	+1.39%
3 - I am fluent in programming (can create a full program)	0	4	+5.55%
4 - I can design a solution of a problem in the form of a program	0	2	+2.78%

Table 7 - The difference between the self-assessed levels of programming skill

According to the results of the follow-up questionnaires;

- *43.05% students find the activities complex and 47.22% indicates that they need external assistance to play the game. However, 36.11% of the students thinks most people learn the C4G games in short time.*
- *Only 18.05% of them would like to play the game often and 48.61% of students think that they need to learn many concepts regarding coding before using C4G.*
- *56.94% of the participants feel happy and 54.17% of them think the game is fun.*
-

Students' comments

Students' comment was gathered after the activities in each class. They state their enjoyment with the C4G games and learning coding with this way. They are very satisfied with the received materials and provided guidance but indicate that they still need assistance to learn more. Some of the students criticise the volume of the game and the high technical requirements for playing the 3D game and asked the possibility of playing the game via phone or tablets at home.

Teachers' observations and comments

After the implementation activities, teachers were asked to express their qualitative opinions about the C4G methodology and the implementation process using the forms T1 and T2. In total, we gathered 14 responses from the participating teachers.

All of them stated that the students were interested and actively participated in the activities. Most of the students successfully completed all the tasks with the help of prepared materials. Video tutorials were especially useful to them. Teachers indicated that some students had technical difficulties in using the 3D game since it requires much of the processor and the graphic card. This situation made some students working slower.

Teachers' comments

Using the form T2, teachers reported on accomplishment of learning objectives, relevance, effectiveness and acceptance of the proposed methodology by the students, and the overall organization of the implementation.

The opinion of the teachers is that game-based learning is fun for students. They are motivated to solve tasks (problems) which makes this way of learning effective for learning programming. All teachers stated that the gamified learning and the serious game approach are very suitable and motivating for the students.

Game-based learning always attracts the attention of students and is particularly effective in areas where mental activities such as programming are intense. However, a little more attention should be paid to the fine line between the current game and missions. Especially middle school 5th and 6th grade students may get into the game and programming confusion and think that they are just playing games and cannot concentrate on tasks. Serious game design and approach with proof of concept can be problematic, especially for low-level students (in groups where the concept of abstract concrete is not very clear). However, with the concept-proven serious game approach, the usability of coding training is extremely high.

The approach of the coding4girls project seems positive, as gamification and design emerge as sub-skills in the acquisition of coding skills.

The validation activity of C4G activity was implemented online, so the insight regarding achieved fun by the students could not be complete. However, the teachers stated that it is easy to understand that students had fun and did not get bored from the activities. Besides, the students demanded more activities from the teachers.

DISCUSSION AND CONCLUSIONS

The validation process includes more than 10 hours of working with the participation of around one hundred students, teachers and experts. The first results from the students (S1) shows us that the online education has highly increased the time they spend online and the students meet digital devices at around their 9. Therefore, the students have about 4 years of experiences with computer or phone/tablets. Although their basic skills for the implementation of the C4G approach are adequate, only a few of them has previous coding or programming experiences. This situation is also confirmed by the results regarding the familiarity with programming concepts which showed that most students are not familiar with basic concepts such as statements and loops.

The Follow-up questionnaire (S2) applied to the students revealed that they found programming motivating and not challenging but not easy. They have fun with the programming activities and find that activities are relevant for learning programming. They understand presented concepts and had fun during conducted activities. When compared to the first self-assessment test, students' programing skills increased. For example, the number of students who selected their levels as novice programmer increased by 15.27%. The analysis showed that the effect of C4G approach on coding and programming skills is useful on students.

After the implementation activities with students, teachers reported that conducted activities enable students to achieve learning outcomes and at the same time had fun. Teachers think that creating games is a very effective way for students to learn programing concepts and they plan to apply the C4G methodology in the future as well. They observed that C4G approach encouraged creativity and problem solving and students were motivated to complete the project (their own game) to the end. The external experts who participated in the validation activities agreed with these observations and support the application of game-based learning approach using visual programming tools for learning programming. They emphasized the good choice of topics of the projects included in the learning scenarios which are interesting to girls and encouraged them to apply their programming knowledge.

In conclusion, the C4G methodology is appropriate for students and enables the achievement of learning outcomes in an effective and fun way via serious game approach and positively contributes to the creativity of student via design thinking approach. The main problem were technical difficulties such as the volume of the game, need for a high capacity computers encountered by students who used the 3D game.

