D5.4 – Report and findings from experimental pilot in Austria

Grant Agreement number: 645215
Project title: No One Left Behind
Funding Scheme: Innovation Action

Due date: 01/05/2017
Actual date: 17/07/2017
Document Author/s: Bernadette Spieler, Elena Mashkina, TU Graz
Version: 1.0
Dissemination level: PU
Status: Final

This project has received funding from the European Union's Horizon 2020 research and innovation program under grant agreement No 645215

Document History			
Version	**Date**	**Comments**	**Author**
0.1	11/04/2017	Creation of the document	Bernadette Spieler (TU Graz), Elena Mashkina (TU Graz)
0.2	02/05/2017	The characterization of the pilot, Methodology	Elena Mashkina (TU Graz)
0.3	10/05/2017	Statistics, Summary students	Bernadette Spieler (TU Graz), Elena Mashkina (TU Graz)
0.4	16/05/2017	Co-participative development and templates	Bernadette Spieler (TU Graz), Elena Mashkina (TU Graz)
0.5	06/06/2017	Summary students, Hasenzahl, surveys	Elena Mashkina (TU Graz)
0.6	15/06/2017	Summaries teachers, barriers and challenges, recommendations	Bernadette Spieler (TU Graz), Elena Mashkina (TU Graz)
0.7	19/06/2017	Austrian pilot plan	Bernadette Spieler (TU Graz)
0.8	20/06/2017	Finalize surveys, Hassenzahl, add lesson plans, program statistics	Bernadette Spieler (TU Graz), Elena Mashkina (TU Graz)
0.9	21/06/2017	Add parts for risk of social inclusion	Bernadette Spieler (TU Graz), Elena Mashkina (TU Graz)
0.10	22/06/2017	Finalize students' comments, observations, executive summary, instruction	Bernadette Spieler (TU Graz), Elena Mashkina (TU Graz)
1.0	26/06/2017	Add Behavioural assessment, Finalization of the document	Bernadette Spieler (TU Graz), Elena Mashkina (TU Graz)
1.0	30/06/2017	Proofread, formatting, conclusion	Bernadette Spieler (TU Graz), Elena Mashkina (TU Graz)

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LIST OF ABBREVIATIONS

NOLB	No One Left Behind
STEM	Science Technology Engineering and Mathematics
WP	Work Package

EXECUTIVE SUMMARY

This delivery summarizes all NOLB experimental activities during the feasibility study, first and second cycle of the project. Three schools participated in the Austrian pilot: GIBS (Graz International Bilingual School), Akademisches Gymnasium, and Borg Birkfeld.

Women are underrepresented in technical fields, both in Austria and worldwide. This starts in IT related classes at high school, continues in STEM (Science, Technology, Engineering, and Mathematics) related university studies (especially in advanced semesters), and similarly later on in the business environment. Teenage girls are discouraged from entering ICT related fields in all levels. While younger girls often can imagine pursuing a career in technology later on, their interest drops dramatically when they become teenagers. E.g., only 1% of the finalists from Austria at the International Computer Science Olympiad for teenage high school students over the last 12 years were girls. We assume that girls who do not consider a technical career either do not know enough about IT jobs, or/and are less confident whether they have the skills to succeed in IT.

In Austria, the study was concentrated around the teenage girls, as they are considered to be at risk of exclusion in STEM subjects. One of the goals of the study was to make STEM subjects more attractive to this target group.

To address this gender bias, the NOLB activities included engagement of female students by integrating the educational tool Pocket Code/Create@School into different subject areas. Thus, our vision built on three pillars: We wanted to 1) provide girls a positive first experience in programming, 2) encouraged them to engage in our community and within the app by providing them interesting programs and sample content, and thus 3) influence their career choices towards STEM related fields. We achieved these objectives largely during the project's period.

From all participating schools 59% of the students who took part in Pocket Code/Create@School courses in Austria were girls (259 out of 438). We focused on collecting and comparing different strategies and results from performed initiatives for girls worldwide. Therefore, we summarized several girls' programs, girls coding clubs initiatives, and include findings of Kafai, combined with further research. Our goal was to find out playing behavior and special game characteristics girls tend to like. Our observations and preliminary results of our cycles show similar results. These results were validated with different methodologies e.g., Hassenzahl model assessment, behavioral assessment, qualitative/quantitative assessment as well as interviews and focus group discussion.

After the NOLB project, TU Graz is planning to continue educating younger girls in programming. For example, we will conduct special "Girls Coding Days". The first pilot event is planned for August 2017 with the girls from the Austrian partner schools.

1 INTRODUCTION

The intent in the Austrian pilot was to find out how to enhance Pocket Code in ways that specifically empower girls by engaging with them and thus making the study of Science, Technology, Engineering and Mathematics (STEM) related subjects more attractive to them. Additionally, the differences in the game creation process has been analyzed. Aspects of self-identity and stereotyped gender categories was taken into consideration. Further, we observed differences in game design, performance, interests, and experience.

Therefore, this delivery is structured as follows:

In the second Chapter, we summarized all participated schools, teachers, and students from our pilot schools beginning with the feasibility study, to the first and second cycle. This is followed by a description of the TU Graz participation to the development of the Create@School app. Therefore the four parts of the app (GPII, PMD/analytics data, feature completeness, and the templates) were listed and linked to our performed activities. The templates created in Austria are described in more detailed. For each template their development as well as their evaluation process is documented. We put a special emphasis on the Adventure RPG template. This one was created especially for girls (bases on the results from our interviews) and was integrated in one computer science course with a lot of care. Additional surveys were performed with a focus on the usability and simplicity of this template. At the end of this Chapter additional statistics to program uploads and general web-share statistics are presented.

The third Chapter presents the Austrian pilot’s plan. The focus for this Chapter lies on the Gantt chart which has been developed at the beginning of the study and is explained in more detail in Delivery 5.2. Therefore, we refer to every task of this chart and explain our contribution. To sum up this chapter, we provide a summary about the participated teachers, e.g., their background and their courses, their acceptance of the apps and their intention to use it in the future. To recap the student’s activities we provide, a detailed summary of all programs submitted through all three phases of the project (feasibility, first, and second cycle). For every course the following details are provided: class, Create@School accounts, group constellation, lesson plans, learner achievement, finished uploaded games, as well as on-site observations to the whole course. All these information is represented in form of a table in the Appendix. The tables about the programs of the students contain additionally the user id, gender, program id, program name, as well as notes about the collaboration, persistence, and engagement of the students. In addition, screenshots of the submitted games were added. The most important aspect of these tables is the evaluation if the games fulfil the predefined learning goal. Finally, we present barriers and challenges as well as recommendations for the app.

Finally, within Chapter 4, we present our results. We validate our results in four ways: 1) With the help of the Hassenzahl model assessment, 2) a behavioral assessment through the PMD/analytics data we collected within the app, 3) with quantitative and qualitative surveys and 4) interviews and focus group discussion with our target group girls. At the end of this chapter a description of performed actions to meet the needs for students at risk of exclusion (girls) in Austria is summarized and results of interviews etc. described.

2 THE CHARACTERIZATION OF THE PILOT

The Austrian pilot aimed to address the gender bias, by testing and engaging girls in game-making (computational thinking), as well as STEM subjects in a day-to-day academic environment; by making Pocket Code as attractive as possible to different female teenage user groups. In Graz, there were three participating schools, where almost 60% of all students were young girls (each school had at least 50% female students). There were no students with disabilities in the pilot in Austria. Details to each school, the teachers and to the classes are summarized in the following sections.

2.1 *The participant schools and teachers*

In Austria, Pocket Code/Create@School was introduced in the following curricula subjects: physics, music, arts, computing, and language learning (German, English). The Austrian pilots were conducted together with three high schools situated in and around Graz:

- "Graz International Bilingual School" (GIBS),
- "Akademisches Gymnasium Graz", and
- "BORG Birkfeld".

For the preparation of the feasibility study we collected information about the curricula and lesson plans and started to create use cases and suitable classroom projects for including Pocket Code into the different courses. These use cases were sent out to all teachers from the pilot schools. The teachers were invited to take part in the study and were asked to participate on a voluntary basis. Eleven teachers took part in the Austrian study. Their subjects, and background (technical or non-technical) are described in Table 1. In addition, teacher meetings and teacher training sessions as well first workshops with school classes were held to kick off the feasibility study. The teachers according to their schools are listed in Table 1 to 3.

Teacher No.	Gender	Technical background	Subject in which Pocket Code has been integrated
1	female	no	English
2	female	no	English
3	male	yes	computer science
4	male	yes	computer science
5	female	no	physics
6	male	no	fine arts

Table 1: Pilot School 1: GIBS

Teacher No.	Gender	Technical background	Subject in which Pocket Code has been integrated
7	female	yes	physics, computer science
8	female	no	fine arts, computer science

Table 2: Pilot School 2: Akademisches Gymnasium

Teacher No.	Gender	Technical background	Subject in which Pocket Code has been integrated
9	male	yes	computer science
10	male	no	music
11	female	yes	computer science

Table 3: Pilot School 3: Borg Birkfeld

2.2 *The participant students*

All together we had 22 Pocket Code/Create@School courses in Austria in the subjects English, computer science, physics, fine arts, music, and German. All courses and the participated students per class are listed in Table 4.

Austria pilot schools	Course	Age	Subject	Students	Teen girls	Teen boys
GIBS	3rd grade (3b) / 2015	12-13	physics	26	17	9
	5th grade (5b) / 2015	14-15	English / computer science	25	16	9
	5th grade (5c) / 2015	14-15	English / computer science	24	16	8
	5th grade (5a) / 2015	14-15	computer science	24	13	11
	5th grade (5c) / 2015	14-15	fine arts	24	16	8
	6th grade (6b) / 2015	16-17	fine arts	25	12	13
	5th grade (5a) / 2016	14-15	fine arts	24	11	13
	5th grade (5b) / 2016	14-15	fine arts	25	19	6
	5th grade (5c) / 2016	14-15	fine arts	26	17	9
	3rd grade (3a) / 2017	12-13	physics	25	17	8
	5th grade (5c) / 2017	14-15	computer science	12	6	6
Akademisches Gymnasium	3nd grade (2a) / 2015	11-12	fine arts / German	29	17	12
	5th grade (5a) / 2015	14 -15	computer science	21	15	6
	5th grade (5a) 2016	14-15	computer science	11	5	6
	2nd grade (2a) 2016	12-13	physics	29	17	12
	3rd grade (3a) / 2016	12-13	fine arts	29	17	12
	8th grade (8b) / 2016	17-18	computer science	11	6	5
	3rd grade (3a) / 2017	12 -13	physics	29	17	12
Borg Birkfeld	5th grade (5a) / 2015	14 – 15	music	21	16	5
	5th grade (5c) / 2015	14-15	computer science	13	5	8
	5th grade (5a) / 2016	14-15	computer science	19	-	19
	6th grade (6a) / 2016	15-16	computer science	6	6	-
			TOTAL	**478**	**284**	**194**

Table 4: Students per school and course

2.3 *Co-participative development of Create@School*

The Pocket Code app was repeatedly reviewed through interviews, surveys, focus group discussions and programs submitted by students. During the preparation phase a list with suggestions for app improvements were created by the whole NOLB team. This list has been prioritized and played a role in the future planning of the app. Furthermore, the four parts of the New Generation of Pocket Code were defined: 1) Accessibility Preferences, 2) Data Analytics and Visualization, 3) Project

Management Dashboards (PMD), and 4) Predefined templates. This new generation, which was called later on Create@School, was developed during the first cycle at TU Graz. For a detail description of the parts see D4.2. Create@School was released as an open beta version in October 2016 for the use at our pilot schools through the second cycle. In the following the TU Graz part of the development is described.

2.3.1 Accessibility Preferences

In the settings menu the users can choose different profiles which help them with Create@School's user interface, e.g., it is possible to increase the size or the contrast of the font. TU Graz did together with HdM the specialization, prioritization and definition of these setting from March to May 2016. The first prototype which was released as part of the Create@School app in October 2016 was designed, developed and integrated as a whole at TU Graz.

2.3.2 Data Analytics and Visualization

Different types of events have been tracked and visualized on dashboards to show teachers basic information about the students (e.g., duration of the programming units, how often a new program has been created, etc.). Therefore the app makes use of an SDK, the BDSClientSDK (Big Data Services Client software development kit), which is a very simple to use and lightweight library with no external dependencies that allows developers to send different types of events related with their applications to the Big Data Services (BDS) platform. In that way, it is possible to explore information about users, their sessions, and their actions. This SDK was provided by ZED and integrated as a whole by TU Graz. Therefore, the events and parameters were added to the source code (e.g., event name: createProgram with the parameter programname, landscape, example program) in order to send it to the BDS. All together about 90 events were integrated from TU Graz into the source code.

2.3.3 Project Management Dashboard (PMD)

With the help of the PMD, teachers can plan, assign, and manage the delivery of the game projects. It allows qualitative evaluation of students regarding the project's completion and the objectives achievements. TU Graz provided the interface between the web-share and the PMD. Therefore a new button was integrated into the detail page of the web-share with the name "Submit your project". If the student clicks on this button he/she must provide a project id which links the submitted program to the corresponding project/student in the PMD.

2.3.4 Usability Improvements and Feature Completeness

The feasibility study showed a certain demand on improving the usability of the app as well as developing new features to make the app easier to use for the target group. A list of all new features that should be integrated could be find as part of the Delivery 2.2. In summer 2017, TU Graz implemented 47 new features and improvements and released them in October 2016 as part of the Create@School app. New features are for example, a more accurate object detection, speech bubble for storytelling games, etc. A complete list of all these features can be found in Delivery 4.2.

2.3.5 Development of the Create@School predefined templates

Students can edit existing game design templates and personalize them according to their own wishes and ideas. These templates refer to different game genres such as adventure, action, quiz, and puzzle. Game modules include rewards and victory mechanisms such as score or inventory. The goals, genre, dynamics, and aesthetics of the templates were already defined in Delivery 3.2. Further, the topic and the gameplay of each template was defined based on D3.2 data and in agreement with all responsible partners (Game City, UPM, TU Graz). The programs created in all pilots were collected from TU Graz and it was decided which partner will prepare which template, see Table 5 to 7.

The workflow was the following: The first versions of each template were collected by the TU Graz for the purpose of redesigning the graphics, restructuring the programs, and performing iterative feedback rounds from the TU Graz usability team and partners. The graphics were designed from TU Graz in order to have the same look & feel and to support the shape of a game. The template's code was adjusted to integrate scenes and groups (for structuring the programs). In additional the programs are available in both, landscape and portrait mode. Although, only four of the 13 templates were initially created by TU Graz all of them needed a lot of rework. The partners only delivered a scaffold for the template or the template idea (e.g., the games consist out of one scene, with dummy graphics, no example level, etc.). We at TU Graz finished them or in other words created all templates.

The templates were created in three cycles: October 2016, February 2017, and May 2017, see Table 5 to 6.

Template No.	Genre	Topic	Gameplay	Responsible partner
1.	Adventure	Space	Answer "Yes" or "No" to the questions in relation to the space scenario.	Game City
2.	Action	Respiration	Learn about de-/oxygenated blood cells by tapping on the objects. Avoid the virus cells.	Game City
3.	Puzzle	Instrument groups	Tap on the musical instrument, which does not fit to the group (odd one out).	Game City
4.	Quiz	Properties of physical objects	Learn about physical objects and their properties (e.g., inertia) through questions and answers.	TU Graz

Table 5: 4 templates created in October 2016

Template No.	Genre	Topic	Gameplay	Responsible partner
5.	Action platform	Periodic system	Move a player character from surface to surface to catch halogens.	Game City
6.	Physical simulation	Newton's laws of motion	Apply Newton's 2nd and 3rd laws of motion to the rockets.	TU Graz
7.	Action shooter	Division rules	Shoot asteroids which can be divided by 4, 3 and 11.	UPM
8.	LEGO simulation	Robotics	Use the LEGO NXT / EV3 extension and solve tasks using the sensor values of the robot (e.g. navigating a robot through a maze).	TU Graz
9.	Interactive book	Water cycle	Add descriptions and images to an interactive book to explain the water cycle principles.	UPM

Table 6: 5 templates created in February 2017

Template No.	Genre	Topic	Gameplay	Responsible partner

10.	Adventure RPG	Color circle	Collect certain colors to the inventory and mix them afterwards to draw a picture. Additional: Create your own character.	TU Graz
11.	Racing simulator	Pollution	Collect trash to get points and level up. Avoid the other cars to keep playing.	UPM
12.	Life simulation	Work skills	Help the character to get ready for work. Keep the customers happy by serving them the right drinks.	Game City
13.	Strategy	History	Multiplayer (on one tablet). Strategy decisions via a simple connect 4 template.	Game City

Table 7: 4 templates created in May 2017

All templates are all based on the "Shape of a Game" and were translated in the languages of the participated countries. This shape was defined by Game City in Delivery 1.2 and designed by TU Graz. There exist five versions of this shape (one with every Catrobat family member). Template tutorials for teachers and students were created by TU Graz and translated by the Spanish partners (see the project's education-platform[1]). A new option "Templates" has been added to the Create School's main menu to access the templates list, see Figure 1.

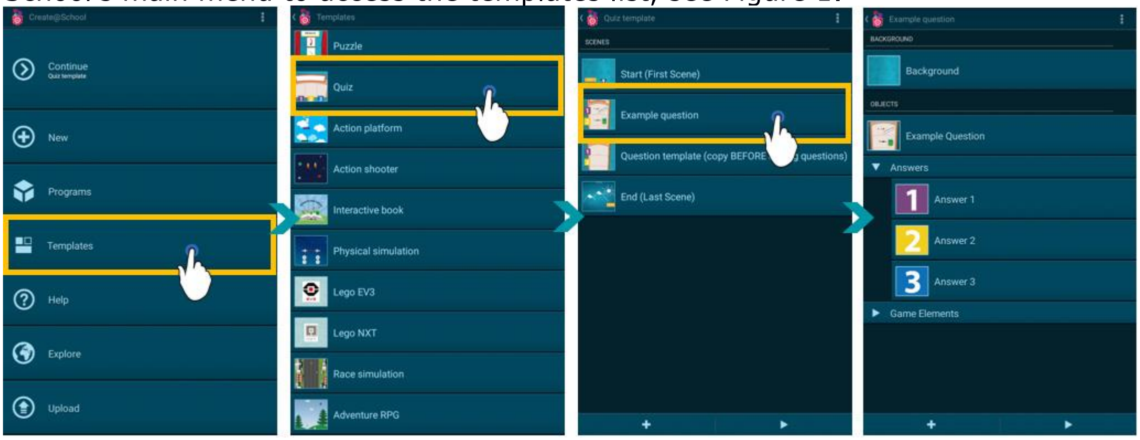


Figure 1: Game templates in Create@School that supports scenes and grouping of objects

By changing or adding different contexts, game assets, or game mechanics the students adapt, customize, and create diversity with the dynamics and aesthetics of the games. By using the game design elements they can build new games and remix existing ones. The templates allow to edit the existing design, giving the students freedom in the personalization of backgrounds and characters. Fun, engaging experiences are generated through the creation of new, challenging levels or changing the difficulty of a game.

2.3.6 Templates created in Austria

To summarize four out of 13 templates where developed as a whole in Austria. In the following their development as well as an evaluation is presented.

1 https://edu.catrob.at/

Quiz Template

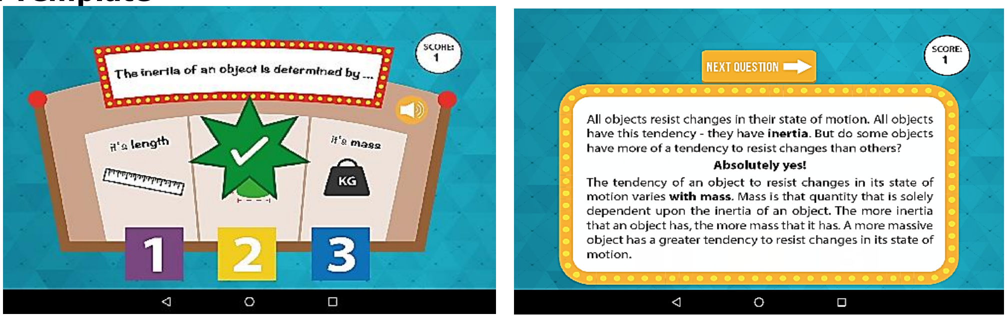


Figure 2: Quiz template

Development

During the first cycle one teacher at our partner school "Akademisches Gymnasium" required a quiz template for the 2nd grade. She told the students from the 5th grade to create the template in computer science class (April 2016). This template was used afterwards by the 2nd grade students (May 2016). The template created by the 5th grade students was used as a starting point for the developed quiz template for Create@School. In the first feedback round provided by the TU Graz UX team and partners suggested the fallowing changes:

- Integrate a speaker button to hear the question
- Provide an answer text for the asked question

Evaluation

The Quiz template was used at the school "Akademisches Gymnasium" in May 2017. The 8th grade students used it in the computing class to create a quiz about the school building. The special codes like room numbers were used to unlock the certain questions and make the quiz more interactive. For example, if the player is in front of the library it is possible to type in a code to unlock a specific question about the library. An "Ask brick" was used to implement this type of behavior.

This class had already programmed their own adventure/action games before and thus they were very fast in applying the quiz template. They had one unit to prepare their questions. In the following one and a half units, all games were finished and uploaded (five questions per student). They needed some time to integrate the first question, but after they understood the overall concept of the template, they added the other questions very quickly. This teacher is planning to use the template in the future for other grades as well.