ANNEXES

S1. PRELIMINARY QUESTIONNAIRE FOR STUDENTS (in Turkish)

S1. ÖĞRENCİLER İÇİN ÖN ANKET

Bu anket, dijital cihaz kullanımınızı ve programlama deneyiminizi ölçmek amacıyla "KIZLAR İÇİN KODLAMA" Projesi çerçevesinde hazırlanmıştır. Proje, programlama becerilerini geliştirmek için ciddi oyun yaklaşımı geliştirmeyi hedeflemektedir.

Yanıtlarınızda ad ve soyadı bilgileriniz yer almayacak olup cevaplarınız yalnızca araştırma amacıyla kullanılacaktır. Zaman ayırdığınız ve işbirliğiniz için teşekkür ederiz.

Lütfen aşağıya okul numaranızı yazınız. Okul numaranız yalnızca bir sonraki anket ile eşleştirme amacıyla kullanılacaktır.

GENEL BİLGİ

Okul No: ______________

Yaş: ______________

Cinsiyet: E K

Okul: ______________

Sınıf: ______________

DİJİTAL CİHAZLARIN, İNTERNETİN VE VİDEO OYUNLARIN KULLANIMI	
1. Bilgisayarları, tabletleri veya diğer dijital cihazları ne kadar süredir kullanıyorsunuz?	__________ yıl
2. Haftada kaç saat bilgisayar, tablet veya başka bir dijital cihaz kullanıyorsunuz?	__________ saat
3. Haftada kaç saat internet kullanıyorsunuz?	__________ saat
4. Haftada kaç saat bilgisayar/telefon oyunu oynuyorsunuz?	__________ saat

KODLAMA VE PROGRAMLAMA DENEYİMİ

Lütfen yanıtlarınızı daire içine alınız.

1. Programlama seviyeniz nedir?

a) Daha önce hiç kod yazmadım veya programlamadım.

b) Acemi bir programcıyım (sadece temel fikirlerim var).

c) Basit programları kodlayabilirim.

d) Programlamada akıcıyım (tam bir program oluşturabilirim).

e) Bir problemin çözümünü program şeklinde tasarlayabilirim.

2. Daha önce bir kodlama yaptıysanız aşağıdaki kavramlardan hangisi size tanıdık geliyor? Birden fazla yanıtı işaretleyebilirsiniz.

€ Döngüler	€ Koşullar	€ İfadeler
€ Değişkenler	€ İşlemler	€ Olaylar
€ Çift yönlülükler		

Programlamayı öğrenmeniz için sizi motive eden nedir? Birden fazla yanıtı işaretleyebilirsiniz.

€ Motive değilim.

€ Bilgisayar dersinde başarılı olmak istiyorum.

€ Programlayabileceğimi diğer öğrencilere göstermek istiyorum.

€ Programlamada kariyer yapmak istiyorum.

€ Mantık problemlerini ve bulmacaları çözmekten zevk alırım.

€ Diğer: ____________________________

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S2. FOLLOW-UP QUESTIONNAIRE FOR STUDENTS (in Turkish)

S2. ÖĞRENCİLER İÇİN TAKİP ANKETİ

Bu anket, C4G öğrenme metodolojisinden memnuniyetinizi anlamak ve programlama/kodlama becerilerini edinmeye yönelik faaliyetlerin uygunluğunu ölçmek amacıyla hazırlanan bir takip araştırmasıdır.

Yanıtlarınızda ad ve soyadı bilgileriniz yer almayacak olup cevaplarınız yalnızca araştırma amacıyla kullanılacaktır. Zaman ayırdığınız ve işbirliğiniz için teşekkür ederiz.

Lütfen aşağıya okul numaranızı yazınız. Okul numaranız yalnızca "ön anket" ile eşleştirmede kullanılacaktır).

KOD ve GENEL BİLGİ

Okul No : ______________
Yaş: ______________
Cinsiyet: E K

Okul: ______________
Sınıf: ______________

C4G Öğrenme Yöntemi

3. Aşağıdaki ifadeleri yandaki ölçek ile değerlendiriniz.	*Tamamen katılmıyorum*	*Katılmıyorum*	*Kararsız*	*Katılıyorum*	*Tamamen Katılıyorum*
a) Programlamayı zor buldum.	1	2	3	4	5
b) Programlamayı motive edici buldum.	1	2	3	4	5
c) Programlamayı kolay buldum.	1	2	3	4	5
d) Programlamayı sevdim.	1	2	3	4	5
e) Programlama kavramlarının çoğunu anladım.	1	2	3	4	5
f) Bu şekilde öğrenmek eğlenceli oluyor.	1	2	3	4	5
g) Bu öğrenme yöntemini ilgi çekici buldum.	1	2	3	4	5
h) Faaliyetler öğreticiydi.	1	2	3	4	5
i) Ders esnasında ne yapmam gerektiği belliydi.	1	2	3	4	5
j) Öğrendiklerim geleceğimle ilgiliydi.	1	2	3	4	5

ALGILANAN PROGRAMLAMA DÜZEYİ

Lütfen yanıtlarınızı daire içine alınız.

2. Şu anki programlama seviyeniz nedir?

a) Daha önce hiç kodlama veya programlama yapmadım.

b) Acemi bir programcıyım (sadece temel fikirlerim var).

c) Basit programları kodlayabilirim.

d) Programlamada akıcıyım (tam bir program oluşturabilirim).

e) Bir problemin çözümünü program şeklinde tasarlayabilirim.

OYUN ORTAMININ KULLANILABİLİRLİĞİ

3. Aşağıdaki ifadeleri yandaki ölçek ile değerlendiriniz.	*Tamamen katılmıyorum*	*Katılmıyorum*	*Kararsız*	*Katılıyorum*	*Tamamen Katılıyorum*
a) Bu oyunu sık sık kullanmak istiyorum.	1	2	3	4	5
b) Oyunu karışık buldum.	1	2	3	4	5
c) Oyunun kullanımı kolaydı.	1	2	3	4	5
d) Bu oyunu kullanabilmek için bilgi sahibi bir kişinin desteğine ihtiyacım var.	1	2	3	4	5
e) Bu oyundaki çeşitli işlevler birbirine iyi bir şekilde entegre edilmişti.	1	2	3	4	5
f) Bu oyunda çok fazla tutarsızlık vardı.	1	2	3	4	5
g) Çoğu insan bu oyunu kullanmayı çok çabuk öğrenebilir.	1	2	3	4	5
h) Oyunun kullanımı çok zahmetliydi.	1	2	3	4	5
i) Oyunu kullanırken kendime çok güveniyordum.	1	2	3	4	5
j) Bu oyuna başlamadan önce birçok şeyi öğrenmem gerekiyordu.	1	2	3	4	5

OYUN DENEYİMİ

4. Aşağıdaki ifadeleri yandaki ölçek ile değerlendiriniz.	*Tamamen katılmıyorum*	*Katılmıyorum*	*Kararsız*	*Katılıyorum*	*Tamamen Katılıyorum*

a) Memnun hissettim.	1	2	3	4	5
b) Kendimi maharetli hissettim.	1	2	3	4	5
c) Oyunun hikâyesiyle ilgilendim.	1	2	3	4	5
d) Eğlenceli olduğunu düşündüm.	1	2	3	4	5
e) Oyunla tamamen konsantre oldum.	1	2	3	4	5
f) Mutlu hissettim.	1	2	3	4	5
g) Bana kötü bir ruh hali verdi.	1	2	3	4	5
h) Başka şeyler düşündüm.	1	2	3	4	5
i) Yorucu buldum.	1	2	3	4	5
j) Yeterli hissettim.	1	2	3	4	5
k) Zor olduğunu düşündüm.	1	2	3	4	5
l) Estetik açıdan hoştu.	1	2	3	4	5
m) Etrafımdaki her şeyi unuttum.	1	2	3	4	5
n) Kendimi iyi hissettim.	1	2	3	4	5
o) Bunda iyiydim.	1	2	3	4	5
p) Sıkılmış hissettim.	1	2	3	4	5
q) Başarılı hissettim.	1	2	3	4	5
r) Kendimi yaratıcı hissettim.	1	2	3	4	5
s) Bir şeyleri keşfedebileceğimi hissettim.	1	2	3	4	5
t) Eğlendim.	1	2	3	4	5
u) Oyunun hedeflerine ulaşmada hızlıydım.	1	2	3	4	5
v) Sinirli hissettim.	1	2	3	4	5
w) Baskı altında hissettim.	1	2	3	4	5
x) Zamanın nasıl geçtiğini anlamadım.	1	2	3	4	5

y) Zorlandığımı hissettim.	1	2	3	4	5
aa) Etkileyici buldum.	1	2	3	4	5
bb) Oyuna derinlemesine yoğunlaşabilidim.	1	2	3	4	5
dd) Zengin bir deneyim gibi geldi.	1	2	3	4	5
ee) Dış dünya ile bağlantımı kaybettim.	1	2	3	4	5
ff) Zaman baskısı hissettim.	1	2	3	4	5
gg) Bunun için çok çaba sarf etmem gerekti.	1	2	3	4	5