Physical Simulation Template

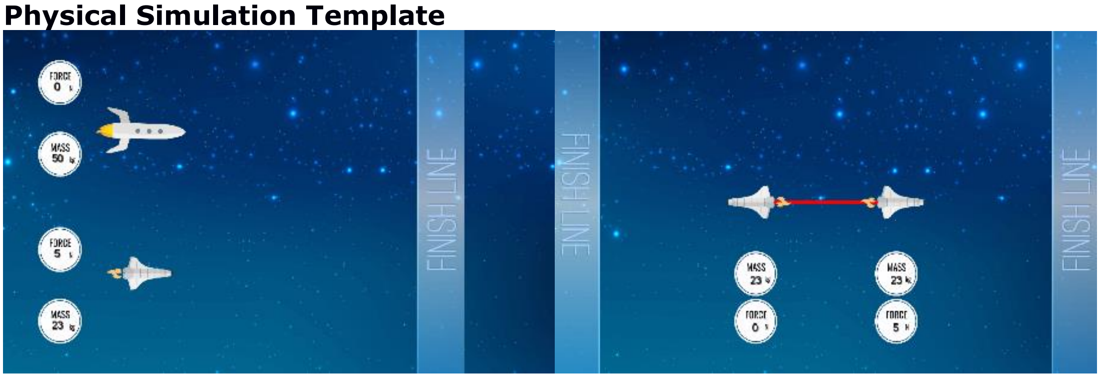


Figure 3: Physics simulation template

Development

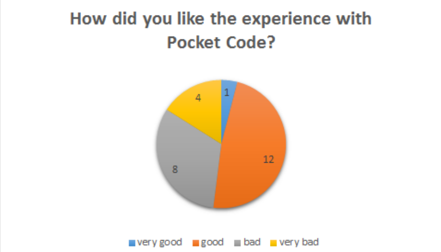
The physics teacher at our partner school GIBS wished to have a Physical Simulation template in order to consolidate the student's practical knowledge about Newton's 2nd and 3rd law of motion. This template was created together with this physics teacher in several sessions between Octobers to December 2017. It was her idea to provide an extra level for students who were faster and to use rockets. Before the actual units with this template started, she provided the students the needed content and they created their own paper rockets to conduct real life simulations as well.

Evaluation

For the evaluation of the Physics Simulation template the data of two classes in Austria will be compared. Both times we used the app in physics in Year 3 (12-13 years old), with the same teacher the same amount of learners (25 students). The first class was conducted during the feasibility study (December 2015), see **¡Error! No se encuentra el origen de la referencia.** and the second class had their lessons during the second cycle of the project (March 2017). After both units, a post-questionnaire was conducted with the students and an interview was performed with the teacher. Both classes (theme, learning goal) were created together with the teacher and the first prototypes of both programs were reviewed by her as well. The TU Graz team was present in both units. See the results in Table 8 and 9.

	First class (December 2015)	Second class (March 2017)
Number of units	6 units à 45 minutes: • 4 instruction units • two programming units	4 units à 45 minutes: • 2 instruction units • 2 programming units
Theme	Density of objects and liquids Formula: object density < fluid density = floats object density > fluid density = sink	Newton's' second law of motion Formula: force = mass * acceleration
Learning goal	• Add an object and let it glide • Set/Show variables to define the properties of the objects • Apply the formula	
Instruction unit	Every student starts with a new program. One student adds one step to the program in the front of the class (this was displayed on the projector). At the end of all instruction units every student had one example level integrated for reference	The class programs one game together with the same principle. The finished program was a simple "ping-pong" game which with the use of physical properties. In the second unit everyone used the own device and played the first example level, adjusted the code, and answered the question (apply the formula).
Programming unit	Add a new object (own drawing) and define its movement and behavior by adjusting its density. Apply the formula.	Add own code and a look (picture of self-constructed rocket) to the empty object within the template level and define its behavior. Apply the formula. Extra level for students who finished level 2 earlier (Newton's' 3rd law of motion).
Learner achievement	**6 of 25 reached the learning goal**	**16 of 24 reached the learning goal** (one was absent during programming unit)
Summary teacher interview	The teacher comment that it was maybe a little bit too difficult for the students and that it is necessary to repeat the different steps slowly. Some of the students had more problems doing the density program and some were quite fast.	After those units, the teacher said that the project was very successful. It was nice to see the students engaged and working on their program.

Table 8: Physics project with and without the use of a game template

"How did you like the experience with the app?"		

What did you like the most?	The students liked that they could make their own apps the most, and that they learned something about coding	Most times mentioned: It was very straightforward and simple, the programming of the rocket itself was fun, and they like the possibility to add their own pictures.
What did you like the least? Any suggestions for app improvement?	They mostly mentioned that it was confusing at the beginning and that it was very time consuming to have the first simple steps. Improvements: more help functions, tutorials, more tools, less typing	The most mentioned comment was that the game to create was still seen as too complicated and it was confusing them. Improvements: To add a search function for bricks
Have you used Pocket Code in your spare time?	None of them Reasons for not using Pocket Code: no interest, no time, too difficult	2 also used it in their spare time Reasons for not using Create@School: no interest and no motivation to use it

Table 9: Evaluation of the Physics simulation template

Based on the results from the first class, not only the program but also the whole packaging of the course was adapted. For example, the students received a more general instruction lesson about the app itself. The templates idea was to let students first change existing code, thus understanding the overall concept of the game template. In a second step, they had to add a second similar object and apply the same concept they learned from the previous level. Therefore, instead of four instruction units, only two were needed before they started programming on their own. The on-site observations showed that the second class understood better how to apply the physical formula and solve the physics related problem. In contrast, the first class dealt more with programming/app problems and most of them did not reach the point to even apply the physical formula. Thus the students of the second class felt more engaged, were more concentrated, and more of them reached the predefined learning goal as a result. It addition, it was seen as very positive that the template allowed personalization by adding a student’s own picture of their self-constructed rockets.

Lego Simulation Template

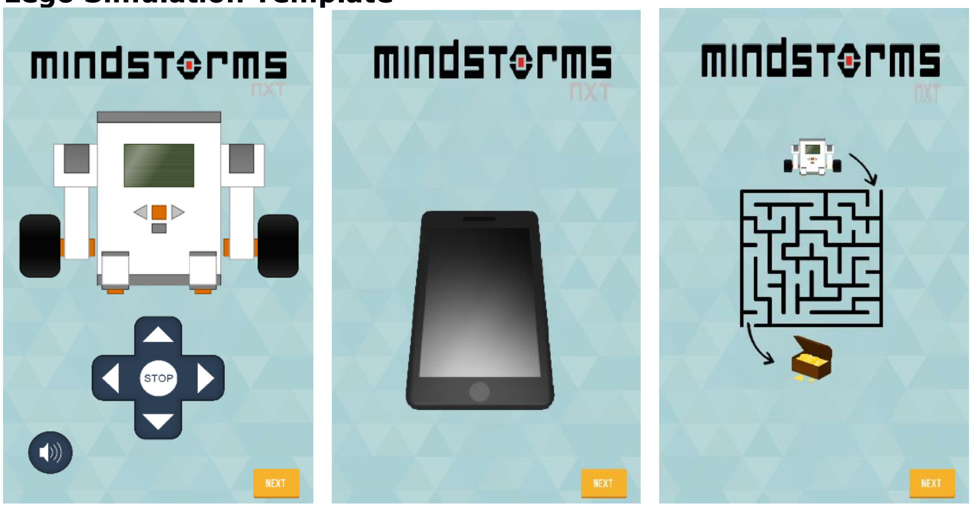


Figure 4: Lego NXT/EV3 Simulation template

Development

This template was developed with the support of the robotics club at the TU Graz[2] and in reference to available games from the Catrobat community. The template is split into three levels and support both: interaction with the mobile device as well as with the robot itself. Therefore, different sensors were addressed (e.g., inclination sensor of the phone, infrared/ultrasonic senor of the robot). At the time of the

2 http://www.robocup.tugraz.at/

development only the NXT robot was available within the app. At the end of February 2017 the Lego EV3 feature has been released within Create@School. Therefore, we decided to provide a template for both lego robots, NXT and EV3.

Evaluation

A first version of the template was tested in December 2016 with four students (all male) of the robotics club (not within the NOLB study). These students tried to finish all three levels within three hours. They worked in groups of two and both groups met that learning goal at the end. Level 2 was indicated as the most difficult and the students needed information to understand the axis within Create@School and to apply the coordinate system. In addition the template was tested a second time with 12 students (1 girl and 11 boys) from Jordan (again the had units during the robocup club). At the end of these units the completed at least one level of the template.

Adventure Storytelling Template

Figure 5: Adventure RPG template

Development

The idea and the contents of the Adventure RPG template is based on the results from the focus group discussion with three girls in December 2016 (see Chapter 4.2) and based on the observations during the feasibility study at all. This game should especially attract teenage girls. All of these female students agreed that they like to play games like Sims were they are able to customize their own characters. The results of the survey during the feasibility study showed that girls like at most adventure and storytelling games. The Adventure RPG template tried to take into account characteristics of both genres and additionally integrate an inventory to collect items.

Evaluation

This template was used in May 2017 with a 5th grade in computer science over the period of ten school units, see **¡Error! No se encuentra el origen de la referencia. ¡Error! No se encuentra el origen de la referencia.**. The goal was to define the general applicability of this template, therefore the students were asked to randomly choose a school subject from a list prepared by NOLB team and adapt the template to this subject. The students had previous experience with Create@School, they used the app in the arts class in December 2016, see **¡Error! No se encuentra el origen de la referencia.**. Because some of the students were missing during the units, the total number of survey participants was 10, 6 girls and 4 boys.

After the introduction, the students had an opportunity to try out the example level of the template and evaluate it in a survey. Feedback can be seen in Figures 6 and 7. Students were not satisfied neither with the language of the example game, nor found the template example game easy to understand. Majority of the students evaluated the template with OK, only 2 students (girls) considered playing it as no fun.

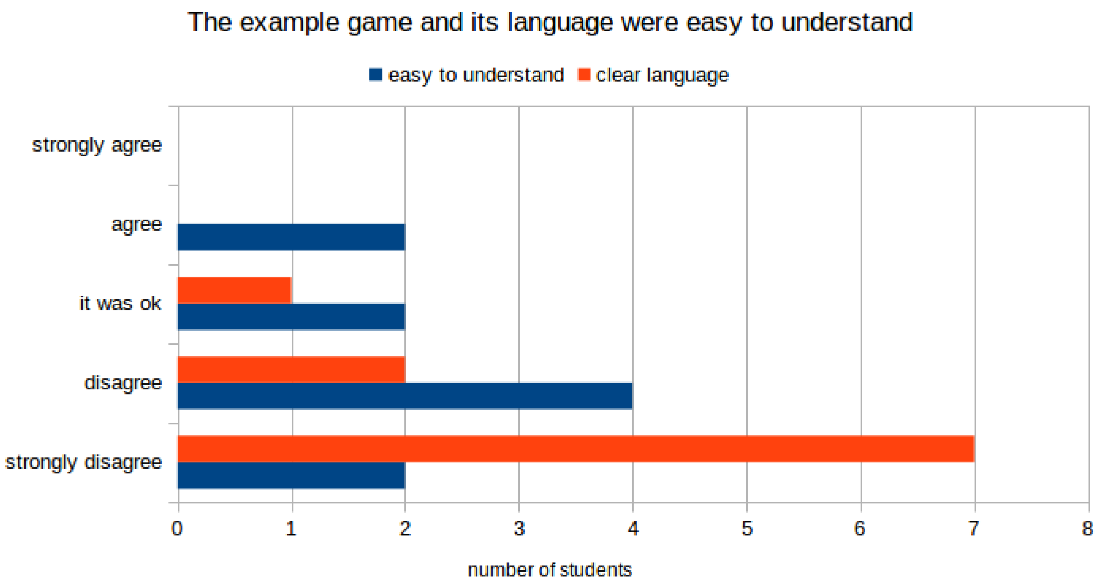


Figure 6 Feedback about the language and understanding of the Adventure Storytelling template example game

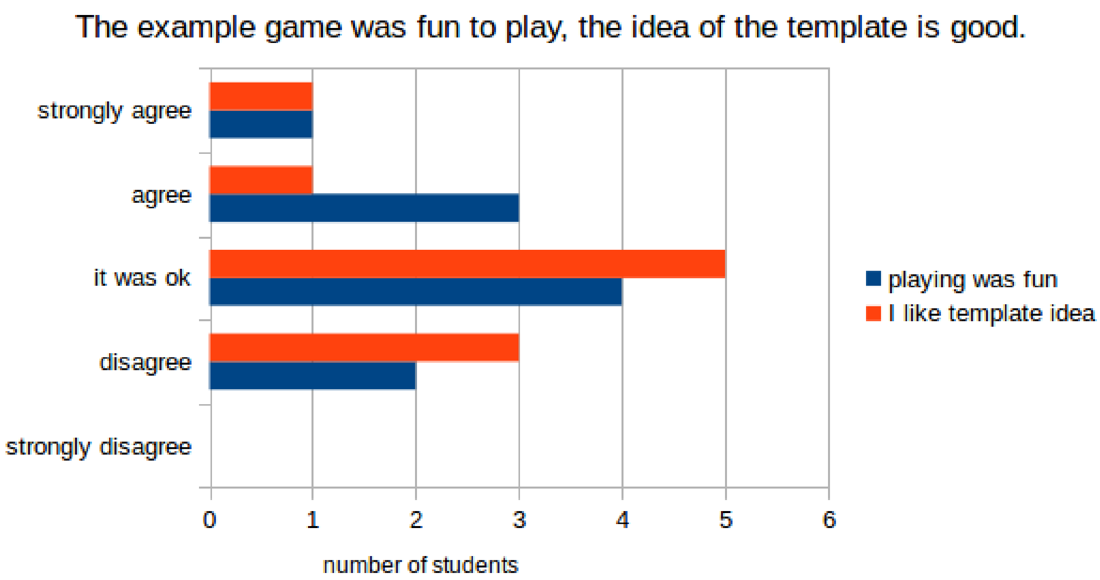


Figure 7 Feedback about the fun aspect and idea of the Adventure Storytelling template example game

During the last unit, the students were asked to fill out another questionnaire about their experience with the template in general. There were 3 students (2 girls and 1 boy) who found the template hard to expand. The language of the template was not clear to 4 students (3 girls and 1 boy), see Figure 8. As can be seen in Figure 9, when asked if it was easier to achieve the learning goal with or without template, 6 students (5 girls and 1 boy) would prefer to work without a template.

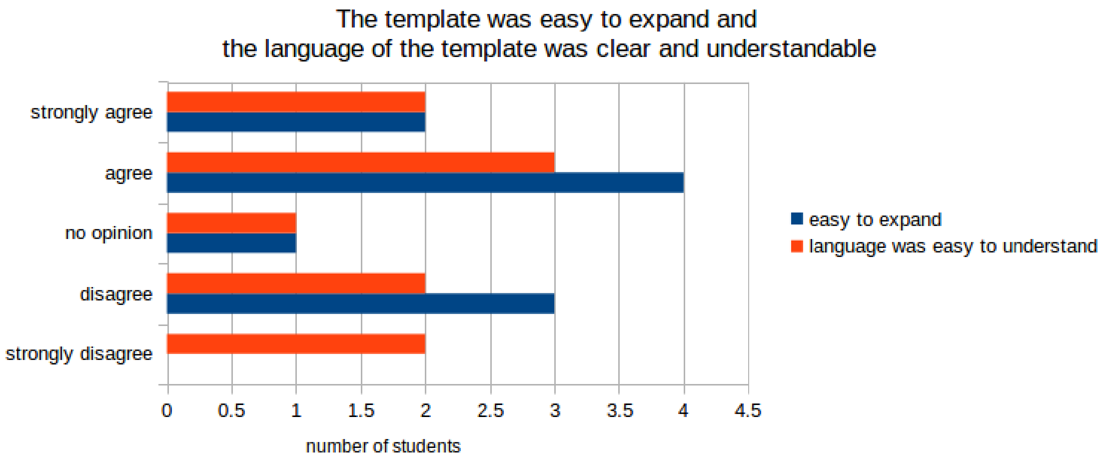


Figure 8 Feedback about the language and extendibility of the Adventure Storytelling template

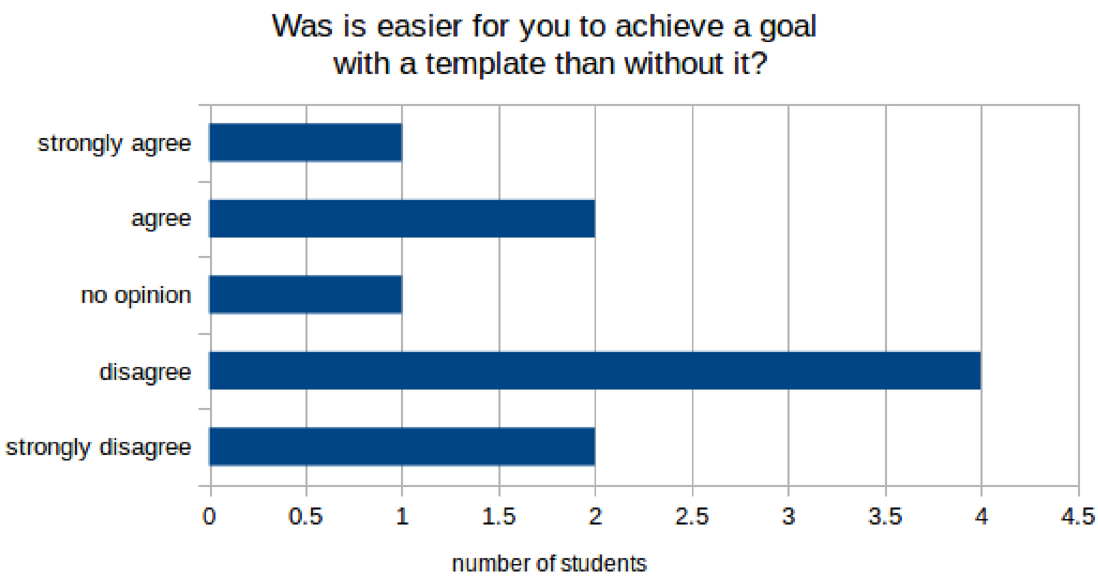


Figure 9 The evaluation of the Adventure Storytelling usefulness to reach the learning goal of the school unit

The students were asked to fill out a survey about their previous Create@School experience in the beginning of the introduction unit. During the last unit they were asked the same questions again. As can be seen in Figure 10, the results of the second survey are distributed smoother and follow a normal distribution.

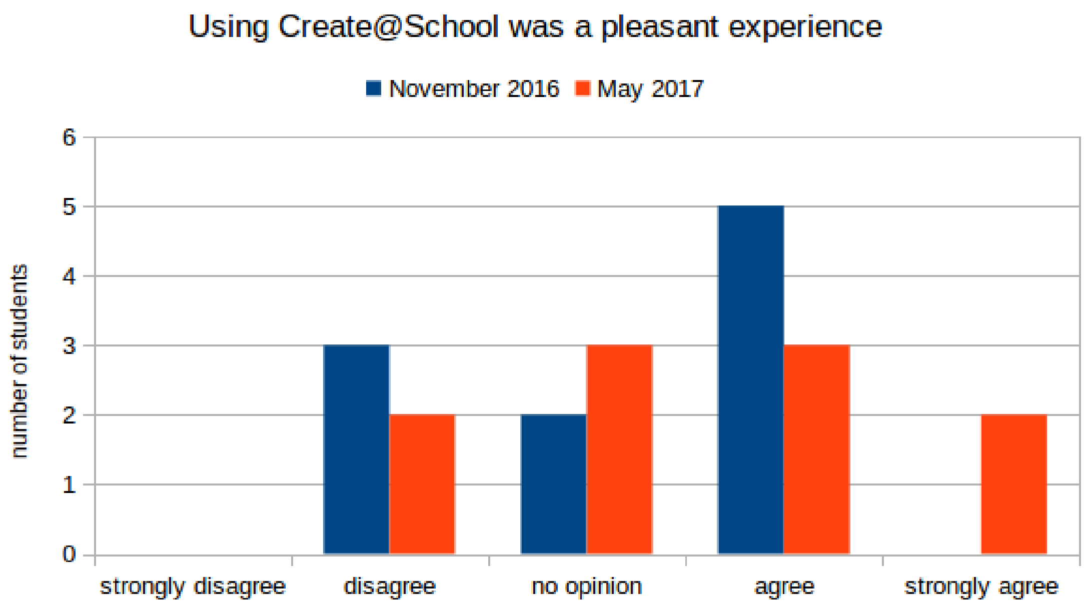


Figure 10 comparison of Create@School app experience with and without template.

As shown in Figure 11, after playing the example game of the template majority of the students were skeptical if the template could be applied to the subjects different from arts. In the final unit only one student (a girl) did not change her opinion and believed the template cannot be used for diverse school subjects.

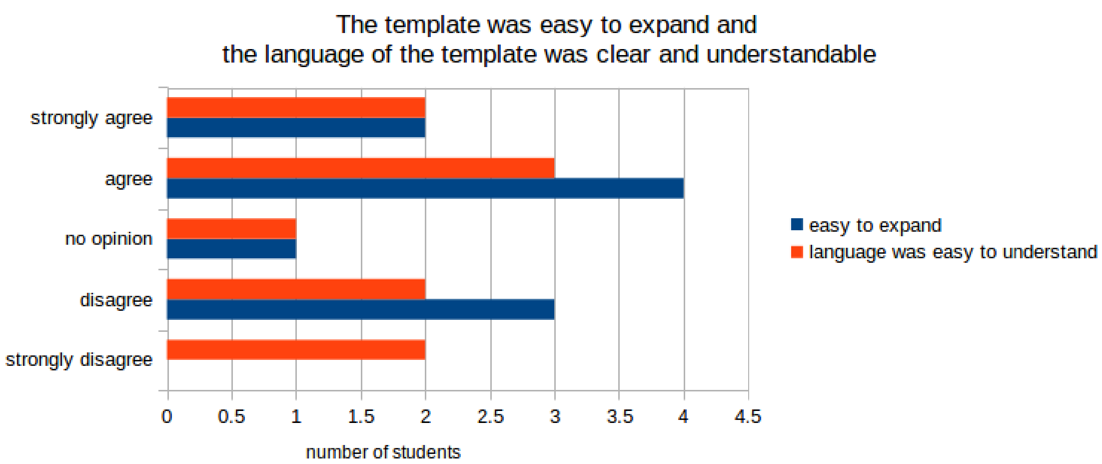


Figure 11 Students' opinion on whether the Adventure Storytelling template can be applied to different school subjects before and after they used the template

Evaluation of the Puzzle template

In addition, in Austria we used the puzzle template provided by GameCity in a 3rd grade, see **¡Error! No se encuentra el origen de la referencia.**. The teacher provided more or less a step-to-step guidance for the students which helped them where to change the code, so it was very easy for them to expand the template. In addition, they were asked to add their own drawings. Unfortunately, the teacher changed the goal of the template: Instead of an odd-one-out game, she defined that one answer is correct and two are wrong. In that case, she changed the game idea to a simple quiz game and add a new question to each scene. This was the reason why students were first confused because the correct answer is marked in red and the wrong in green. I think in Austria the "odd one out" principle isn't that common.

2.3.7 Templates: Summary and suggested improvements

The challenge for developing the templates was, on the one hand, to pre-program the templates in an efficient way which provides students with sufficient functionalities to aid the process of building a new game; the templates must explain the important dynamics, mechanics, and aesthetics of a game (like coding how to reward the achievements or how to collect points). On the other hand, students should have the freedom to express themselves in a creative, fun, and dynamic way (e.g. to change images, sounds). Every class project should show them different methods to achieve the goals in a way which supports their logical thinking processes.

During the summer 2017, all templates and tutorials will be revised. Table 10 provide emerged challenges and offers possible solutions.

Challenge	Solution
students seems to ignore all occurred texts (in graphics, note bricks)	instead of text boxes, use graphical hints / descriptions
the script view in several objects seems to be too complex	put scripts students need to understand/adjust on the top of the script list
naming and amount of variables / broadcast messages are confusing	Refactor naming and amount (more local variables instead of global)
students have no idea how and where to start	Mark/rename scenes, object, groups and looks that should be changed
Students can't find the hint in the test or they are too complicated	Avoid long texts in note bricks (just give a small hint) and try to explain the tasks during the game play
Students which are faster have to wait for their colleagues	Add extra tasks for them
For every tutorial we have to describe the shape of a game and how to extend it	Explain the shape in one general template Maybe provide one template that has only the shape of a game (start, instruction, end screen) – could be used to program a game from scratch
Provide all templates in portrait and landscape mode	Much work: the last four are only in portrait mode. Landscape will be added in July 2017

Table 10: Suggested improvement for the templates

2.4 *Statistics*

In this section statistics were presented. First, the final programs per course were summarized. Second, the overall number of uploads and downloads within the second cycle (October 2016 – June 2017) from Austrian NOLB students were summed up.

2.4.1 Programs statistics

The Tables 11 to 13 present all uploaded and finished programs per course (should be more or less one per student or as a group work).

School	Grade	Subject	Number of students	Number of uploaded programs
GIBS	3b	Physics	26	12
	5a	Computer Science	24	6
	5b	Computer Science	25	13
	5c	Computer Science	24	8
	5c	Arts	24	4
	6b	Arts	25	7
Akademisches Gymnasium	2a	Arts/Language Learning	29	15
	5a	Computer Science	21	10
Borg Birkfeld	5c	Computer Science	13	6
	5a	Music	21	10
			Total	**91**

Table 11: Uploaded and finished programs feasibility study

During the 1st cycle, we supervised 2 courses at 1 of our partner schools.

School	Grade	Subject	Number of students	Number of uploaded programs
Akademisches Gymnasium	5a	Computer Science	9	-
	2a	Physics	29	20
			Total	**20**

Table 12: Uploaded and finished programs 1st cycle

During the 2nd cycle, we supervised 10 courses at 3 of our partner schools.

School	Grade	Subject	Number of students	Number of uploaded programs
GIBS	5a	Arts	24	8
	5b	Arts	25	8
	5c	Arts	26	9
	5c	Computer Science	12	10
	3a	Physics	25	22
Akademisches Gymnasium	3a	Arts	29	23
	3a	Physics	29	25
	8a	Computer Science	11	4
Borg Birkfeld	5a	Computer Science	19	12
	6a	Computer Science	6	-
			Total:	**121**

Table 13: Uploaded and finished programs 2nd cycle

Total number of final programs: 232 programs

2.4.2 Web-share statistics

All NOLB students have a common username and are represented as an own table in our SQL database. In the following, we present the upload and download statistics from the Austrian students from October 2016 to May 2017.

Number of uploads in total	**408 programs**	
Uploads from girls	187 programs	
Uploads from boys	222 programs	
Uploads GIBS	143 programs (53 m, 90 f)	
Uploads Akademisches Gym.	140 programs (43 m, 97 f)	
Uploads Borg Birkfeld	125 programs (126 m, - f)	
Used tags	No tag	37 times
	Game	224 times
	Experimental	74 times
	Animation	60 times
	Art	28 times
	Story	22 times

Table 14: Number of Uploads in Austria

Number of downloads in total	**344 programs**
Downloads from girls	92 programs
Downloads from boys	252 programs
Downloads GIBS	88 programs (37 m, 51 f)
Downloads Akademisches Gym.	56 programs (26 m, 39 f)
Downloads Borg Birkfeld	191 (189 m, 2 f)

Table 15: Number of Downloads in Austria

Although, only one class from Borg Birkfeld participated during the second cycle, they had the most downloads and many uploads. This class took part in the Galaxy Game Jam event and therefore they were highly motivated to create a really good game.

Students mostly uploaded more versions of their own games (after every unit) and mostly downloaded their own games or the games from their classmates (e.g., to merge it to one big game). But the download numbers also show a games from the front page of the web-share (section most downloaded, etc.) and also some remixes (games that have been downloaded, changed and uploaded again) were present in the upload list.

Another important observation is that even we had more girls than boys in the study, more boys uploaded and downloaded games at all. Boys downloaded almost triple that number of games than girls.

3 THE AUSTRIAN PILOT'S PLAN

In Delivery 5.2 the plan for the small-scale pilots' validation set-up was defined (schools, courses, etc.). In this sections, we describe all carried out actions in Austria in reference to the Gantt chart, see Figure 7 and how they were put into practice. At the end of this section two important points will be discussed:

- Acceptance of Create@School (by teachers and students)
- Teachers intention to use Create@School after the project

3.1 *Progress of the performed work*

The following sections refer to the Gantt chart, see Figure 7. The description of the first task the "Setting-up" were already part of the Deliver 5.2. In the following the remaining tasks will be described: the Pocket Code approach, the development of pedagogical teaching content, teachers' training, and student's training as well as the evaluation phase in Austria (as part of Chapter 4).

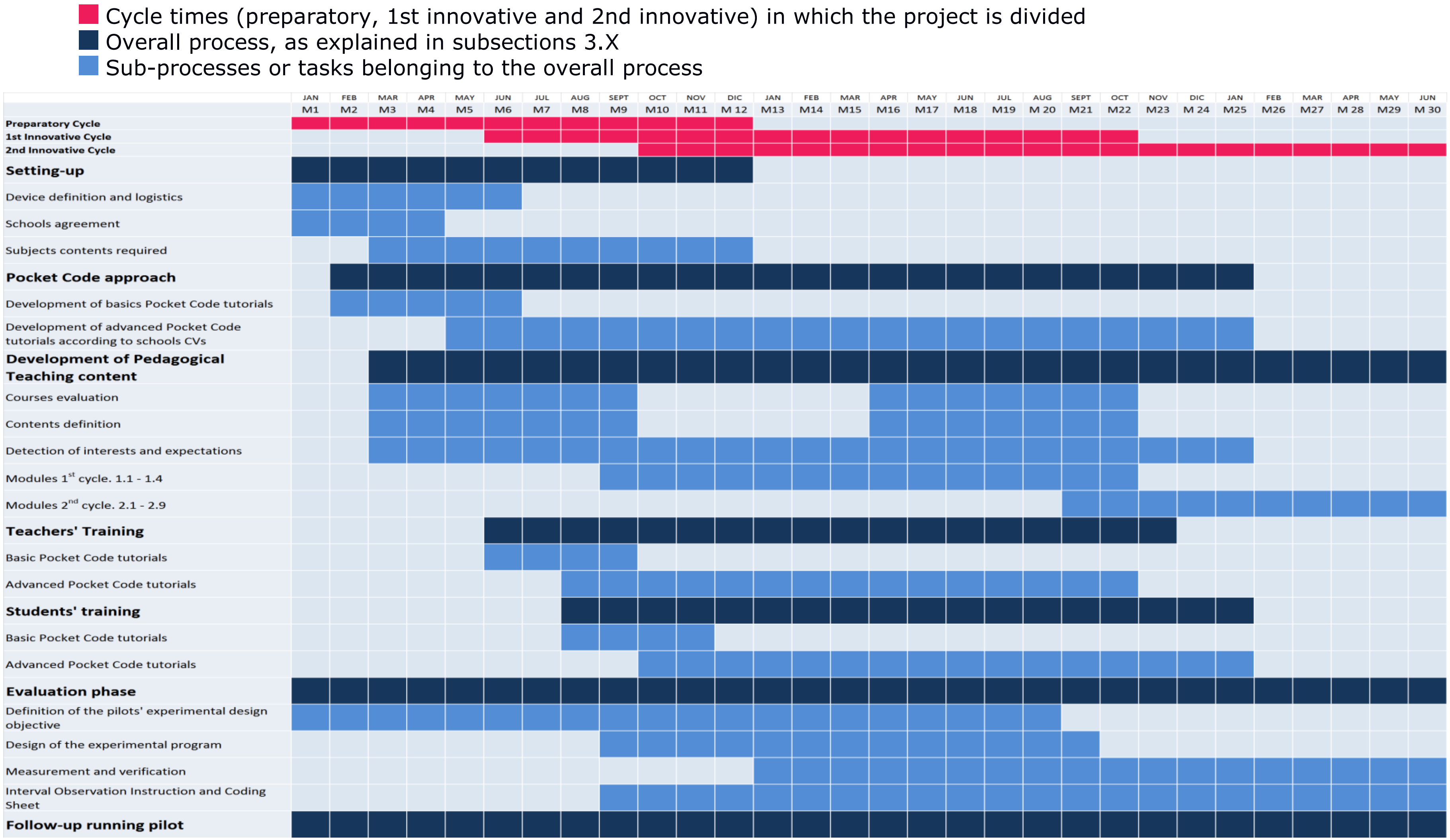


Figure 12: No One Left Behind pilots' Gantt chart

3.1.1 Pocket Code approach

These tasks covered the development of tutorials (M2 - M24): Basic Pocket Code cards as well as advanced Pocket Code tutorials according to schools CVs in reference to leisure gaming techniques. Another task was to generate example programs for teachers and to add new bricks that support gaming dynamics in Pocket Code.

The basic tutorials (developed in M2 – M6) summarized simple steps like how to change the size of objects, how to play a sound etc. These one were very similar to the Scratch cards form the Scratch MIT team, see https://scratch.mit.edu/info/cards/. The basic tutorials can be found here: https://share.catrob.at/pocketcode/tutorialcards and were also available for download (as a pdf-file), see Figure 6. They were helpful for short introductions, small workshops and beginner steps but not for specific use cases, e.g., how to make score etc.

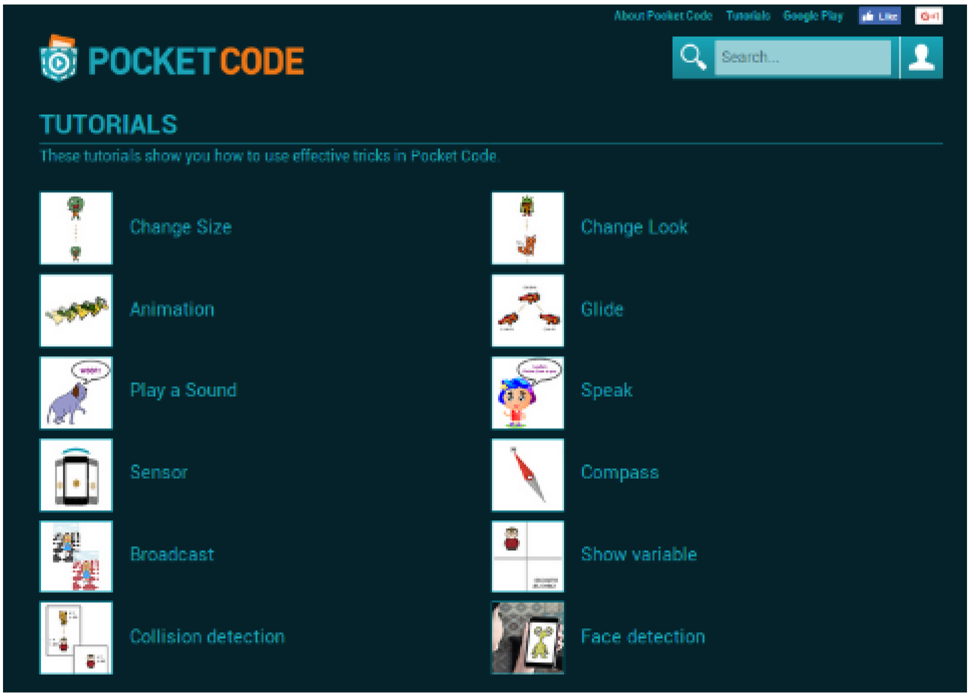


Figure 13: Pocket Cards

In addition to these tutorials a first version of a brick documentation was produced, see https://edu.catrob.at/sites/default/files/pictures/Bricks-on-paper_PRINTversion.pdf.
The corresponding actions carried out in the time from M5 – M25 had the aim to provide more useful tutorials, game design steps and use cases as well as tutorial cards for the created templates. This was done in three stages:

First, in M12 necessary game design tutorials with the Alice theme were developed, see Figure 7. These one were used to promote the Alice Game Jam event to help novice to submit a game as well.

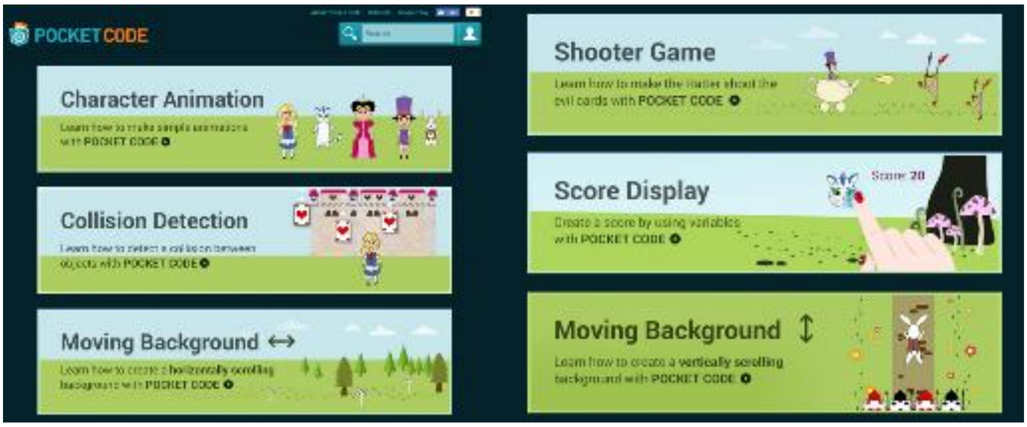


Figure 14: Alice themed tutorials (game design)

Second, during the first cycle (M17 – M21) the Create@School app has been developed. The feasibility study showed a huge demand on improving the usability of the app as well as developing new features to make the app easier to use for the target group. Therefore, 47 new features and improvements have been realized during the first cycle, e.g., a more accurate and easy to use detection between objects, the integration of the physics engine Box2D to make more dynamic games, or speech bubble for story telling games. These features have been already described in Delivery 4.2. Consequently, a lot of tutorials were getting useless or outdated after the release of the school featured app in October 2016. For special use cases there exists now easier ways to achieve the goal with the help of new bricks or the UI changed and the used screenshots do not fit anymore. Therefore, it was necessary to update all templates. Also the basic steps were updated and altogether a number of 21 tutorial cards were created (see Figure 8). They can be found here: https://edu.catrob.at/pocket-cards.

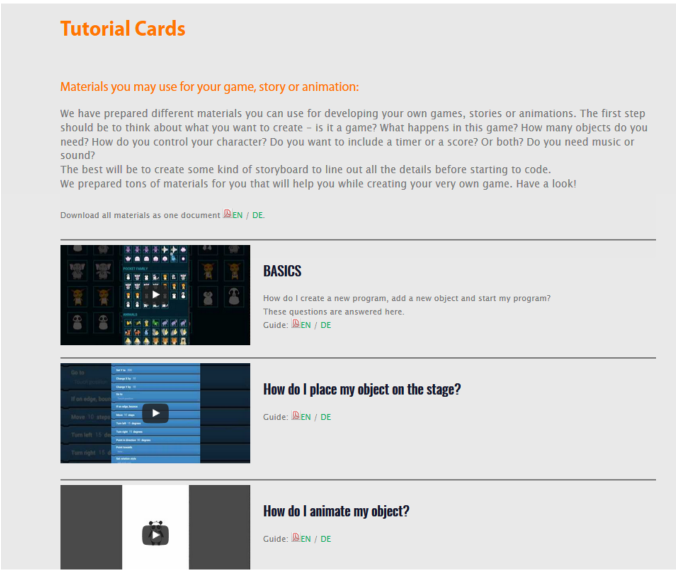


Figure 15: New Tutorial cards summer 2016

These tutorial cards can be downloaded as a pdf document and are currently available in two languages, German and English. For the future it is planned to make the process of updates and translations easier. This should be done via the mediawiki by user created content. In that case the users itself can add screenshots and tutorials in their language.

In 2016 the game jam event was dedicated to the topic galaxy. For this reason, aliens, planets etc. were used to create tutorials, see Figure 9. In addition, especially for the Galaxy Game Jam event more beginner steps were explained, e.g., how to install the app and Pocket Paint, how to upload games etc.

Figure 16: Galaxy Game Jam themed tutorials

Third, the mediawiki was introduced and accessible through the app. By tapping on the bricks help option within the app the user is redirected to the mediawiki, see Figure 10. At this page he or she can find a description for all bricks and short videos (available in German, Spanish and English). The mediawiki is available through: https://wiki.catrob.at/index.php?title=Brick_Documentation

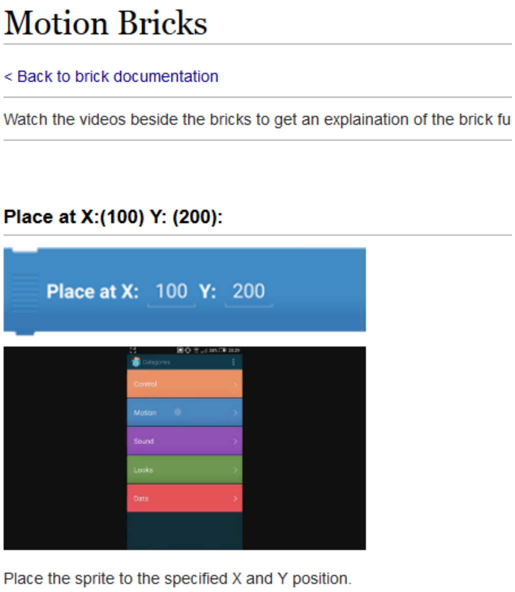


Figure 17: Mediawiki: Control bricks

Finally, in M24 an own dedicated space for NOLB tutorials was integrated in the education platform (see https://edu.catrob.at/no1leftbehind). This pages offers an own space for students, teachers as well as parents, see Figure 11. A more detailed description can be found again in Delivery 4.2.

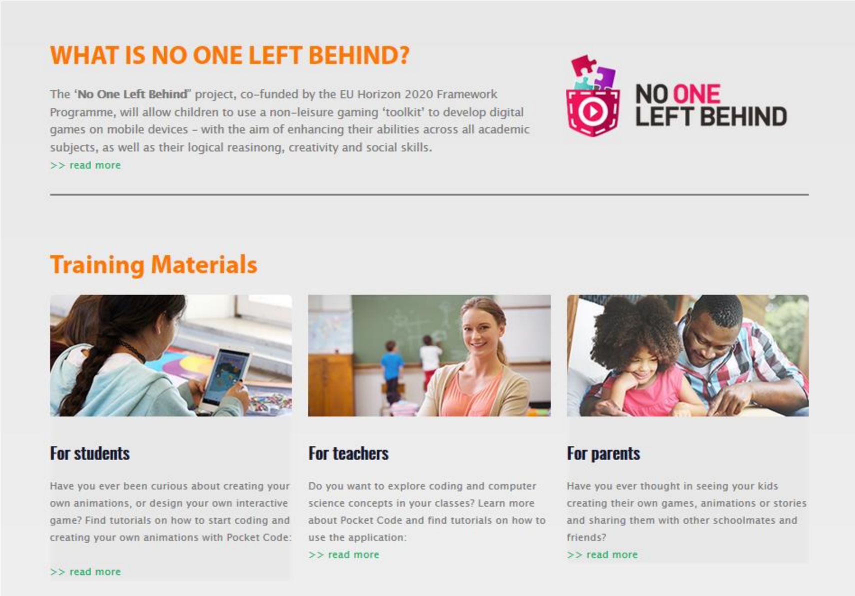


Figure 18: No One Left Behind on the edu-platform

Teachers, students as well as parents can find tutorials, lesson plans and a FAQ-section here. In addition, from M21 – M30 tutorials for the templates has been produced and translated in the pilot's languages English, Spanish and German. For each template an own tutorial exist for teachers (a gradual description how to use the template in class) and for students (a more step to step tutorial to click through).

3.1.2 Development of Pedagogical Teaching content

The tasks aims to define the key contents of each course where Pocket Code could add value and support the teaching/learning processes. Main tasks included the courses evaluation and contents definition (M2 – M8 & M16 – M22) as well as the development of the 13 modules (=templates).

In Austrian we introduced Pocket Code in the following curricula subjects: physics, music, arts, language learning, and computer science. The preparation of the feasibility study took current curricula and lesson plans into account. For preparation, suitable classroom projects, use cases, and templates were created for use with Pocket Code in different courses. Eleven teachers participated on a voluntary basis in the Austrian study and were invited to use the material during their classes. They provided feedback for improvement in a later stage. These teachers, their subjects, background was already described in Table 1 to 3. A description of how they used Pocket Code in their courses are visualised in Tables 14 to 16. Before the start of the feasibility study (M6), a first engagement workshop for students was organized. In addition, teacher meetings and training sessions were conducted to ensure a smooth start and to kick off the feasibility study (M9 – M10). Moreover, an online questionnaire was set up to collect information about the teachers' digital skills and abilities (participating teachers: 1, 2, 3, 4, 7, 8, and 13, teacher numbers are assign in table 1 to 3). This was done in M5. It helped to gain a better understanding of how resources such as training materials can be optimized to fit teachers' needs. The results of the questionnaire showed in Austria that all of them had already used digital media in their classes e.g., presentations, links, video clips, and all except two teachers (7, 8) also used boards/forums, or blogs and other tools for group discussion, or interactive elements such as mobile quizzes or polls. Five out of seven mentioned that they used the school's Management Information System (MIS) to electronically record and monitor information about student's attendance, behaviour, and achievements. Two teachers (1, 7) mentioned that they play computer games

for fun and enjoyment and already used computer games in while teaching their classes.
During the feasibility study (FS), eleven courses were performed; during the first cycle (FC), two courses; and during the second cycle (SC), nine courses. Teachers could decide whether the students should work in small groups (SG) on a joint program (every student should then create one game level which at the end would be merged into one big game); do pair work (PW), where two students work on the same program (either at one or at two tablets); or work individually (I). In addition, teachers could ask the project team for assistance during their lessons for questions specific to Pocket Code. During the feasibility cycle, the team tried to take the role of observer rather than guide.