S3. STUDENT'S COMMENTS (in Turkish)

S3. ÖĞRENCİ YORUMLARI
Programlama becerilerini geliştirmek için C4G oyun temelli yaklaşımın uygulanmasından sonra, öğretmenler öğrencilerin sözlü nitel görüşlerini ve toplar ve bunları yazıya dökerler.
GENEL BİLGİ
Öğretmen: ____________________ Sınıf: ______________ Okul: ____________________ Tarih: ______________
GENEL ORGANİZASYON VE ÖĞRENCİLERİN ALGILARI
Öğrencilere, uygulamanın genel organizasyonu, edinilen bilgilere ilişkin algıları, oyun temelli öğrenmenin uygunluğu ve etkinliği konusundaki algıları ve elde edilen eğlenceye ilişkin görüşleri hakkında sorular sorabilirsiniz.
ÖĞRENME ZORLUKLARI VEYA SORUNLARI
Öğrencilere kurs sırasında karşılaştıkları herhangi bir öğrenme güçlüğü veya sorunu ile bu sorun ile karşılaştıklarında ne yaptıklarını sorabilirsiniz.
ÖĞRENCİLERİN C4G METODOLOJİSİNİN, ARAÇLARIN VE İÇİNDEKİLERİN NASIL İYİLEŞTİRİLECEĞİ HAKKINDA GÖRÜŞLERİ.
İLGİLİ OLDUĞUNU DÜŞÜNDÜĞÜNÜZ GÖRÜŞ VE ÖNERİLERİNİZ

T1. TEACHER'S OBSERVATIONS (in Turkish)

T1. ÖĞRETMEN GÖRÜŞLERİ
Uygulama oturumları sırasında öğretmenler, öğrencilerin tepkilerini ve oyun tabanlı C4G yaklaşımını kullanarak kodlama becerilerini geliştirmedeki ilerlemelerini gözlemler ve belgeler.
GENEL BİLGİ
Öğretmen: ____________________ Sınıf: __________________ Okul: ____________________ Tarih aralığı: ______ ______
ÖĞRENCİLERİN KATILIMI
Öğrenciler aktif olarak katılıyor mu? İşbirliği yapıyorlar mı? Eğleniyorlar mı? vb.
ÖĞRENME ZORLUKLARI VE SORUNLARI
Öğrenciler içerik veya donanımla ilgili sorunlar yaşıyor mu? Destek istiyorlar mı? vb.
İLGİLİ OLDUĞUNU DÜŞÜNDÜĞÜNÜZ GÖRÜŞ VE ÖNERİLERİNİZ

T2. TEACHER'S COMMENTS (in Turkish)

T2 ÖĞRETMEN DEĞERLENDİRMELERİ
GENEL BİLGİ
Adınız: Soyadınız: Okulunuzun Türü:
CODING4GIRLS YAKLAŞIMININ ÖĞRENCİLERİN ÖĞRENME HEDEFLERİNE ULAŞMALARINA KATKILARI NEDİR?
PROGRAMLAMA BECERİLERİNİN GELİŞTİRİLMESİNDE CODING4GIRLS ÖĞRENME YAKLAŞIMININ OYUN TABANLI ÖĞRENMEYE ETKİLERİ NELERDİR?
ÖNERİLEN METODOLOJİNİN ÖĞRENCİLER TARAFINDAN BENİMSENME POTANSİYELİ HAKKINDAKİ GÖRÜŞLERİNİZ NELERDİR?

CODING4GIRLS ÜRÜNLERİNİ KULLANIRKEN ÖĞRENCİLERİN KEYİF ALMA DÜZEYLERİ HAKKINDAKİ GÖRÜŞLERİNİZ NELERDİR?
UYGULAMA ETKİNLİĞİ HAKKINDAKİ DÜŞÜNCELERİNİZ NELERDİR?
CİDDİ OYUN YAKLAŞIMININ KULLANILABİLİRLİĞİ HAKKINDAKİ DÜŞÜNCELERİNİZ NELERDİR? (Coding4Girls Oyun Tabanlı, Tasarım Odaklı Eğitim Çerçevesi ile bağlantılı olarak)
BELİRTMEK İSTEDİĞİNİZ DİĞER HUSUSLAR NELERDİR?