Course No.	Pilot phase	Teacher No.	Students	Topic and Learning Goal	Learning scenario
1	FS	1, 2, 3, 4	48 Year 10	Topic: book retelling Goal: To program an interactive quiz game in computing to a book read in English class.	SG
2	FS	4	6 Year 10	Topic: Game design Goal: Create a simple game (start, instruction, game, and end screen).	I
3	FS	5	26 Year 8	Topic: Density of objects and liquids Goal: Create a game where objects glide according to their physical properties (density) and apply the formula.	PW
4	FS	6	20 Year 10 & 20 Year 11	Topic: Game design Goal: Create a game and finish one level per student.	SG
5	SC	6	75 Year 10	Topic: Game design Goal: Add a start and game over screen, avoid/ catch something, or tell a story and add an interactive part.	SG
6	SC	5	26 Year 8	Topic: Newton's 2nd law of motion Goal: Create a game where objects glide according to their physical properties (mass, acceleration) and apply the formula. Used template: Physical simulation	I
7	SC	4	12 Year 10	Topic: game design Goal: Create an adventure RPG game and apply it to different subject areas e.g., biology, music, etc. Used template: Adventure RPG	I

Table 16: Courses at GIBS

Course No.	Pilot phase	Teacher No.	Students	Topic and Learning Goal	Learning scenario
8	FS	8	29 Year 7	Topic: Alice in Wonderland Goal: Create a vocabulary game by adding missing parts within the code.	PW

9	FC	7	12 Year 10	Topic: Game design Goal: Create a Quiz template for Year 7.	I
10	FC	7	29 Year 7	Topic: Structure of matter Goal: add five questions to the quiz. Used template: Quiz	PW / I
11	SC	8	29 Year 8	Topic: renaissance, baroque, and Romanesque Goal: Create a puzzle game with your graphics. Used template: Puzzle	PW/I
12	SC	8	12 Year 13	Topic: game design Goal: create an adventure game (start, game, end screen) and a quiz with 5 questions. Used template: Quiz	SG / I
13	SC	7	29 Year 8	Topic: Physical experiments Goal: Add an explanation and animation of a performed experiment. Used template: interactive book	I

Table 17: Courses at Akademisches Gymnasium

Course No.	Pilot phase	Teacher No.	Students	Topic and Learning Goal	Learning scenario
14	FS	9	13	Topic: Quiz about computer science Goal: Create a quiz.	PW
15	FS	10	21	Topic: Quiz about musical instruments Goal: Add sounds and catch the used musical instruments.	PW
16	SC	11	17	Topic: Galaxy Goal: Create an action game (start, game and end screen).	I / SG

Table 18: Courses of Borg Birkfeld

Teachers who had introduced this gamified approach during the feasibility study and the first cycle used the app Pocket Code. Teachers who had classes during the second cycle used the app Create@School. This special version was developed for use at schools. It integrates examples in the form of predefined templates, as well as advanced features that should simplify the programming experience for students.

The tasks Modules for 1st cycle (M9 – M22) and Modules for 2nd cycle (M22 – M30) represent the developed templates which has been already descripted in section 2.3.4. Development of the Create@School app. The evaluation of the templates showed that they encourage learning by doing, allow the expression of one's own ideas, and provide a visual programming language that is easy to understand and to learn. The project's goals were archived by linking the generated game templates to the program and design patterns of commercial games and thereby effectively support the development and adaptation of the learning material in a structured and replicable manner.

3.1.3 Teachers training

These tasks cover on the one hand instructions, trainings and discussions with teachers and on the other hand steps to structure the academic curriculums in lesson plans and to adapt and the design the academic curriculums for integration Pocket

Code. In addition, in M28 the Project Management (PMD) for teachers was introduced.

After the feasibility study we decided to provide more mandatory trainings for all teachers, as well as one-to-one trainings to prepare specific units. This should allow teachers to feel better prepared for their lessons by reassuring them that they will be able to conduct their lessons without assistance, regardless their technical background. Therefore every unit was discussed in detail and a lesson plan was filled out to define learning goals, the sequence of the units, the time they can assign to Pocket Code in their classes and other objectives of these units.

To help the teachers in the assessment and feedback process of students' projects, a Project Management Dashboard (PMD) was introduced and a tracking of analytics data, including both qualitative and quantitative data. This was tested with three teachers (teacher 4, 7 and 8). They were told to add a class, to add students and to create a project. The students submit their programs via a unique program id and the teacher could see all the submit projects in an overview. This sequence was described as very strait forward and easy to understand by teachers. The evaluation of the Austrians teachers who used the PMD can be found in Delivery 5.5 report and findings from experimental pilot in Spain.

3.1.4 Students training

These tasks (M8 – M25) compromise a deep learning via the basic tutorials (see section 3.1.1), templates, game making process, academic content and computational skills and expressions needed for coding. For the introduction unit / teaching approach we used three different methods:

Approach 1: *Providing a Pocket Code framework*
Students received a framework in which specific parts of the code were missing (indicated by a note brick): e.g., collision detection or using inclination sensors, see Figure 13. Within small groups the team developed this missing functionality together with them to guarantee student-centered classroom, where students learning and discovery is in their own hands. This framework provided the basis for the developed templates in the second cycle.

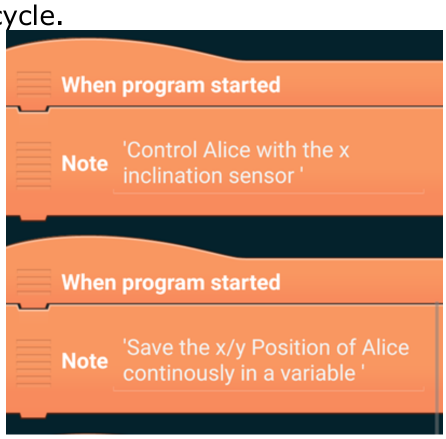


Figure 19: Specific parts in the code are missing indicated by a "Note"- brick

Approach 2: *Programming session together*
Students got a short introduction unit including a hands-on sessions guided by the team and tutorial cards. In these sessions one student at a time comes to the front of the class and tries to add one small but meaningful new feature to the game being developed by the class, see Figure 14.

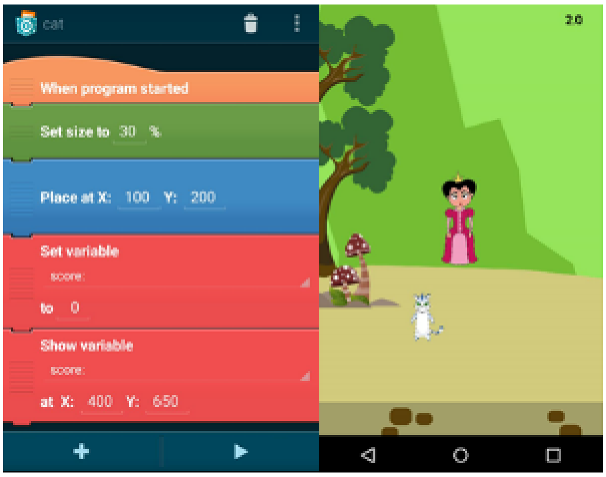


Figure 20: Hands-on sessions guided by the team and tutorial cards

This developed instruction game changed according to the theme/content of the units. E.g., for a physics unit a ping-pong game that makes use of the physics bricks was developed, see Figure 15.

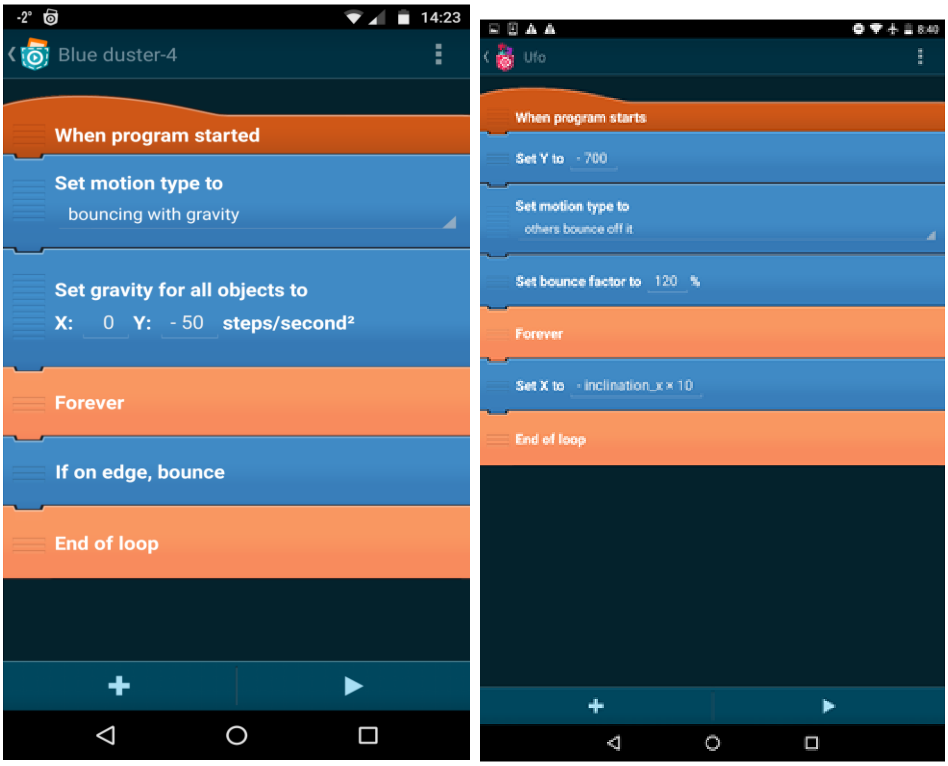


Figure 21: Instruction lesson physics engine

Approach 3: *Free Style Programming*
Students got a physical flashcard system to put together scripts and predict outcome, see Figure 16. They could freely choose the topic of their games and therefore take charge of their own learning process.

Figure 22: Pocket Code bricks as physical flashcard system

These instruction units were followed by two or three double session units were the students worked on their specific project. In many cases the students start with drawing a storyboard to have a clear image of their game and to identify the needed game element, characters and programming concepts. In the last unit we gave the students the chance to present their games in front of their peers. Therefore, we had the chance to ask additional questions, e.g., problems they had during programming, what was fun, what was disturbing etc. All these comments are summarized in the Appendix **¡Error! No se encuentra el origen de la referencia.** Uploaded game statistics. The NOLB team tried to attend all units. In that case we could make notes, write down our observations, and detect bugs or difficulties of the app itself.

3.1.5 Evaluation phase

This compromise the definition of the experimental design as well as measurements and verification (M1 – M30). These tasks are part of the next Chapter 4 Results of the Create@School evaluation.

3.1.6 Follow-up running pilot

These tasks (M1-M30) summarized the continuous tracking of the usage of games developed in Pocket Code, the support and help of teachers during lesson and continuous feedback form teachers and students.

In Austria in all lessons at least one NOLB member was present to 1) support and guide the students and the teacher and 2) to make observations, notes and to conduct interviews. Support in form of lesson plans, meetings, tutorials, the PMD, were already described in the previous sections.

3.2 *Summary teachers*

This section summarizes feedback from teachers collected via interviews, on-site observations, and discussions. First, their experiences during the feasibility study and the first cycle have been summarized and compared with the students' outcomes. Based on these results, the following actions have been performed: the new school app Create@School has been developed and improvements for the setup of the courses have been implemented. Second, these efforts have been evaluated through usage by teachers and students in the second cycle.
The outcome of the feasibility study (students n=187) showed diverse results. Data was collected in two ways. First, the students took part in three quantitative surveys (before, during, and after using the app Pocket Code) to question their attitude towards the learning material and the application of Pocket Code in the lessons. Second, the learning objectives defined by the teacher beforehand were measured against the learning outcomes. By the end of the feasibility study, 105 out of 172

project submissions were rated clearly positive, meaning the students fulfilled the learning goal defined by the teachers. This shows the potential of Pocket Code to act as a supportive learning tool by leading to the accomplishment of academic curriculum objectives. To get feedback from teachers, they were asked at the beginning of the study to journalize each lesson. In addition, we had a debriefing with all teachers in March 2016 (before the start of the 1st cycle).
The evaluation of the student surveys and the teachers' feedback were not uniform but mixed throughout both groups (teachers and students), showing points of improvement for the use of Pocket Code at schools. Suggestions for improvement not only include the application itself, but also the style of teacher training and support, preparation of tutorials and lesson content and the backing of the courses. Consequently, only seven teachers (teacher 4, 5, 6, 7, 8, 11 and 13) decided to continue with the project during the cycles (FC, SC). Teacher 1 and 2 (who were both working on the same projects, both non-technical) were disappointed about the students' outcomes and expected more advanced games from their students. As a result, the students felt quite stressed during the course, thus leading to a bad experience for them as well. These two teachers never programmed with Pocket Code on their own, showed no interest in learning about programming, and expected the students to find out everything on their own, e.g., search for help online. In addition, the 15 to 16-year-old students are used to relatively sophisticated games (e.g., World of Warcraft3). With Pocket Code, however, they have to downgrade their expectations and hence their implementation that the games become curiosities. Teacher 3 and 9 both have a technical background and are advanced programmers. Teacher 3 had already programmed with Scratch, but at that time Pocket Code was not fully Scratch compatible and lacked comfort-functionality like automatic collision detection. Both initially had high expectations towards the app but were eventually disappointed as well.
The remaining group of teachers was highly motivated to work with the app during the experimental cycles. These teachers had either more than one class at one time (e.g., teacher 6), several classes in different subjects (e.g., teacher 7 and 8), or the same class in several of the same subjects (teacher 6, 7 and 8). However, they also said that certain parameters need to be established in order to guarantee future success of the units. Teacher 6 evaluated the Pocket Code exercise of his students precisely [25]. His recommendations included to

1) Design a well-structured pedagogical framework to avoid an overload of technical complexity,
2) Prepare a hardcopy handbook that promotes the overview of all bricks and their functions, along with frequently used brick combinations, and to
3) Limit the project duration to 4-5 double lessons in order to concentrate work towards a deadline and prevent student fatigue with the project.

Based on these results, the focus during the first project cycle was twofold. First, the team decided that the app should become Scratch compatible with a main focus on usability and feature completeness. As a result, 47 new features were developed during the first cycle, which lead to a specialized app for use in schools with the name Create@School. This special flavor of Pocket Code was published in September 2016 as a beta version at Google Play for use at our pilot schools during the second cycle. Second, the team developed more appropriate teacher guidelines, predefined game templates, and resources for teaching. In particular the team provided 1) very general tutorials, e.g., beginner steps, brick documentations, and video tutorials4, 2) specific templates for certain lessons/genres (e.g., action, adventure, puzzle, and

3 https://worldofwarcraft.com
4 https://edu.catrob.at/

quiz) available within the menu of Create@School, and tutorials for teachers, and 3) more mandatory trainings for all teachers, as well as one-to-one trainings to prepare specific units. This should allow teachers to feel better prepared for their lessons by reassuring them that they will be able to conduct their lessons without assistance, regardless their technical background.
During the second cycle (n=160), teachers used predefined templates for their courses (teacher 3, 5, 7 and 8). Teacher 6 again used a package of laminated analogue cards of the Pocket Code bricks, first to translate their composed narratives into coding threads; in a second step, students programmed a game from scratch. Students in the course of teacher 11 started with their own action games. For a preliminary evaluation, the data of six courses (4 teachers) has been observed. Two teachers used a template in their courses (n=47, Year 8), and two teachers told their students to work in small groups and to start a game on their own (n=79, Year 10). This time, 31 students who used a template achieved the learning goal (16 students did not) and only 38 students who started with their own programs achieved the goal (41 students did not). This ratio of successfully reaching the learning goal to failing, clearly shows the advantage of using templates instead of developing from scratch. The feedback and experience of teacher 6, who did not use a template (but used prepared material for guidance, e.g., tutorial cards), was very similar to his previous courses during the feasibility study and the students again needed a lot of guidance. On-site observations led to the conclusion that the students did not properly define the goals of their games and hence lost focus. Additionally, they had only two double units instead of four, like in the feasibility study, for finalizing their games. Consequently, these students were once again frustrated, stressed, and not able to finish their games (thus they did not reach the learning goal). Teacher 6 felt discouraged as well.
The rest of the teachers felt more confident during the lessons due the use of predefined templates or the tutorial cards. On-site observations showed that the students had less questions, were very concentrated, worked on their own, solved the underlying problems, and felt engaged with the whole class. Since everybody had the same learning goal, they also had similar problems and in that way could help each other.
All seven teachers (and additionally teacher 11) are planning to continue working with Pocket Code after the NOLB project and plan to integrate Pocket Code permanently in their lessons.

Teachers who used the templates with a given learning goal needed to adopt them to their subject. On one hand, they needed more time for preparing their courses or they needed more individual meetings with the NOLB team. On the other hand, the classroom atmosphere was much more relaxed because teachers guided the students more by focussing on the topic rather than explaining complex program structures to them. Most teachers (5, 7, 8 and 13) switched from group or pair work to individual work. The reasoning was that individual work fosters computational thinking. If everybody is working on the same problem, everybody could find a different solution for it. In this way, students are able to support each other, working independently but in small groups, thus feeling more engaged as a result. Furthermore, it has been observed that if everyone is working on one level of a game (and on their own problem), much more stress arises because everyone has to work on his or her own problem in order to merge it together into one game at the end.

The observations showed three similar challenges for teachers:

- their confidence in teaching computing as a subject,
- structure of the course and defining the learning goal, and
- the issue of having enough technical support in the classroom.

In order to give teachers more confidence and guidance in future, it has been planned to create a hardcopy book as proposed by teacher 6. These strategies could help teachers to feel more confident in using Pocket Code in the classroom.

Finally, we conducted a questionnaire with all teachers from the second cycle. The evaluation of these questionnaires will be again part of the Spain Delivery 5.5.

3.2.1 Future Work with teachers

On 27th of June 2017 we had a final meeting with all teachers form the second cycle to finish the project, present results, provide an outlook and thanking the participating teachers and students (who assisted during the lessons). The teacher 4, 5, 6, 7, 8, 9 and 11 asked us already if it is possible to have our support in the next semester in autumn 2017. The following is planned:

- teacher 4 will continue to use the predefined templates
- teacher 5 will create a new template for another physical experiment
- teacher 6 will continue allowing students to create their own game ideas but with a clearer topic
- teacher 7 and 8 will do a game with the Arduino feature
- teacher 9 will do a game with the EV3 Lego feature
- teacher 11 will ask the students again to create action games (to the topic Magic)

We will support them further with preparing these lessons and continue with our research (with a focus on girls).

3.3 Summary students and courses

In this section we provide an overview about all courses per cycle. Therefore, we describe the constellations of the teams/classes, link to the corresponding lesson plans (to check whether or not the learning goal has been achieved and to see the amounts of units), and provide an overview about the created games, our notes/observations as well as students collaboration, persistence and engagement.

3.3.1 Feasibility study (M1 – M12)

Pilot School 1: GIBS

At the GIBS we had six classes: a 3rd grade in Physics, one 5th grade Computing, two 5th grade who had interdisciplinary lessons in English / Computing and the same 5th and another 6th grade in fine arts. In the following for each class an overview of the uploaded games will be provided to summarize if the learning goal was achieved, to show their engagement, and persistence and list comments from the TU Graz team.

Class	Accounts	Groups	Topic and Learning Goal	Learning Goal
3b Physics	profile/3610	10 teams of two 2 teams of three	Topic: Density of objects and liquids Goal: Create a game where objects glide according to their physical properties (density) and apply the formula.	6/25
5a Computer science	profile/3598	Individual work	Topic: Game design Goal: Create a simple game (start, instruction, game, and end screen).	4/24
5b English / Computer Science	profile/3600	3 teams of two 3 teams of three 1 team of four	Topic: book retelling Goal: To program an interactive quiz game in computing to a book read in English class.	10/ 24
5c English / Computer Science	profile/3601	2 teams of two 2 teams of three 2 team of four 1 team of five	Same as 5b	17/24

5c Arts	profile/3607	1 teams of five The rest in teams of 2/3	Topic: Game design Goal: Create a game and finish one level per student.	5/26
6b Arts	profile/3606	2 teams of two 2 teams of three 2 team of four 1 team of five	**¡Error! No se encuentra el origen de la referencia.** as 5c	14/24

Table 19: FS: Pilot School 1: GIBS

Pilot school 2: "Akademisches Gymnasium"
At the "Akademisches Gymnasium" we had two classes: a 2nd grade in Arts and a 5th grade in Computing.

Class	Accounts	Groups	Topic and Learning Goal	Learning Goal
2a: Arts	profile/3475	14 teams of two 2 teams of one	Topic: Alice in Wonderland Goal: Create a vocabulary game by adding missing parts within the code	25/29
5a: Computer science	profile/3534	9 teams of two 1 team of three	Topic: game design Goal: create an action game (start, game, end screen)	6/21

Table 20: FS: Pilot School 2: Akademisches Gym.

Pilot school 3: "Borg Birkfeld"
At the "Borg Birkfeld" we had two classes: a 5th grade in Computing and a 5th grade in Music.

Class	Accounts	Groups	Topic and Learning Goal	Learning Goal
5a: Music	profile/3597	7 teams with two 1 with three	Topic: Quiz about musical instruments Goal: Add sounds and catch the used musical instruments.	4/21
5c: Computer science	profile/3596	Individual work	Topic: Quiz about computer science Goal: Create a quiz.	6/13

Table 21: FS: Pilot school 3: "Borg Birkfeld"

3.3.2 First cycle (M6 – M22)

The 1st evaluation circle in Austria was conducted only in cooperation with Akademisches Gymnasium. We supervised the units of two classes: a 2nd grade in physics and a 5th grade in computing.

Class	Accounts	Groups	Topic and Learning Goal	Learning Goal
5a: Computing	profile/5709	Groups of 2	Topic: Game design Goal: Create a Quiz template for Year 7.**¡Error! No se encuentra el origen de la referencia.**	-
2a Physics	profile/5708	Individual work	Topic: Structure of matter Goal: add five questions to the quiz. Used template: Quiz	14/29

Table 22: FC: Pilot school 2: Akademisches Gymnasium

3.3.3 Second cycle (M10 – M30)

The 2nd evaluation circle in Austria was conducted at all partner schools: GIBS, Akademisches Gymnasium, and Borg Birkfeld. All together 9 courses were prepared and supervised. For these courses the Create@School app was used. A detail description of these beta app could be found in Delivery 4.2. For this app a login is required. Therefore, each student had his or her own account.
Example of a username:
nagif0001

- n = NOLB, a = Austria, gi = GIBS, f/m = female/male and sequential number

Pilot school 1: GIBS

At GIBS we supervised 5 classes, 3 of them in arts, 1 in computing, and 1 in physics.

Class	Accounts	Groups	Topic and Learning Goal	Learning Goal
5a Arts	nagif0001 – 0011, nagim0001 - 0013	7 groups of three 1 group of 4	Topic: Game design Goal: Add a start and game over screen, avoid/ catch something, or tell a story and add an interactive part.	21/24
5b Arts	nagif0016 – 0030, nagif0050 – 0052, nagim0016 - 0021	4 groups of two 4 groups of three	Same as 5a	6/25
5c Arts	nagif0031 – 0047, nagim0031 - 0039	8 groups of three	Same as 5a	6/26

Table 23: SC: Pilot school 1: GIBS Arts classes

Summary:

- Girls programs: 13
- Boys programs: 8 (1 of them without genre)
- Mixed programs: 3
- Programs with 2 genres: 6

	Action Avoid Obstacles	Action Collecting	Adventure Storytelling	Action Jump and Run	Life Simulation
Girls	6	5	3		
Boys	3	4	2	1	
Girls and boys in one group	1	1	2		1

Table 24: Summary GIBS SC

Total: 29 games (30 games - 1 program without genre)

Class	Accounts	Groups	Topic and Learning Goal	Learning Goal
3a: Physics	nagif0100 - nagif0120 nagim0001 - nagim0020	Individual work	Topic: Newton's 2nd law of motion Goal: Create a game where objects glide according to their physical properties (mass, acceleration) and apply the formula. Used template: Physical simulation	15/26
5c: Computer science	nagim0031 – nagim0039 nagif0031 – nagif0049	Individual work	Topic: game design Goal: Create an adventure RPG game and apply it to different subject areas e.g., biology, music, etc. Used template: Adventure RPG	9/12

Table 25: Table 23: SC: Pilot school 1: GIBS

Pilot school 2: Akademisches Gymnasium

We supervised three classes at the "Akademisches Gymnasium": a 3rd grade in Arts, an 8th grade in Computing and again the same 3rd grade in Physics.

Class	Accounts	Groups	Topic and Learning Goal	Learning Goal
3a: Arts	Naakf0001 – naakf0020 Naakm0001 – naakm013	Teams of 2	Topic: renaissance, baroque, and romanesque Goal: Create a puzzle game with your graphics. Used template: Puzzle	15/26

8b: Computer science	Naakf0022 - naakf0026 Naakm0016 - naakm0021	Individual work Group work (2 teams of two, 2 teams of four)	Topic: game design Goal: create an adventure game (start, game, end screen) and a quiz with 5 questions. Used template: Quiz	4/11
3a: Physics	naakf0001 – naakf0020 naakm0001 – naakm013	Individual work	Topic: Physical experiments Goal: Add an explanation and animation of a performed experiment. Used template: interactive book	17/30

Table 26: SC: Pilot school 2: Akademisches Gymnasium

Pilot School 3: Borg Birkfeld

At Borg Birkfeld we had this time 2 classes: a fifth and a sixth (they could submit their programs as an extra work).

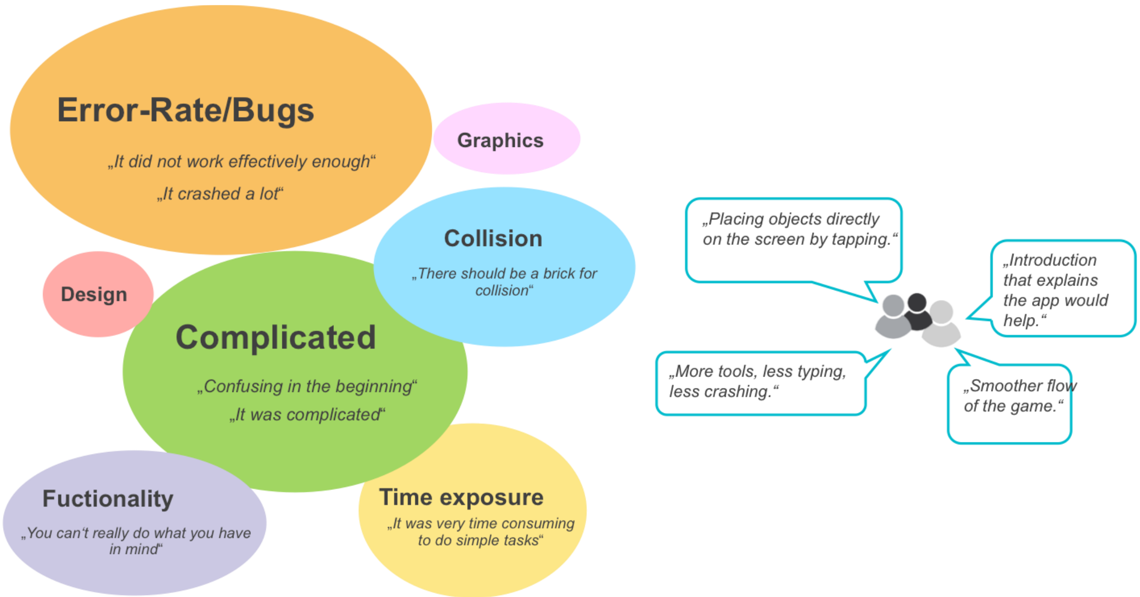
Class	Accounts	Groups	Topic and Learning Goal	Learning Goal
5a: Computer science	Nabbm00001 - 0020	Teams of 4	Topic: Galaxy Goal: Create an action game (start, game and end screen).	4/19
6a: Computer Science	nabbf0001 - nabbf0006	Individual work	Same as 5a	-

Table 27: SC: Pilot School 3: Borg Birkfeld

3.4 *Barriers and challenges managed during the project*

Challenge 1 (feasibility study): Barriers of using Pocket Code

It was important for students to create something meaningful, to work creatively and learn. The most negative aspect of their experience was the high error rate and the occurrence of bugs. During the feasibility study many students mentioned that the app often crashes and that Pocket Code was complicated to understand and use (especially at the beginning). The formula editor in the Pocket Code received mixed evaluations. The negative feedback on the different features of the Pocket Code can be seen in Figure 13, where the size of the bubbles correlates with the frequency of mentions.



Students are less likely to use Pocket Code on voluntary basis because of a lack of interest or time. To enhance their motivation they said it is necessary to improve the usability of Pocket Code and make it easier to use.

List of actions after the feasibility study:
Pocket Code needed a lot of improvement regarding the usability and the ease of use. Ideas included to integrate an in-app tutorial that helps novices to navigate through the app and create their first program. Additionally, a hinting system was planned to be implemented via snackbar elements. In that way novice Pocket Coders will have a much smoother and easier start. Further we planned to rework the formula editor. Especially on tablets it was mentioned that the keyboard was too small and mistyped often. Further we saw a need to include the following new functionalities:

- Collision brick (needed by the younger school kids)
- Physics engine (enables the user to define certain physical features to objects and the stage, e.g., the definition of velocity, gravity, mass, bounce factor or friction, to create simple simulations of real world experiments)
- Introduction of scenes (to ease the creation of game levels and better structure the application)
- Grouping functionality of objects (to increase clarity of the user interface)
- Scratch completeness (since a lot of students are already familiar with Scratch one goal is to implement important bricks from Scratch)
- Beginner mode with less bricks per category, simplified UI and language

As a result, these functionalities and altogether 47 new features were developed during the first cycle, which shaped the Create@School app. A detailed description of these features can be found in D.4.2. This special flavor of Pocket Code was published in September 2016 as a beta version at Google Play for the use at our pilot schools during the 2nd cycle.

Challenge 1: teaching material, non-technical teachers
Based on the results of the surveys and teacher discussion, the team developed more appropriate teacher guidelines, predefined game templates, and resources for teaching. In particular the team provided 1) very general tutorials, e.g., beginner steps, brick documentations, and video tutorials (see https://edu.catrob.at/), 2) specific templates for certain lesson/genres (e.g., action, adventure, puzzle, and quiz) available within the menu of Create@School, and 3) more mandatory teacher trainings for all teachers, as well as one-to-one trainings to prepare specific units. This should allow teachers to feel better prepared for their lessons by reassuring them that they will be able to conduct their lessons without assistance from experts, regardless of if they have a technical background or not.

To evaluate the effectiveness of these efforts, a survey will be conducted by using a tool (attrackdiff.de) which provides usability and design evaluation to see if Create@School is now appropriate for schools. Second follow up questions regarding the material and guidelines will also be collected. Results will be available after the last programming units in May 2017. The preliminary results of the programmed games showed that many important concepts that are necessary for the development of games are now easier to understand for our target group, e.g., a more accurate detection between objects, or speech bubble for storytelling games. In addition, the predefined templates can be adopted to different subjects, e.g., a quiz template was used in physics as well as in arts class. This allows students to focus more on the subject-relevant problem solving activities than on understanding the functionality of the app. This leads directly to more time to express their creativity on different levels and more time for extra tasks. All six teachers are planning to continue working with Pocket Code after the NOLB project and plan to integrate Pocket Code permanently in their lesson. These implementations will be tested and evaluated in our last school lesson in May 2017.

Challenge 2: more teaching material
There was a huge demand from teachers on having enough guidance, material, and help. As already mentioned we tried to provide them with tutorials for all templates, and much more. When creating tutorials there are two big barriers we try currently to overcome. First new functionalities and a redesign changes the appearance and the look and feel of the app and thus it is difficult to keep the tutorials up-to-date. Second we can provide the tutorials currently in Spanish, English, and German (these languages were spoken in the NOLB team) but it is a huge workload also to adopt all screenshots to all languages or for example click tutorials. For the template (and also for the app) we use the translator software crowdin (https://crowdin.com/) but we have neither automatic localization for the education platform nor for all tutorials.
Solution: Via the "Help" option of the bricks menu the user navigates to a mediawiki page: https://wiki.catrob.at The use case of a wiki page is to allow all users to add content. Currently only our administrator are allowed to add content. For the future it is planned to open up this wiki page for all users and that they could login with their Pocket Code account. Thus we expect that teachers, and schools all over the world who already use the apps in their lessons, share there guidelines with us and also translate existing guidelines for their needs and an applicable use.

Challenge 3: high error rate of the app
The students comment that the app is very buggy and crashes often. In addition during the 1st cycle it happened that all programs get lost (the reason was an update of the app which deleted all not uploaded games within the app). So we saw a huge demand of refactoring the app. The performed action forces to announce a feature stop of the app. Since all important functionalities of the app were integrated with February 2017 – we announced a feature stop. The TU Graz developer team worked now on refactoring the app and rework the test environment (switch from robotium tests to espresso). In detail the following functionalities get reworked:

- Scenes and grouping functionally
- Backpack for objects, scripts, scenes, looks and sounds
- Looks handling
- Clone feature
- Physics engine
- Code.xml (structure of the program)
- ….

We expect a first stable version by the end of summer 2017.

Challenge 4: Difficult to use
All in all Pocket Code does not follow the Android Guidelines thus it is not intuitive to use. Many features are not used correctly or are not used because the user does not know that they exist at all. For example:

- delete, copy, rename of programs, objects, looks.
- Use of grouping, scenes, backpack
- Navigation through the app, menu options, settings menu

For this reason a redesign of the whole app is currently in development. The redesign will cover:

- Navigation drawer instead of the main menu
- Landing page as a first page should consist of a Grid List with all programs and a news bar on the top.
- Feature Discovery: try to establish an intelligent system which reacts to the user behavior.
- A more intuitive scenes overview, object overview and stage overview
- More app tutorials and a redesign of the hints

We expect a first version of the redesign by the end of June 2017.

3.5 *Recommendations*

The students suggested that the design should be simpler and clearer, the general performance of the app as well as functionalities should be improved. Additional to the questions about the Pocket Code we asked students questions about the formula editor. The formula editor is needed to access the devices sensors, to manipulate the objects attributes, to insert different formulas and to use variables/lists within conditions. These functionalities are difficult to understand (especially for younger students) and hence it was important to collect their opinion about the usage and possible improvements.

Suggested usability improvements for the formula editor include the simplicity of the formula editor (clearness, simple and terminology), additional descriptions and help options, scalability of the buttons (to avoid misclicks) and simplicity of the use of variables by think of the most basics commands and offer bricks for it.

Recommendations include also a redesign of the app to make it more clear, organized and intuitive and to add helping options, e.g., "How to get started with Pocket Code". Moreover, a redesign of the formula editor should make it more understandable to avoid misclicks. The use should be easy especially for novice and beginners. Further an improvement of the perception is essential, e.g., through push notification for new / less used functionality, news or updates.
As a result, it is imperative to acknowledge the educational user experience in order to provide an optimal learning environment and for learners to become active participants in technology enhanced learning environments.

4 RESULTS OF THE CREATE@SCHOOL EVALUATION

In this Chapter we are going to present our results. We validate our outcome in four ways. First, (during the feasibility study) we conducted qualitative and quantitative surveys (see Chapter 4.1.3.1). Second (during the second cycle) we conducted an "AttrakDiff" test (see http://attrakdiff.de/index-en.html) to personally evaluate the usability and design of our app, see next section (4.1.1). Third, with Create@School we were able to collect analytics data. The result of this data is presented in 4.1.2 Behavioral assessment. Finally, we conducted again a survey in the second cycle, see results in 4.1.3.2. At the end of this Chapter we present results to the Austrian target group girls and corresponding statistics, literature, observations as well as our efforts and future efforts, see Chapter 4.2.

4.1 *Methodology*

The methodology used to evaluate Create@School consisted out of the Hassenzahl model assessment, behavioral model, qualitative and quantitative research, and focus groups. The Hassenzahl model gives an insight on how usable the app was for its users highlighting the values of hedonic and pragmatic attributes assigned to the product by the users. Qualitative and quantitative research. Focus group discussions concentrated on the interests and values of the students at risk of exclusion

4.1.1 Hassenzahl model assessment

Hassenzahl model is based on 2 aspects of user perception of the product quality, pragmatic and hedonic. The pragmatic perception concentrates on how the product is used, which practical qualities it has. The hedonic perception is characterized through possibilities the product gives to the user (e.g. learning something new), its symbolic meaning (e.g. attention from the other people). The evaluation is done in form of a survey consisting of the 28 pairs of terms with polar different meanings, for example motivating-discouraging. The user has to cross one of the six circles between each pair according to user's personal view of the product [44].

Altogether 152 girls and 198 boys participated in the survey used to construct this model. The students were from schools in both Austria and Spain, they were asked to out an anonymous feedback form after their final unit with Create@School.

As can be seen in Figure 23, Create@School received neutral evaluation from pragmatic and hedonic perspective. The small confidence intervals signify that the results are reliable and not coincidental.

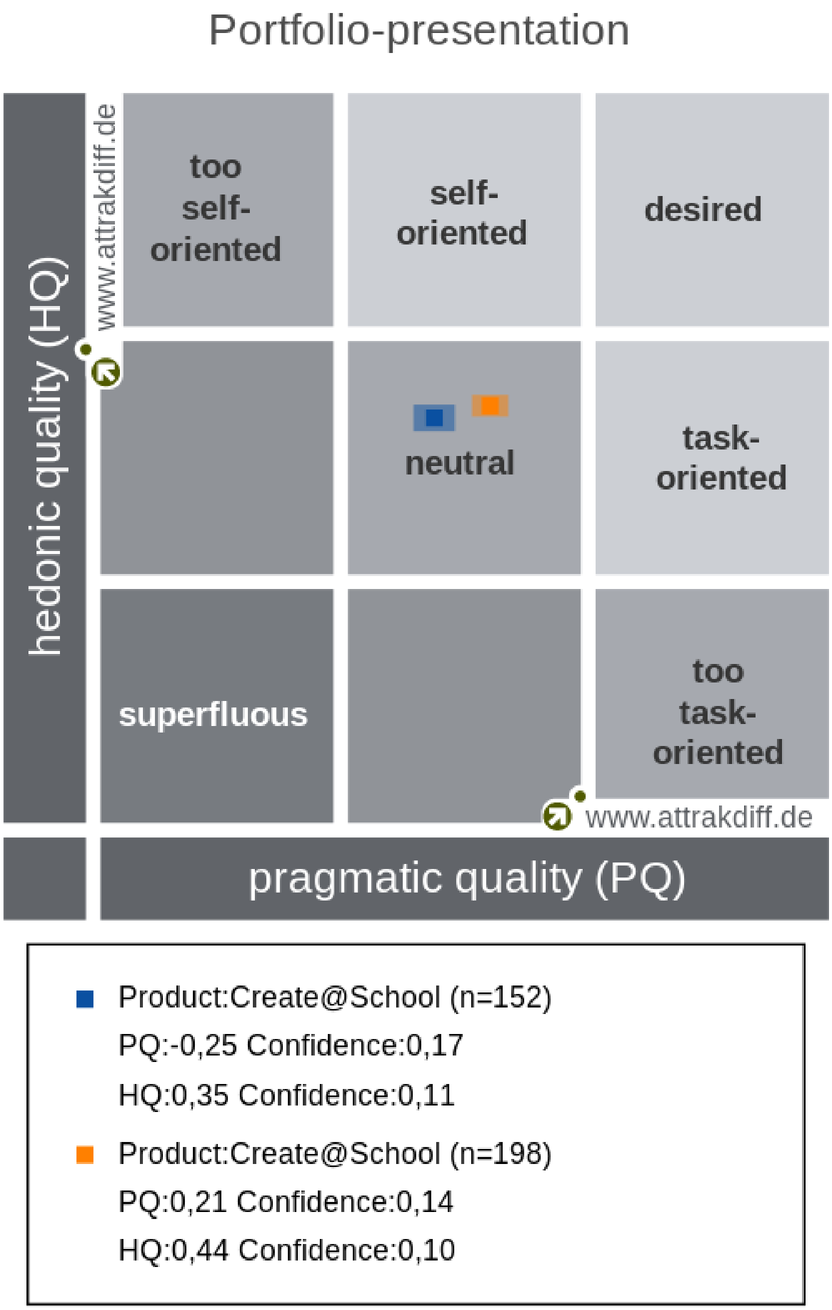


Figure 23 Overall evaluation of hedonic and pragmatic qualities

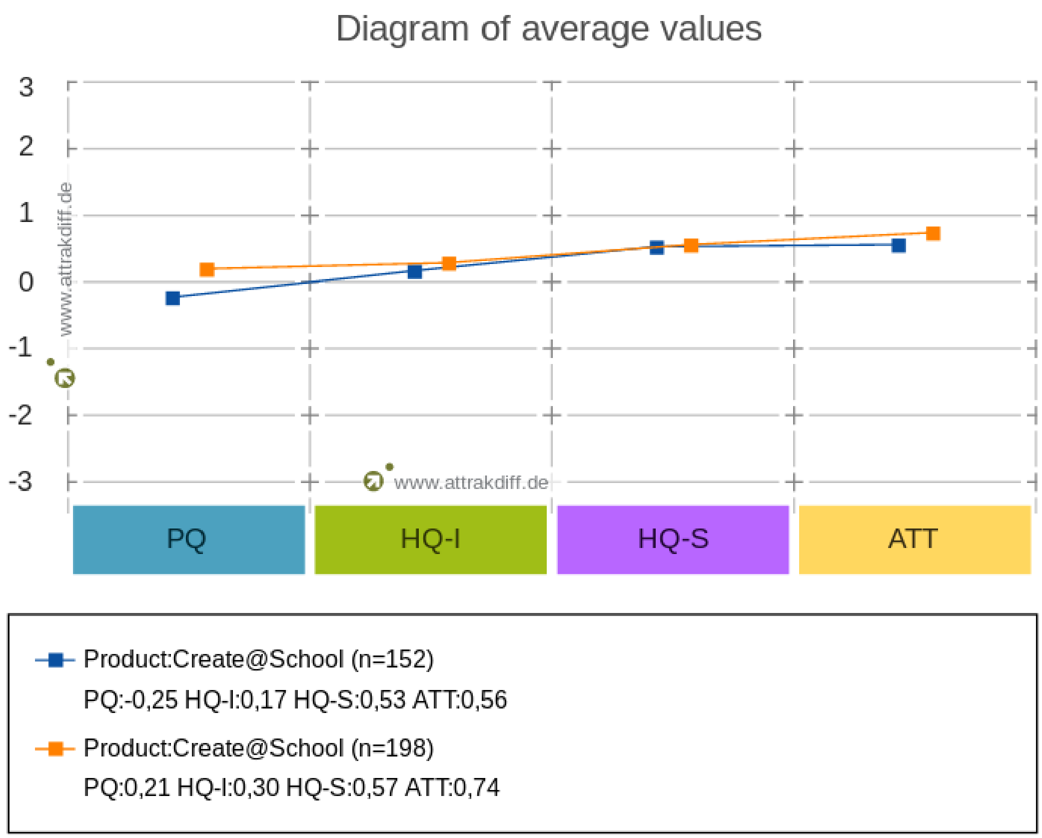


Figure 24 Diagram of average values

The diagram of the average values can be seen in the Figure 24. The average value of the pragmatic quality (PQ) evaluation has the largest absolute distance of 0.46 between female and male students. The average value of the PQ rated by the female participants has the value -0.25 and thereby is below 0. The Identity (HQ-I) and Attractiveness (ATT) average value is slightly larger for the male participants with the difference 0.13 and 0.18 respectively. The Stimulation (HQ-S) has the approximately same average values with 0.53 from the female and 0.57 from the male students. The average values of the hedonic qualities do not reach maximum values in any of the aspects.

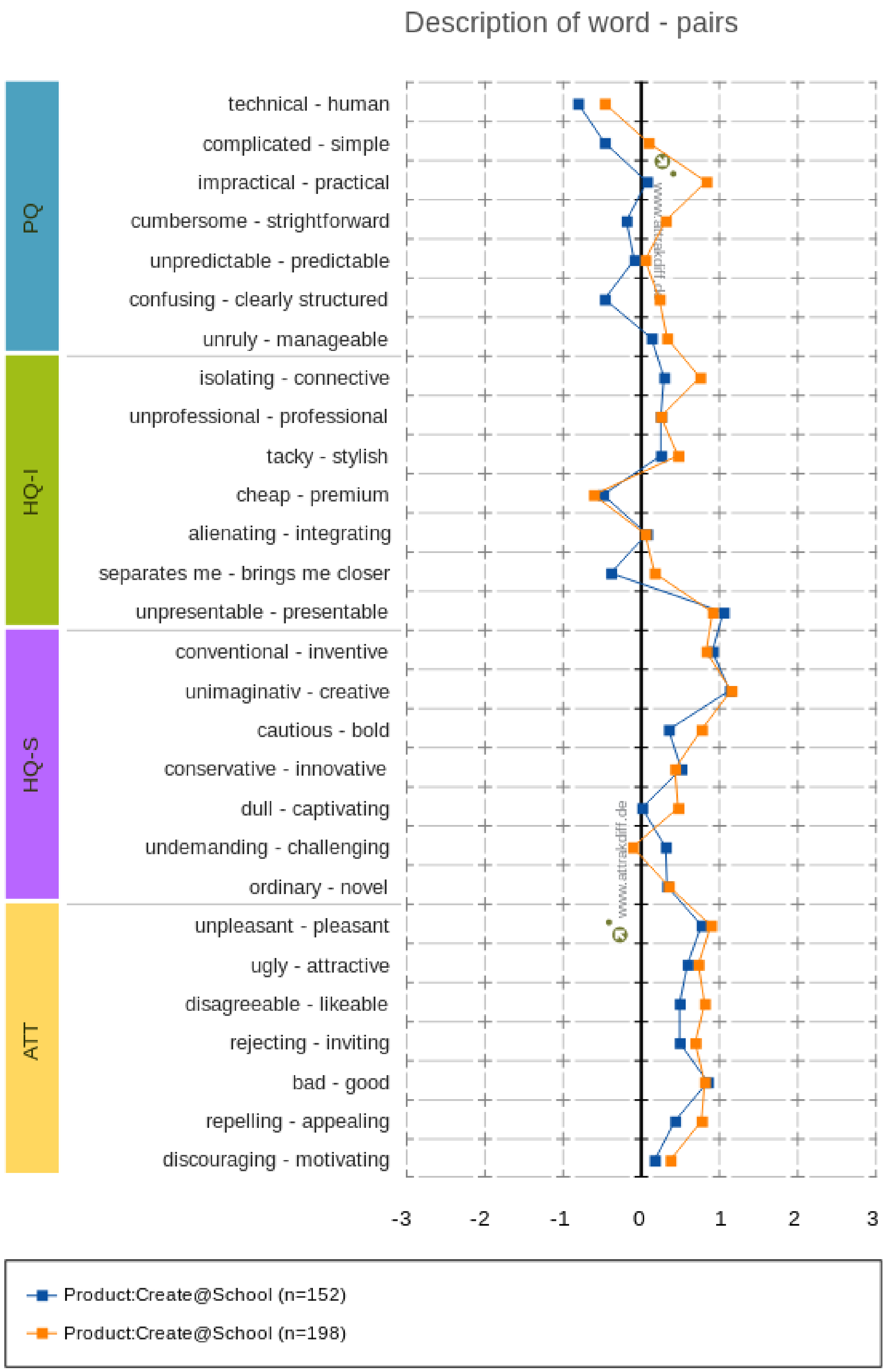


Figure 25 Description of word – pairs

Figure 25 shows the description of the word-pairs according to the Hassenzahl model. Overall, none of the Create@School qualities reaches the maximum value. The negative feedback is mostly given by girls, except for the cheap-premium pair.

As described in the average values analysis, the pragmatic quality (PQ) of Create@School mostly achieved negative assessment from the female participants. They considered the app more technical than human, as well as more complicated than simple and confusing rather than clearly structured. Male participants also rated the app more technical than human, but at the same time found it more practical than impractical, more straightforward than cumbersome and more structured than confusing. Both groups did not have any opinion on the predictability of the app.

The Identity (HQ-I) as well as the Simulation (HW-S) evaluation of the app are mostly consistent between the two groups. Both groups found the app rather cheap than premium, professional than unprofessional, as well as more stylish than tacky and presentable than unpresentable. The participants did not have any opinion about the alienating-integrating behavior of the app. Male students found Create@School more connective than female students did. Girls said that the app separates them from people rather than brings them closer to people. Both female and male students considered the app inventive, creative, innovative and novel. Boys rated the app more bold and captivating than girls did. Male participants assessed the Create@School slightly undemanding, rather than challenging, whereas the female participants have seen the app as challenging.

The Attractiveness (ATT) of the Create@School was positively rated by both student groups. The boys rated the app more likeable, inviting, appealing and motivating than the girls did. Female and male participants found the app rather pleasant than unpleasant, attractive than ugly, and good than bad.

4.2 *Behavioral assessment*

Behavioral assessment refers to an approach to understanding and changing behavior by identifying the context in which it occurs (the situations or stimuli that either precede it or follow from it). It involves the recording the frequency of various behaviors; an approach that focuses on the interactions between situations and behaviors for effecting behavioral change. The methodology and further information is provided in Delivery 4.3.

Goal is to answer two questions:

1) Under what circumstances is the behavior most/least likely to occur (e.g., when, where, with whom)?
2) What outcomes does the behavior produce (i.e., what does the person get or avoid through his or her behavior)?

The graphics below compromise the following behavior:

- Confidence:
  - Event creation, e.g., create program, object, look, sound and copy actions
- Creativity:
  - Look&Feel Customization / Aesthetics , e.g., Create your own resources (Pocket Paint , Camera, Recorder)
- Effort/dedicated time:
  - Time in Web View
  - Time spent with playing / testing the game
- Interest

  - Event creation
  - Look&Feel Customization / Aesthetics
  - Time in Web View
  - Time spent on research/tutorials (help function in Create@School)
- Persistence:
  - Event deletion, e.g., delete program, object, look, brick
  - Time in web-view
  - Time spent in Pocket Paint
  - Time spent with playing / testing the game
- Positive affect
  - Look&Feel Customization / Aesthetics
- Self-efficiency:
  - Absolute time spent in Create@School
- Self-engagement (over average in positive affect)
  - Look&Feel Customization / Aesthetics
  - Time spent in Pocket Paint
- Usage of Create@School
  - Coding Skills
    - usage of simple bricks (e.g., simple loops, show/hide, position bricks)
    - usage of advanced bricks (collision, physics bricks,…)
    - usage of variables, lists, broadcast messages
    - merge programs
    - use templates

The analytics data has been tracked from October 2016 until the end of the project. The PMD/measurement was ready for use in April 2016. Consequently, only three classes could be evaluated because the other classes already finished their lessons. Behavior measurements are available for the following three classes:

Class	Accounts	Groups	Topic and Learning Goal	Learning Goal
3a: Physics	nagif0100 - nagif0120 nagim0001 - nagim0020	Individual work	Topic: Newton's 2nd law of motion Goal: Create a game where objects glide according to their physical properties (mass, acceleration) and apply the formula. Used template: Physical simulation	15/26

Table 28: Akademisches Gymnasium (teacher 7), 3a physics (30 students)

8b: Computer science	Naakf0022 - naakf0026 Naakm0016 - naakm0021	Individual work Group work (2 teams of two, 2 teams of four)	Topic: game design Goal: create an adventure game (start, game, end screen) and a quiz with 5 questions. Used template: Quiz	4/11

Table 29: Akademisches Gymnasium (teacher 6), 5a computer science (11 students)

5c: Computer science	nagim0031 – nagim0039 nagif0031 – nagif0049	Individual work	Topic: game design Goal: Create an adventure RPG game and apply it to different subject areas e.g., biology, music, etc. Used template: Adventure RPG	9/12

Table 30: GIBS (teacher 4), 5c computer science (12 students)

In the following the results of the collected data is presented and analyzed. Figure 26 provides an overview about all three classes. The parameter "Coding Skills" and "Time spend on resources/tutorials" is over the average (>3.5).

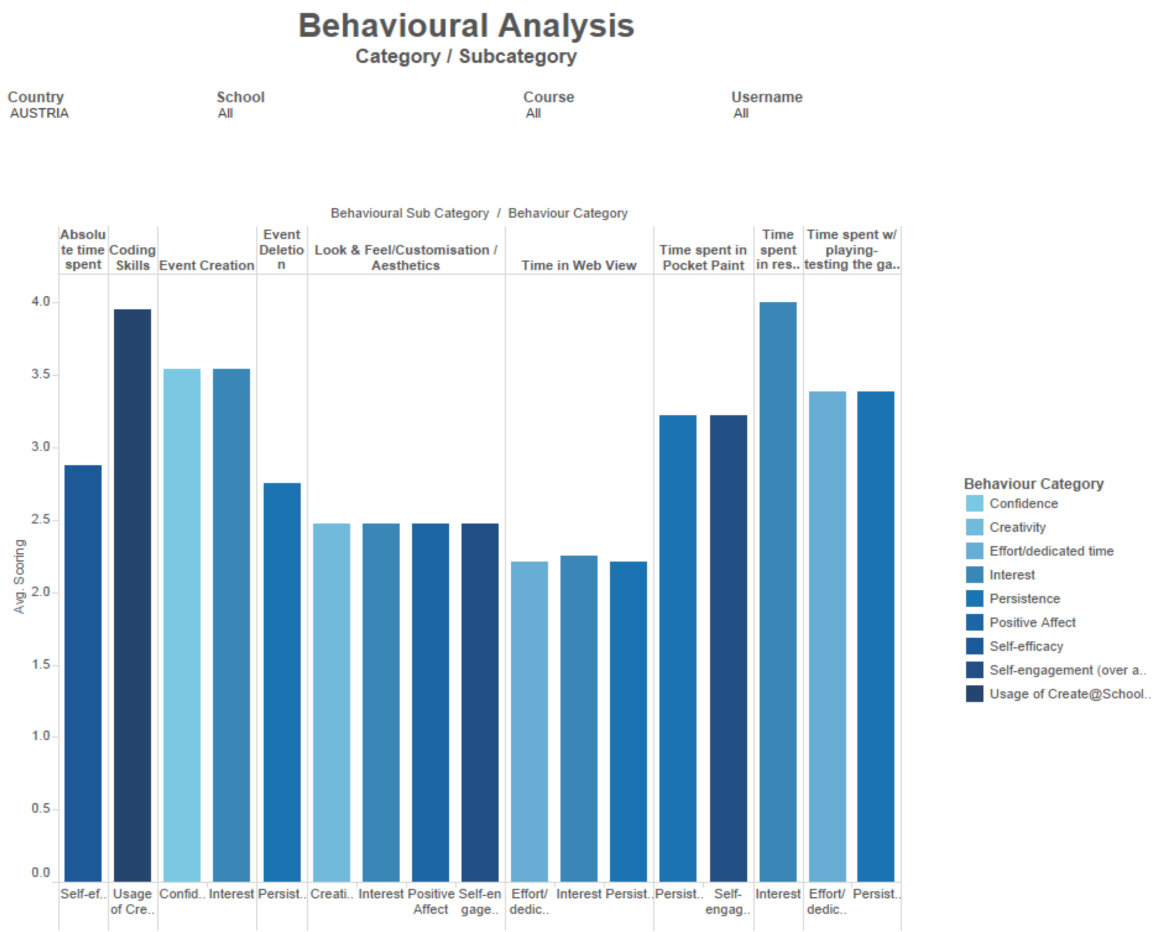


Figure 26: Behavioral analysis results Austria

Figure 27, 28, and 29 shows the three classes separately.

The absolute time spent by students in Create@School in Figure 27 is significantly lower (2.4) than time spent by students in Figure 28 (3.2) and 29 (3.5). The reason is that the students from Figure 27 only had 3 units at 45 minutes, students from Figure 28 had 8 units (and even worked on their games at home), and students from Figure 29 had 10 units (one student also worked at home).

The parameter "Coding Skills" is significantly high in all three classes (~3.9). There are only slight differences between girls and boys, from students from Figure 27, see Figure 31 and in the GIBS class, see Figure 29 (3.8).

A notable difference could be seen in the persistence rate between the three classes. Students in Figure 29 (value = 3.5) used a template (Adventure RPG). Therefore, they deleted scenes, objects, looks more likely which wasn't needed for their games (value Figure 27 = 2.3, value Figure 28 = 2.9).

The parameter "Look&Feel Customisatzion / Aestetics" is slightly higher in Figure 28 (2.9). This class created a game from scratch and used more own graphics/assets (value Figure 27 = 2.4, value Figure 29 = 2.3).

Students from Figure 28 (3.7) and 29 (3.8) spent much more time in Pocket Paint (creating their own graphics). The reasons is that students from Figure 27 (value =

2.7) included more pictures from the camera (the made photographs from their experiments) than drawing their own graphics.
In addition, students in Figure 29 (value = 4) spent more time testing and playing their games than the other two classes (value Figure 27 = 3.4, value Figure 28 = 3).

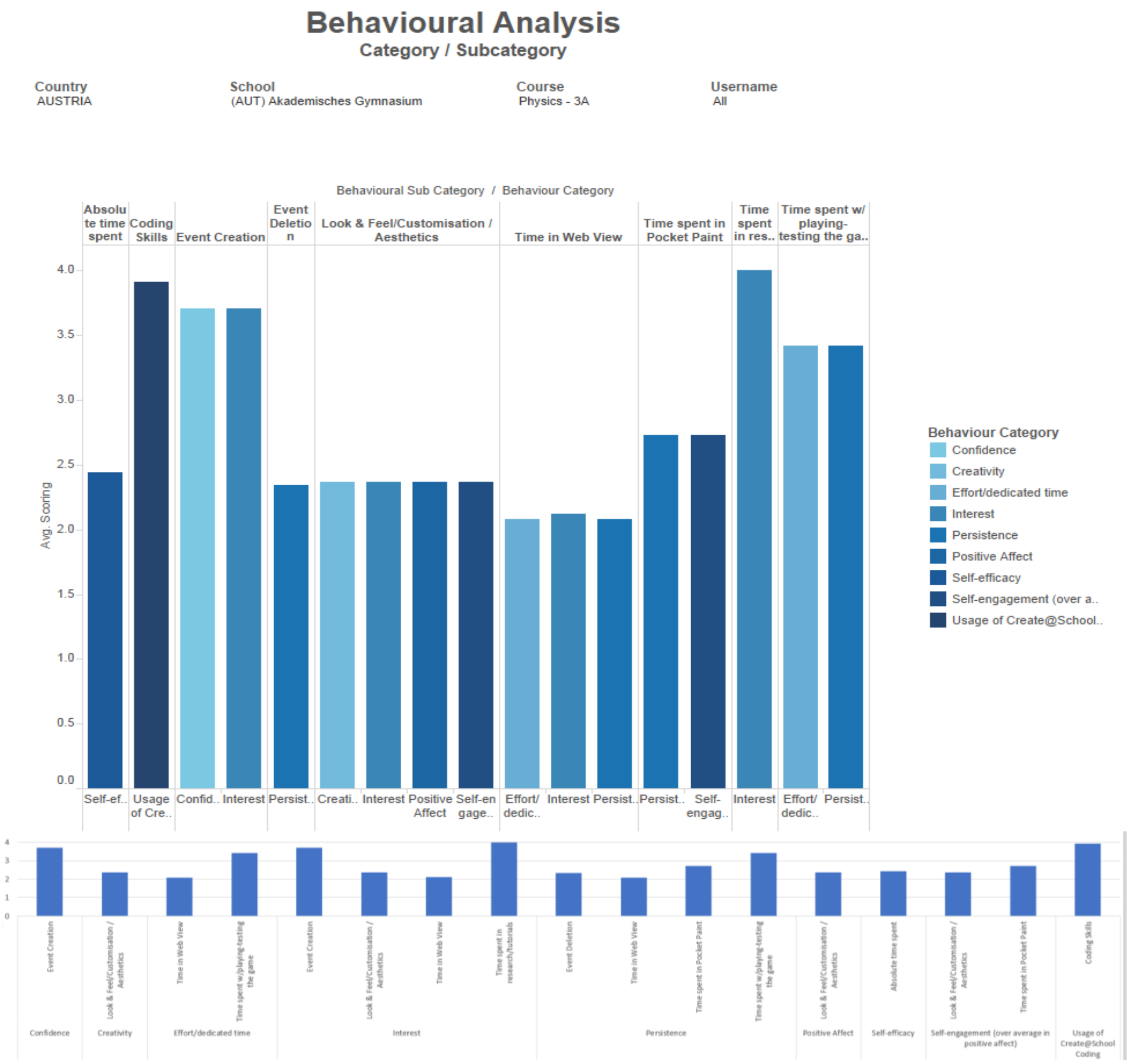


Figure 27: Behavioral analysis Akademisches Gymnasium 3a physics

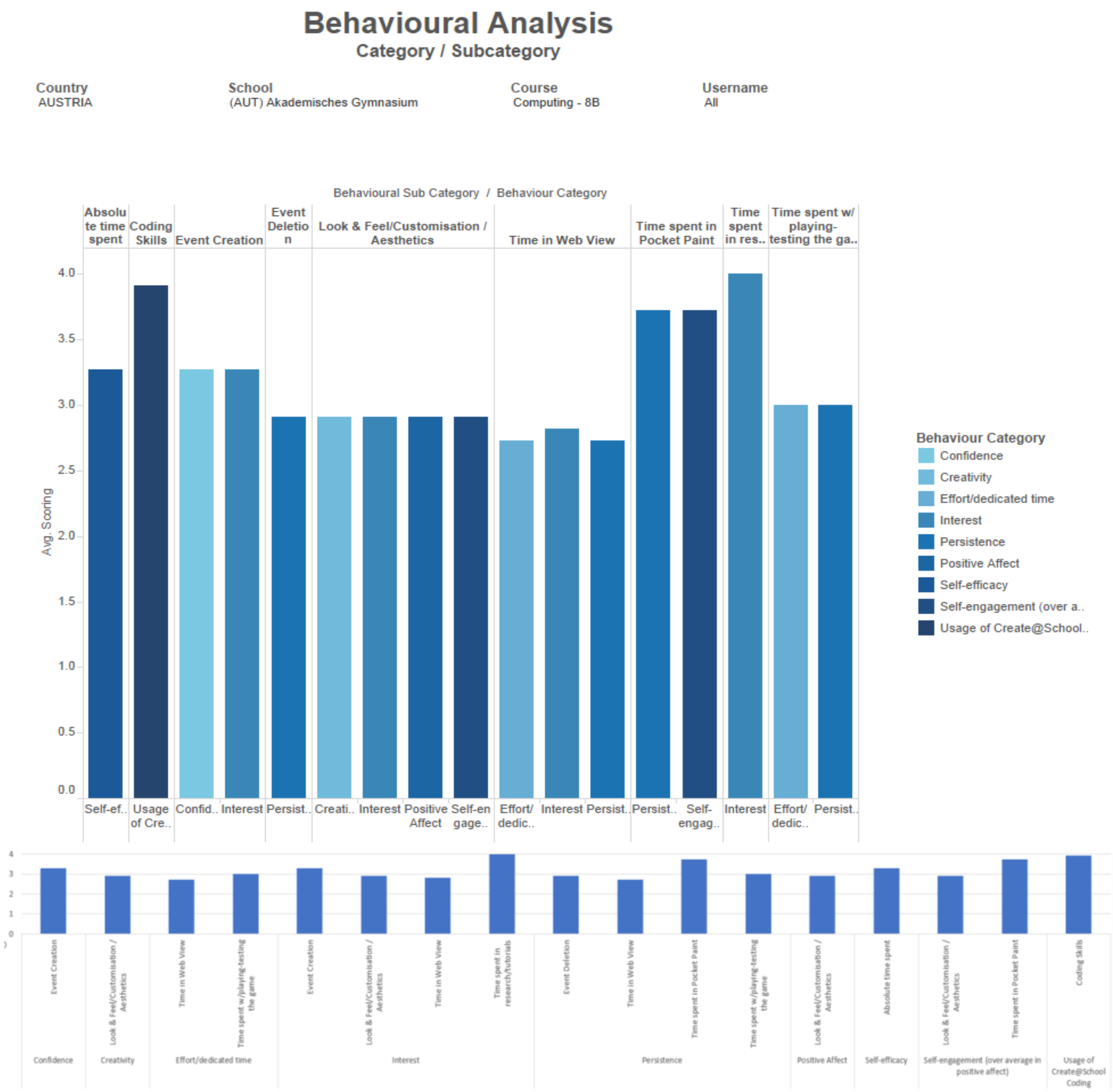


Figure 28: Behavioral analysis Akademisches Gymnasium 8b computer science

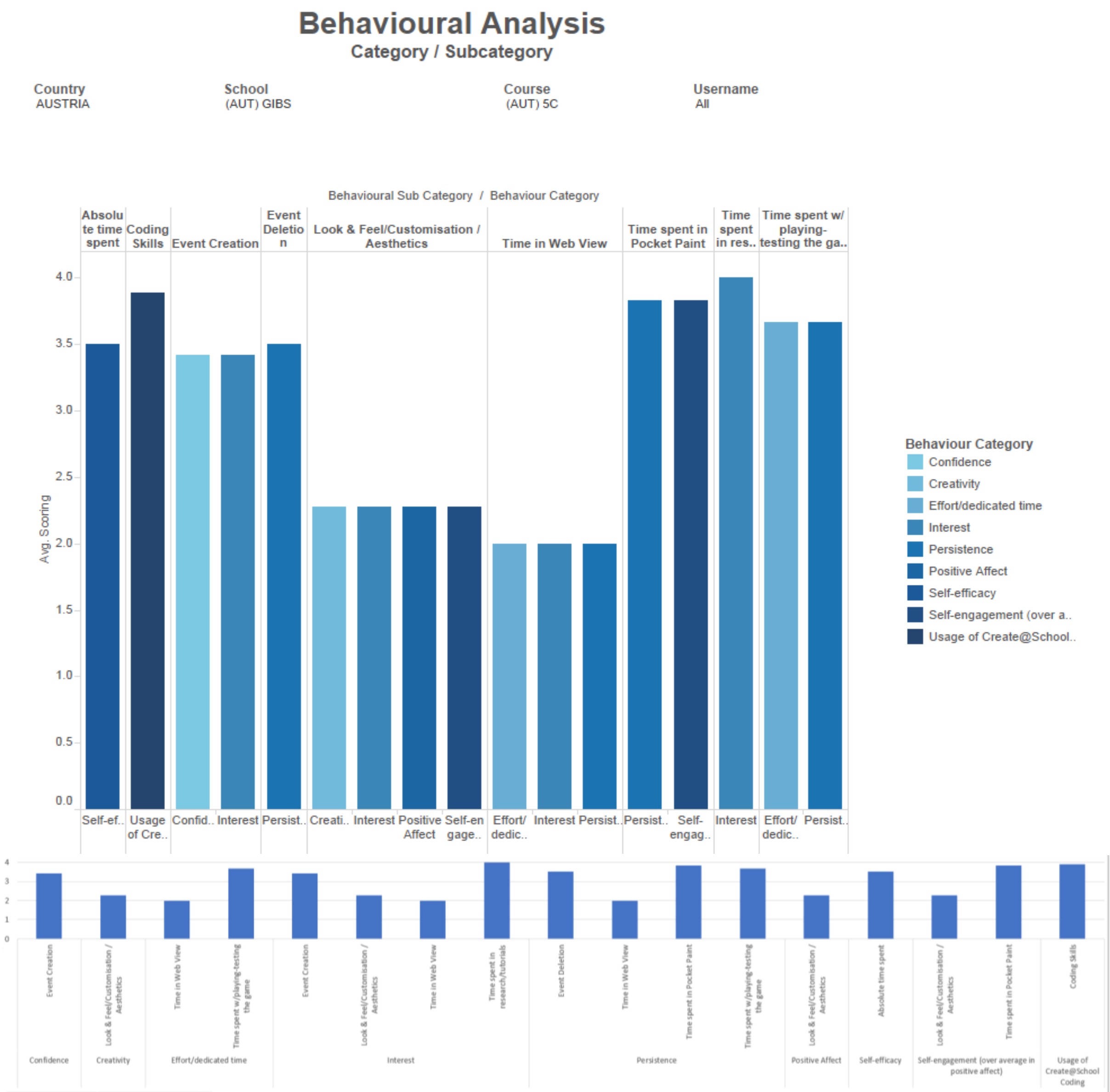


Figure 29: Behavioral analysis GIBS 5c computer science

4.2.1 Behavioral analysis on gender

The next figures show differences in Austria between boys and girls. In Figure 30 all three classes are compared. Slight differences between girls and boys are notable in students engagement (difference = 0.4), effort, confidence, creativity and interests (difference = 0.5). In all of these cases the higher value is dedicated to the girls.

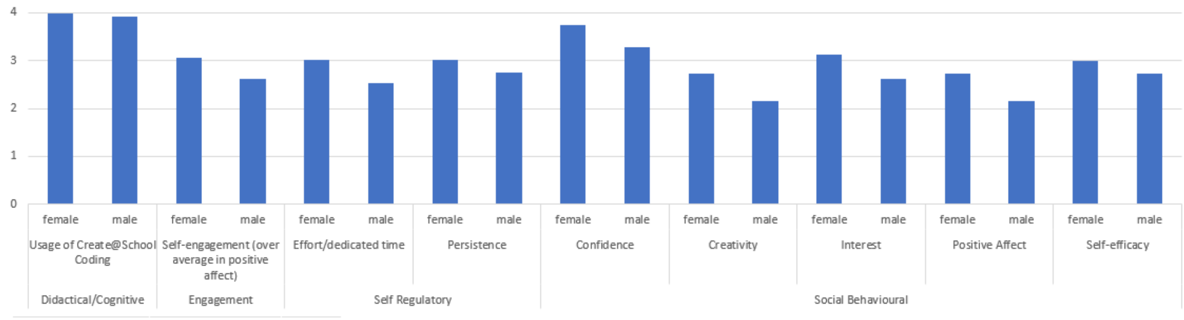


Figure 30: Social-Behavioral Measures - Austria in total

Figure 31, 32, and 33 shows the three classes again separately by gender.

In Figure 31 the engagement parameter shows a significant higher value in those of girls (2.8) than in those of boys (2.1) as well as in parameter confidence (girls = 3.9 and boys = 3.3). This means that the female students in this class used more creation events and spent more time within the app than male students. The most interesting one is the parameter Creativity. Here the value for female 2.7 and the value for male students 1.8. This means that the female students spent much more time on rework the photographs of their experiments in Pocket Code than the female students.

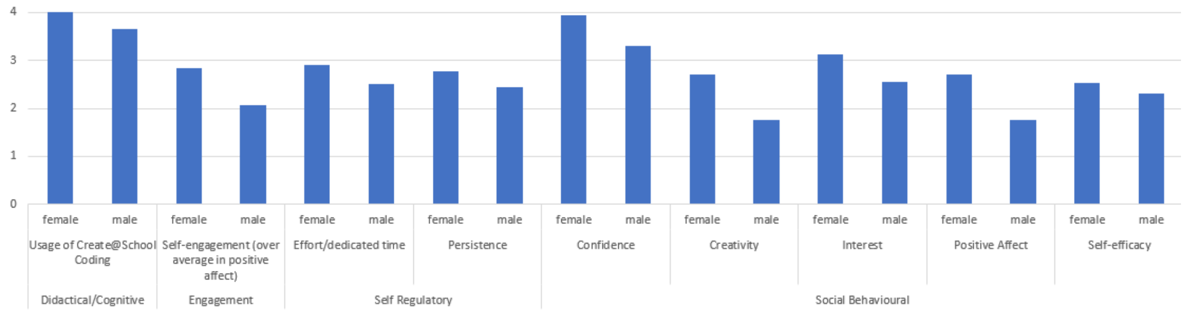


Figure 31: Social-Behavioral Measures – gender - Akademisches Gym. 3a physics

Figure 32 shows not that many differences between genders. Here the only significant difference is in the effort/dedicated time parameter. The value for females is 3.2 and those fore male students 2.6. This means the female students spend more time with playing their games and searching for other games. In addition, in this class the female students seemed to work again more creatively than the male students (difference = 0.5).

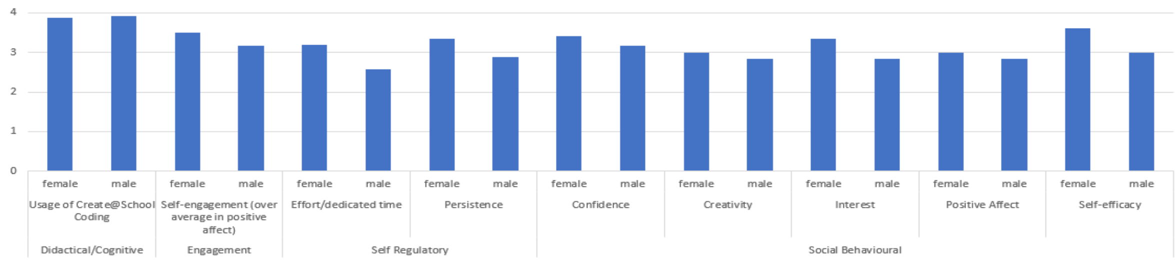


Figure 32: Social-Behavioral Measures - gender -Akademisches Gym. 8b computer science

In class of Figure 33 there are the following notable differences: Again female students spent more time with playing their games than male students (difference = 0.7), and the female were also again more creative (difference = 0.5). In addition, female students show a higher value (3.8) in self-efficiently which means they also spent more time in Create@School in general than their male colleagues (value = 3.1).

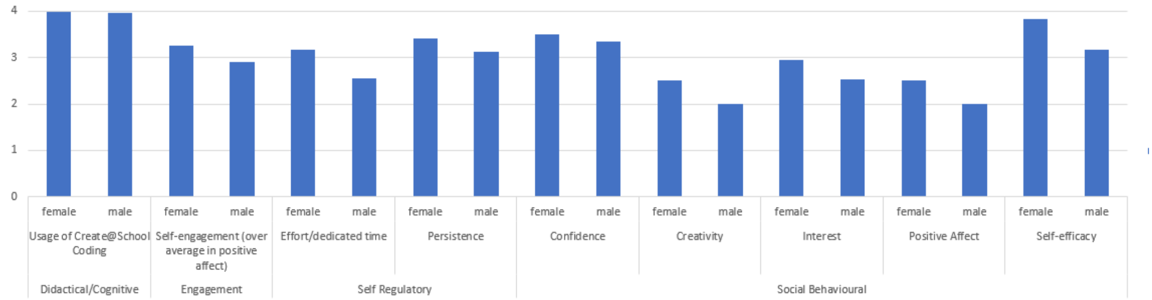


Figure 33: Social-Behavioral Measures - gender - GIBS 5c computer science

4.3 *Qualitative and Quantitative assessment (survey)*

The goal of the quantitative and quantitative research was to collect the students' opinion about the Create@School app and the school units in which the app was used. This was done with the help of the surveys. The surveys were filled out by the participants after the last school unit in the sequence. The surveys were kept anonymous to encourage the genuine opinion about the app and the units. The only information students were asked to write down about themselves was age, gender and school.

During the experimental pilots we conducted two surveys (both quantitative and qualitative). One during the feasibility study and a second one during the second cycle. Find the results of the surveys during the second cycle below.

4.3.1 Surveys: Second cycle

Overall, 131 students filled out feedback forms in Austria, 63 of them were boys and 68 girls. The feedback forms were filled out by the participants after the last school unit in the sequence. The feedback forms were kept anonymous to encourage the genuine opinion about the app and the units. The only information students were asked to write down about themselves was age, gender and school. First, students were asked to evaluate how good was their experience with Create@School with the help of the Likert-type scale. Afterwards the open-ended questions, "What did you like the most?", "What did you like the least? Any suggestions for app improvement?" and "Have you used Create@School in your spare time/outside school. If no, why?" were asked to gain a deeper understanding of the experience evaluation.

Likert-type scale answers

The evaluation of the Likert-type scale answers about the experience of the participants with Create@School can be seen in Figure 34. There were 5.34% female and 4.58% male students, who rated the experience as "very good". The experience with Create@School was rated "good" by 29% of the female students. At the same time 20.6% male participants crossed "good". 14.5% boys and 12.97% girls crossed the response "bad". The answer option "very bad" was chosen by 4.58% of the boys and 2.29% of the girls. There were 3.81% of boys and 2.29% of girls who did not have an opinion. To clarify the motivation for these answers it is necessary to take a look at the analysis of the open-ended questions.

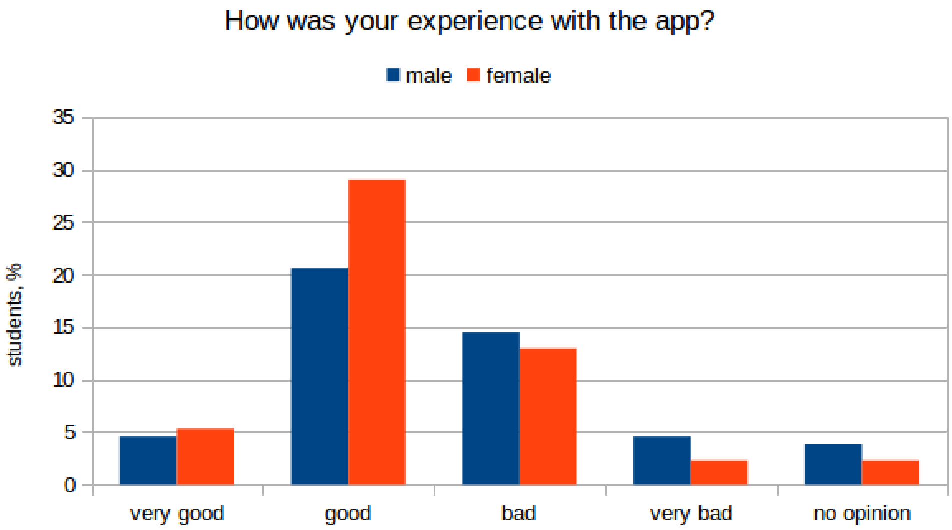


Figure 34: Distribution of the answers about their experience with Create@School

Positive impressions

The answers of the participants describing their positive impressions about the Create@School experience ("What did you like the most?") were classified into 5 different categories. One answer could contribute to 2 categories, for instance the feedback "the finished products + the students" contributed to both game and organization categories. The distribution of the answers among the categories can be seen in Figure 35.

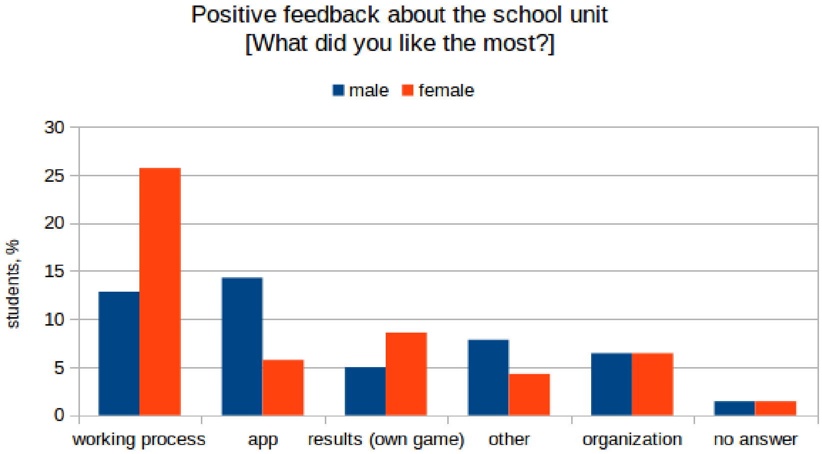


Figure 35: Categorization of the positive impressions about the app and the school unit.

The category *working process* contains the feedback about which actions (to program, to play, to design, and so on) or properties of the school unit (having a freedom of choice, requirement of being creative) were valued by the students, e.g. "to play the game", "that you could be very creative". The largest quantitative difference between the responses of male and female participants was observed for this category, namely 25.71% girls and 12.86% boys gave positive working process related feedback.

The category *app* contains the answers mentioning the experiences directly connected with the app itself, e.g. "the simplicity of the app", "the different effects and backgrounds". Boys seemed to be more positively impressed by the app than girls were, there were 5.71% girls and 14.28% boys that evaluated app qualities as positive.

Some students were especially satisfied with the results of their work or the concept of game creation, the category *results (own game)* contains this type of feedback, e.g. "the results & how everything turned out", "I liked the idea of creating a game". There were 8.57% girls and 5% boys that were satisfied with the results or their own game.

The answers from the category *organization* highlight how the unit was structured, this includes if students were enjoying teamwork or solving the problems on their own, the presence of external people, usage of tablets during the school units, etc. It was noticeable that children in the younger age group of 12-14 years were very excited about using the tablets during the school units. Typical responses for this category were "to work in a team with your friends", "when you (the students) explained to us how the app really worked", "that we had own tablets", etc. The same number of the male and female participants' feedback falls into the category organization with 6.43% responses from boys and 6.43% responses from girls.

The replies that could not be clearly classified to any of the described above categories were summarized into other category, for example the answers with no clear message or containing the feedback connected to the particular game or classroom setting, as well as such responses as "nothing" or "everything". There were 7.86% such responses from male students and 4.28% from female students.

The category *working process* was divided into 6 different subcategories. Figure 36 represents the distribution of the responses of this category in more detail. The subcategory named *designing* summarizes the feedback related to drawing, taking pictures, personalization of the characters, etc., for example "drawing our pictures" or "creating the characters". There were 31.48% girls and only 3.7% boys who identified design related activities as the essence of their positive experience. The subcategory *creativity* represents the feedback praising creative side of the school unit, for instance, "you could be very creative", "you could do almost any game you wanted". There were 12.96% female students and 3.7% male students who evaluated creativity as the positive aspect of the Create@School experience. There were 11.1% boys and 5.5% girls who stated that they considered *playing* as positive experience, such answer as "you were allowed to play" would be typical for this subcategory. No constrains in choice or actions were valued by 3.7% boys and 9.26% girls, these responses were the basis for the subcategory *freedom of choice,* representative statement for this subcategory was "That you could do whatever you want". There were 7.4% boys and 3.7% girls who enjoyed the programming process itself, typical responses for *programming* subcategory were "programming the rocket" or "programming ourselves".

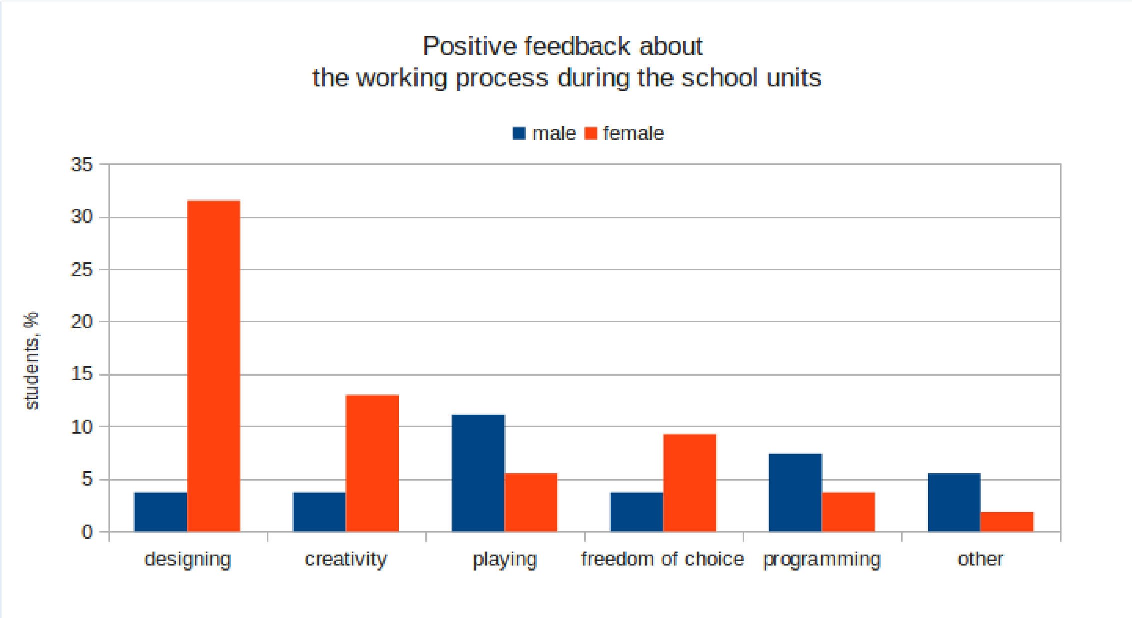


Figure 36 Detailed overview over the working process category

The category app was divided into 4 subcategories, the distribution of the feedback can be seen in Figure 37. None of the girls and 20.69% boys stated that they were pleased about the LEGO-style bricks in Create@School, "brick system" was representative response for the subcategory *LEGO-style bricks*. There were 31% boys and 13.79% girls who praised the *simplicity* of the app, with feedback like "It was relatively self-explaining!" or "components are easy to understand". The subcategory *features* contains such responses about the features of the app as for example "the different effects and backgrounds" and "variables were available", 13.79% boys and 6.9% girls contributed to this subcategory. There were 6.9% girls and 6.9% boys who praised the *design* of the app.

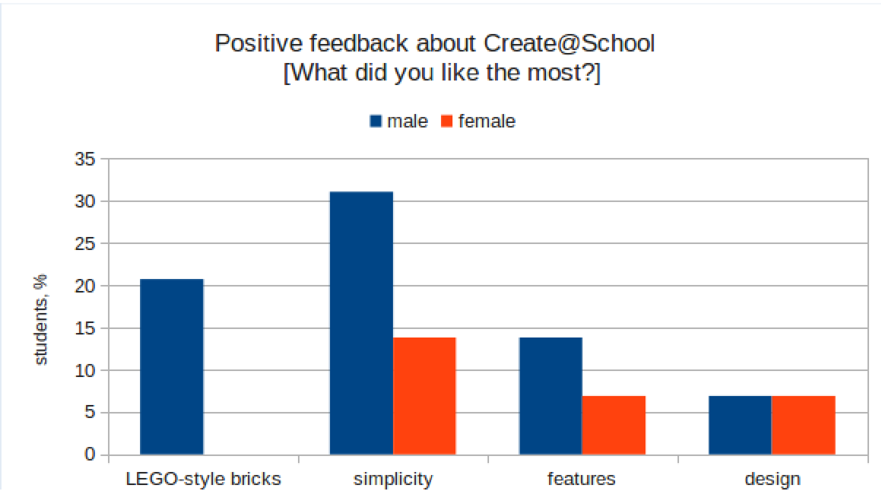


Figure 37 Detailed overview over the app category

Negative impressions

The answers to the questions "What did you like the least? Any suggestions for app improvement?" were the basis for the negative feedback evaluation. It is worth mentioning, that 0.04% boys and 0.23% girls responded that everything was fine and 0.04% girls and 0.04% boys did not give any answer to this question. One answer can contribute to 2 categories, for instance the feedback "It was too complicated and the way was too long to finish the game" contributed to both unit structure and complicated categories.

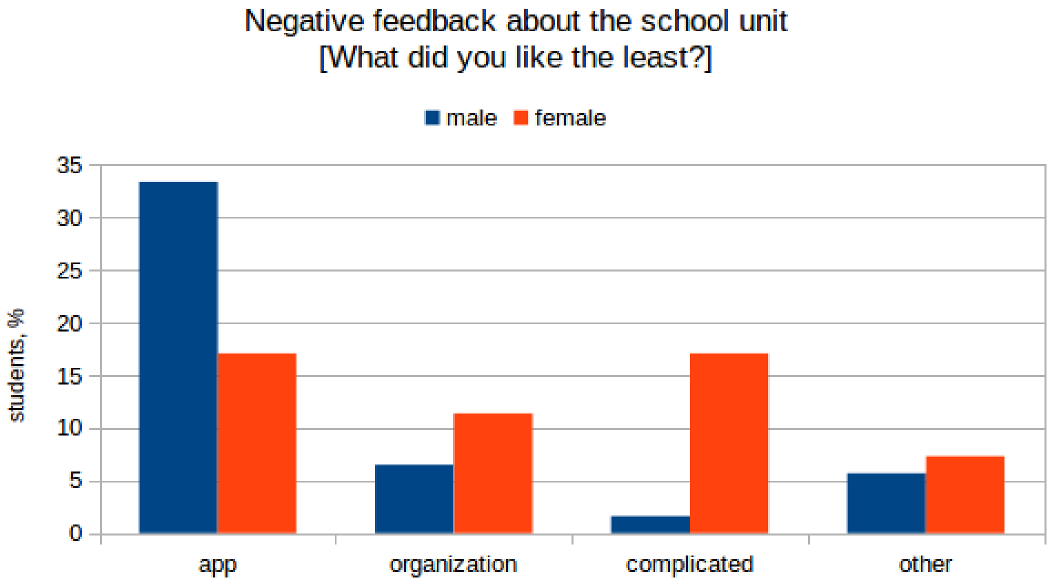


Figure 38 Categorization of the negative impressions about the app and the school unit.

The category *app* consists of the feedback related only to the Create@School app, for example, "it looked kind of tacky, complicated, confusing", "the axes of the screen" or "it was buggy". There were 33.3% boys and 17% girls who gave this kind of responses. Such feedback as "The way was too long to finish up the game", "introduction of the app was boring" or "The instructors were not able to explain everything to us" about the unit was summarized into the category *organization*. There were 6.5% boys and 11.38% girls who gave this kind of responses. The feedback of the contents of the type "I found some things complicated", "make it more simple for people that are not technical" or "you needed help a lot" were summarized under the category *complicated*. There were 17% girls and 1.6% boys who gave feedback of such kind about their experience with Create@School. The replies that could not be clearly classified to any of the described above categories were summarized into other, for example, the answers with no clear message, complaints about the devices and Pocket Paint app, and so on.

The breakdown of the category *app* into subcategories can be seen in Figure 39. The subcategory *buggy* contains the feedback about the behavior of the app that students considered as bugs, the responses about the slow performance and if the students have experienced app crashes. There were 31.94% boys and only 8.3% girls who gave this type of feedback about the app. The representative answers for this subcategory were "Create@School crashes ALL the time", "It sometimes stopped and didn't always work as smoothly" or "it took AGES to load". There were 9.72% boys and 1.39% girl who stated that the app lacks structure clarity and is confusing, e.g. "the app totally lacks the structure", "some things should be easier to find". There were 4.17% girls and 1.39% boys who complained about the design of the app, for example "it looked kind of tacky", "the design is rather boring". The other subcategory contains all responses that were related to the app, but could not be classified into one of the subcategories, e.g. the answers about the app features "the clones didn't really work" or more general feedback "it took some time to get used to the program".

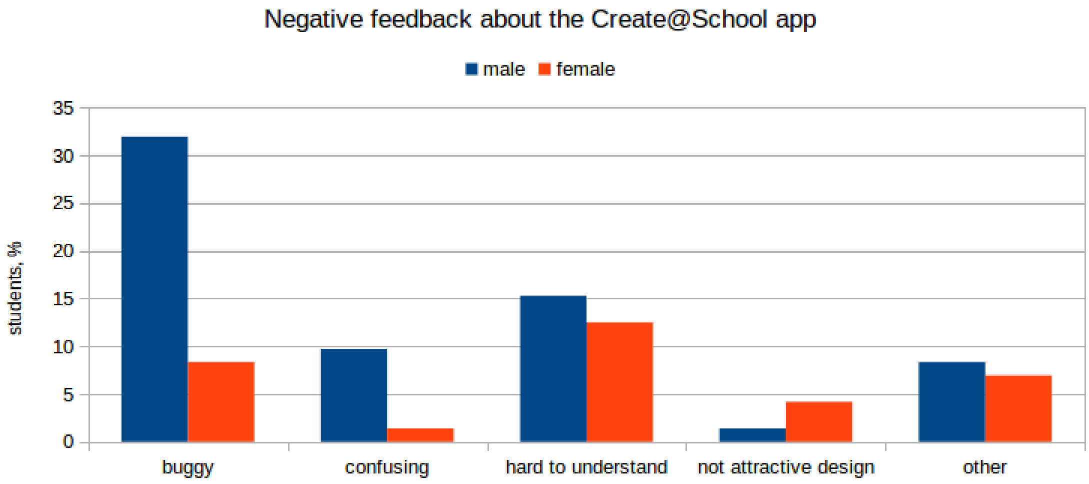


Figure 39 Detailed overview over the app category

Reasons for not to use the app outside school

The last question of the feedback form was "Have you used Create@School in your spare time/outside school. If no, why?" Out of 131 students, 18.27% used the app outside school, 3% of them being girls and 15.27% boys. There were 80.85% of the total number of students, who did not use the app in their free time, 48.85% of them girls and 32% boys, and there was 1 boy did not give any answer to the question. Figure 40 shows the pie charts of the reasons why the students did not use Create@School or Pocket Code in their spare time.

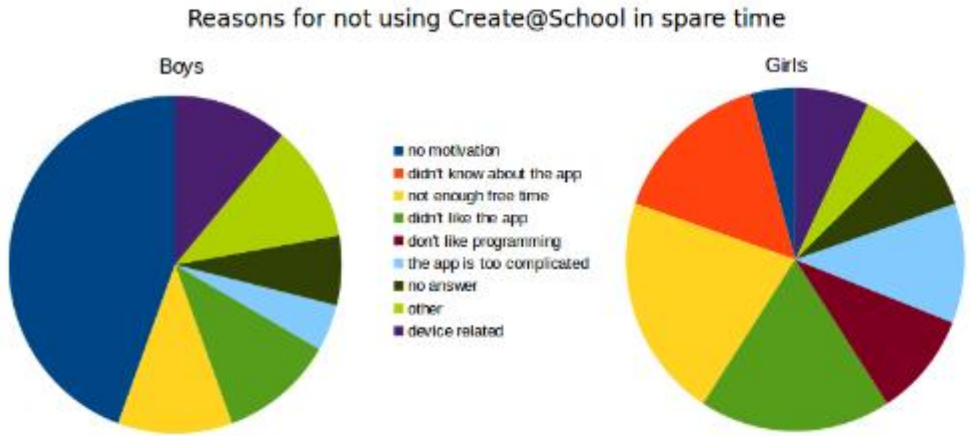


Figure 40 the overview over the reasons for not using Create@School in spare time

The main cause for 46.6% of the students (44.4% boys and 4.2% girls) was the *lack of motivation*, typical answers were "I don't want to" or "I have better things to do". None of the boys and 15.49% of girls answered that they did not know about the app. There were 11% (boys) and 21% (girls) who answered that they *do not have enough time* to use the app, representative response was "I don't have much spare time". There were 11% (boys) as well as 18.3% (girls) who stated they *did not like the app*, representative answers for this reason were "I didn't like the app so much" or "I'm not interested in it". None of the boys and 9.86% of the girls said they *do not like programming*; typical responses were "Because I am not so technical" and "I personally don't like programming". There were 11.26% (girls) and 4.4% (boys) who stated that *the app is too complicated*, for example, "It is too hard and complicated/confusing" or "It would be too complicated to make a game alone". The category named *other* with 16.63% of all responses contains the answers that cannot be generalized or were not clearly formulated, e.g. "I want to do "actual" coding" or "because it is not my thing". There were 18% of students (7% girls and 11% boys) who could not use the app at home, because they either did not have an Android device or were not allowed to install apps on their own.

4.4 *Students at risk of exclusion*

In this section, we will provide an overview about all activities we did to foster girls in informatics and ICT. During the 2nd cycle, background material and information about female teenagers has been gathered, both from the literature as well as through interviews and focus group discussions with teenage girls in Austria. In this section, we present our results. To sum up, we provide a description of follow up interventions that should encourage girls to program with our app.

4.4.1 Considering the Context of Gender Exclusion in Teenager Groups

The number of female students who choose a technical degree course is far below the average number of males, both in Austria and worldwide. Although significant efforts in getting more women in the IT sector has increased the number of women enrolling in higher education, they are still underrepresented. The majority of teenage girls rapidly drop out of voluntary offered IT courses during high school and thus have no interest in choosing an ICT career. The reason for the need of more women in science, technology, engineering, and mathematics (STEM) is not only a matter of fairness. It is necessary because women represent over half of the world's population but are underrepresented in STEM fields [13]. Moreover, studies show that having employees with diverse backgrounds, interests, or cultures leads to better results in science [14].

To address this gender bias, the goal of the Austrian study included how to make Pocket Code more accessible and attractive to female teenagers. Although they constitute the largest group of passive smartphone and tablet users, turning them from mere consumers to active creators is a challenging task. Our goal was to ensure a positive first experience in programming for girls with the education app Create@School which may direct their future career choice towards STEM fields. Our assumption was that it is possible to spark girls' interests by getting them engaged in computational thinking, collaborative, creative, and engaging activities. In Austria, computer science is not considered a core discipline that high school students must take[5]. By teaching the fundamental principles of programming, we wished to give girls the chance to decide for themselves whether it awoke their interest. Programming should not be something intangible and mysterious, but a new opportunity to change their lives.

According to the NOLB proposal two main goals for Austria are:

- The gathering of background material and information about female teenagers, both from literature as well as through interviews with teenage girls in Austria
- To ensure a positive first experience in programming for girls with the education app Create@School

4.4.2 Statistics

Recent numbers at universities show the following: The percentage of female students at the Technical University in Graz in 2017 reaches just 23.70%, and in Austria the total is 34.5%. These data findings relate the MINT subjects, MINT being

[5] https://www.schule.at/portale/informatik-ikt.html

the German term for Math, Computing, Science, and Technology (which also covers Engineering, Production, and Construction), similar to the English term STEM. The situation around the world is comparable: In the UK [15], only 15.8% of engineering and technology undergraduates are female. In Australia [16] in 2015, only 15.5% of those enrolled in information technology, engineering, and related technologies were women. Statistics from the US [17] in 2014 showed that women earn only 19% of engineering and 18% of computer science bachelor's degrees.
A lot of research and literature exists that addresses this bias [18, 19, 20], and as diverse are the named reasons why this bios exists [21, 22, 23, 24]. On the one hand, it has been investigated if girls have different interests, affections, strategies, or qualities [19]. On the other hand, gender equity is not practiced in reality [24]. Here the literature assumes 1) that girls are getting less engaged in STEM disciplines, thus are less confident in technical areas [25], and 2) that existing stereotypes influence their career choice [21]. The challenge is to close the gender gap at universities by understanding girls' intrinsic motivation. Figure 41 provides a general overview of women in ICT in EU member states.

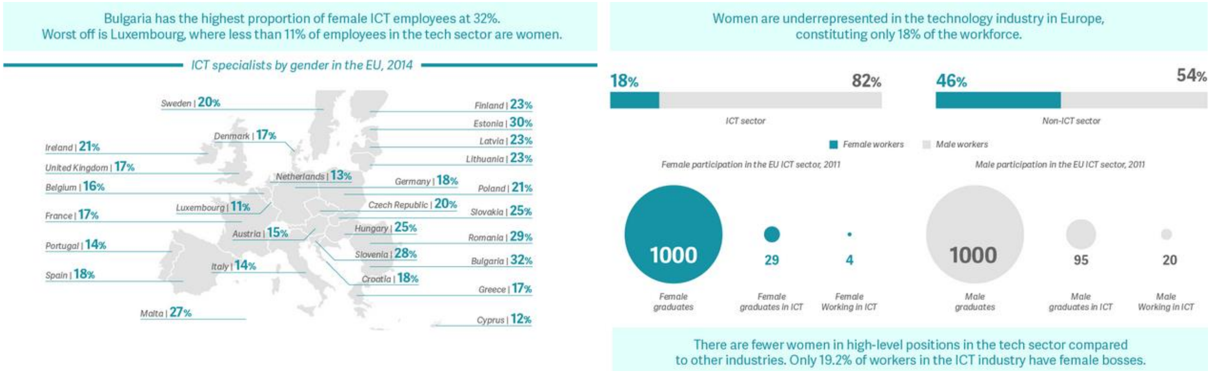


Figure 41: Women in ICT – How do EU member states measure up? [43]

4.4.3 Situation in Austria

As can be seen in Figure 26 the percentage of female ICT specialists reaches only 15% in Austria. This number is below the average in comparison to other European states. The total percentage of females studying MINT is 34,5%[6] in Austria, MINT being the German term for Mathematics, Computer Science, Science, and Technology (similar to the English term STEM). A closer look at the percentage of female students at Graz University of Technology shows that the number reaches only 23.7%[7] in 2017.
An examination of the number of students regarding the degree programs Software Development and Business Management at TU Graz is presented in Table 1.

	Percentage of females 1st semester	**Percentage of females 4th semester**	**Percentage of Retention**
2011	10%	6%	54%
2012	13%	7%	51%
2013	25%	18%	73%
2014	23%	18%	77%

[6] https://oravm13.noc-science.at/apex/f?p=103:36:0
[7] https://online.tugraz.at/tug_online/Studierendenstatistik.html

Table 31: Percentage of female students in Software Development and Business Management at Graz University of Technology

Table 17 points out two major problems we face at Graz University of Technology. First is the moderate increase in the number of female students over the years. Second is the increasing retention rate which represents the decrease in the number of earned degrees.

We defined two hypotheses:
Hypothesis 1: Females have a lack of IT knowledge and thus are feeling excluded in IT courses
Our assumption is that female students who start an ICT study without any prior knowledge in programming 1) are more discouraged about their choice because of unrealistic expectations about this field and 2) feel a higher pressure to perform well by demonstrating competence in competition with men [19]. See next section, related work.

Hypothesis 2: Girls can be encouraged to ICT by increasing their engagement through gamification
From our observations, we see four promising ways to attract girls to ICT:

1. Increase their personal attachment to programming with our app Pocket Code
2. Increase their involvement in computer science by being active members of the Pocket Code community
3. Showing them interesting programs and let them express their own interests
4. Asking them to design their own games

However, it is not our goal to create an environment especially for girls, but to improve our services for girls, which means providing them an environment that offers a safe and interesting community to join.

4.4.4 Related work

This section points out typical educational behavior patterns that may lead to the bias, and presents solutions to generate classrooms free of gender bias.

<u>Programming – A man's world?</u>
A majority of people believe that in the future more girls will enroll in STEM related subjects [26]. However, current numbers are alarming, as stated in the previous Section. High school education is the critical place in which students decide their future careers. Here, the number of women exceed those of men [27].
For a female technician, it is part of life to experience gender-biased situations, e.g., recruitment and evaluation processes, or restrictive regulations and norms. Side effects could also include exclusions from networks, and may create work-family conflicts. All of these factors make women question whether their abilities and interests harmonious with their selected field [19]. Their sense of belonging and collaboration stands in contrast to the image of the lonely programmer often seen as the stereotypes for this work group. They feel a pressure to perform well even when they try to ignore the obstacles. This stress arises from the conflict between wanting to be liked while at the same time having to demonstrate competence in competition with men [28].

<u>Achieving gender equality in education</u>
Studies show that women tend to be less self-confident regarding their beliefs about their abilities in STEM disciplines. Peer acceptance is a central point in adolescence [19] and collaboration is particularly important; when students exchange ideas,

defend their positions, try other ways of thinking, and experience self-confidence, and successful task completion [19, 29]. Students find STEM courses more meaningful when they can connect classroom experiences with personal goals.
Towards programming, different styles exist among genders but also within same gender groups. Teachers that only focus on computer instruction may discourage many students from actively participating. In previous [30] work, the author focused on how to create constructionist learning environment in classrooms. Papert [31], the inventor of constructionism, emphasizes the importance of hands-on projects, rather than abstract instruction. Examples for are coding clubs, robotics clubs, or summer schools. STEM differences start with first performances in mathematics and science [26]: It is important to encourage female students explicitly [20, 22, 23]. For example, if schools offer a voluntary informatics course for all students, the majority of participants will consist of boys. Girls must be invited, and there must be a place for them to express. Activities, which emphasize creativity, allow girls to explore science and technology as fun and it spark initial and long-term interest rather than academic subjects [26].

Promote female role models in STEM
STEM programs and initiatives for females could help to address some of the factors, which can prevent them from choosing a STEM career. One reason why women exclude computer science as a job opportunity is the absence of female role models [24, 32]. It is important that girls see female role models who have succeeded and promote positive beliefs regarding women's abilities, to expose that this job field also suits them or has a space for them to inhabit.

Girls Design – A need for pink games?
Ochsner [35] summarized seven initiatives for girls, including the findings of Kafai [33, 34], Purple Moon [36], or Rapunsel [37] from 1990-2007. The results were very similar. Figure 26 summarized their findings combined with literature [38, 39, 40]. It indicates that there are less successful games available for girls as there are for boys [41]. According to [2640 there exists less motivation for girls to become gamers. On the one hand, most games on the market are designed by man for men. On the other hand, if women have been integrated into world of gaming, it has often been framed within the confines of gender stereotypes. Gender stereotyping in games can be disordered (e.g., a princess who needs a male hero to rescue her may serve as a trophy).

Design	Game characteristics	Content
➢ exploration ➢ collaboration ➢ challenge ➢ vicarious adventures ➢ sophisticated graphic and sound design ➢ role playing[35] ➢ realistic design	➢ rich narrative ➢ roles involving positive action ➢ appropriate levels of challenges ➢ opportunities to design or create ➢ engaging characters ➢ communication and collaboration ➢ use of strategies and skills	➢ storylines and character development ➢ real-life locales ➢ characters who are in charge of decisions and actions ➢ to create rather than to destroy ➢ involving simulation and identity play ➢ chance to swap identities;

Figure 42: Design, characteristics, and content along girl games

4.4.5 Girls On-site observations

Regarding the differences between girls and boys, we could see some slight how both genders approached their tasks. The boys were more concerned with the gameplay itself, the game should be fun, fast and challenging. The girls mostly started with a rough idea and then started designing and drawing their gaming worlds. Afterwards they had often little time to get the game to a playable state. But with some help of the other classmates they could finish their games in time. The comparison of the game design process showed that girls mostly used "girly-like" graphics, e.g., unicorns or ponies but same game genres like the boys, e.g., shooting games, skill games or jump'n'run games. But the results also depended on the learning goal set by the teacher (e.g. two classes were only allowed to make a quiz game etc.). Researches show that many of the changes in teaching and learning that resulted from the study of empowerment of girls improved the situation for all students, not just for girls [12]. We assumed that learners who become game designers and creators will significantly contribute to closing the divide and participation gap in digital culture. On-site observations showed that we see significant promise in getting the youth involved into the world of coding, and letting them create their own computer games. It helps that they can bring their ideas to life and create something that is meaningful to them.

Our observations and preliminary results of our cycles showed similar results to those from the literature. Comparing the playing behavior of girls and boys approximately half of the girls sometimes play computer games. Used game characters or design patterns showed that girls on the one hand like very "girly-like" graphics, e.g., unicorns, but on the other hand they used zombies, pets and animals as well as male and female characters. Against our expectations the genres of games created by girls were very similar to those of boys. They created e.g., shooting games, skill games or jump'n'run games, see Figure 43. The results was also dependent on the learning goal set by the teacher (e.g. two classes were only allowed to make a quiz game etc.).

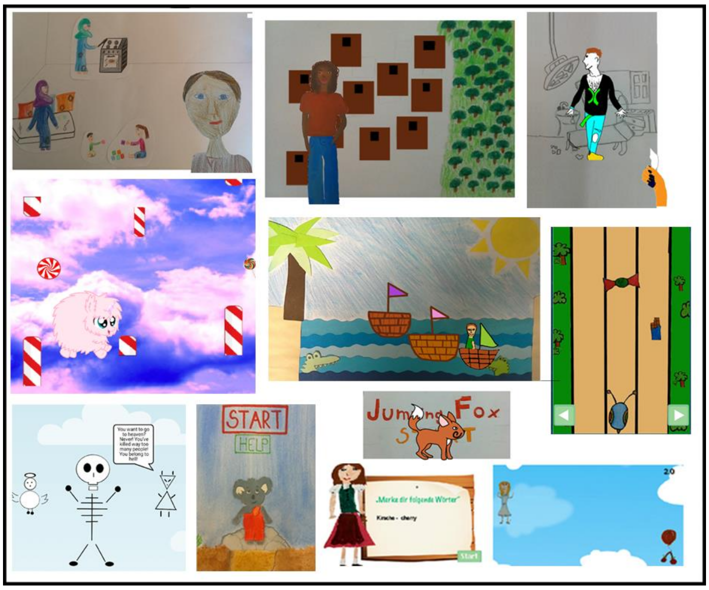


Figure 43: Game design of games created by girls from different partner schools in Austria

4.4.6 Our efforts

In the past, we also tried to encourage girls with challenges like game jams, e.g., the Alice Game Jam event [42], attractive and appropriate sample content[8] (tutorials), and media assets[9] that can be used in one's own programs. Results showed that these have been widely used for creating own projects (download statistic, finished games). Further work regarding teenage girls integrated three improvements in

8 https://share.catrob.at/pocketcode/gaming-tutorials

9 https://share.catrob.at/pocketcode/media-library/looks

Create@School based on the literature and on-site observations. These affected the Create@School's

a) Community[10] : show games they like and let them play,

b) App: let them program games they like, and

c) Creativity aspects: let them be creative in their own ways.

Improvements covered for:

a) a special view for girls on what programs have been uploaded to the sharing website (important: What kind of games are girls programming, games from girls for girls).

Therefore, we collected a list of 10 typical girls' games for girls and 10 boys games. In our web-view we integrated a new section "Example games" where we uploaded these 20 games, see in Figure 28. Most of these games were created during the NOLB project by Austrian students. Moreover, this section was only visible to NOLB students.

Figure 44: New sections Example Games

Unfortunately, the number of downloads for these games is very low. For introduction units we often ask the students to explore the app, download programs and get some code ideas from there. At this stage of the project many students already programmed with Pocket Code and therefore they did not have any general units anymore. See the tables 32 and 33 for the description of the games and the downloads per user.

Program ID	Game description	Genre	Download /Views
4427	The March Hare is having the best tea party of his life. Hit as many of the government members with the supported cups as you can. Hit the White Rabbit to gain extra time. Hit the Mad Hatter to gain extra cups. Don't you dare to hit Alice! The Cheshire Cat provides an extra portion of insanity - shake it off! Have fun!	Action Shooter	Before 10/17 After 21/23

10 https://share.catrob.at/pocketcode/

5758	The refugee girl from Afghanistan.	Action collecting + quiz	Before: 19/36 After: 25/40
5061	Marry me! You must collect the right letters to form MARRY ME. Avoid the wrong one. If you lose, the bride says „no".	Action collecting	Before 37/38 After:43 /72
15939	You are a pilot in a rocket. Avoid the meteoroids, otherwise, you will explode. Collect the aliens to your way to the mars. In the upper left corner, you see the amount of remaining kilometres.	Action avoid/coll ect	Before 26/22 After: 29/25
15379	Tap on the astronaut to catch the stars.	Action collecting	Before 19/19 After: 33/53
983	Gossip Girl cast with the voice description	Adventur e Storytelli ng	Before: 906/2410 After: 942 / 2472
3926	Frozen VS Star Wars. Both movies were merged together. In that way, it seems that the characters fight against each other.	Adventur e Storytelli ng	Before: 282/289 After: 301/301
5816	A refugee is travelling to a new country with quiz to pass the Nil	Quiz	Before: 38/36 After: 46/42
16028	History of magic. Which Harry Potter Character is known for which spell? Tap the right character!	Action	Before 14/20 After: 22/27
4219	Find the key, Alice. Collect the cards and rabbits. The goal is to catch the key.	Action collecting	Before: 55/58 After: 61/61

Table 32: List of girls programs

Program ID	Game description	Genre	Download/Views
5753	Refugee boy. Answer question.	quiz	Before: 22/38 After: 29/41
5878	Refugee game. Avoid the rocks and find the way back to your camp	Action jump and run	Before: 20/43 After: 26/47
16141	Space Billiard!	Quiz Skill	Before: 38/32 After:
19849	With the inclination sensors you can control the UFO. In each level you have to catch 3 friends. If you catch all 3 in one level you get an extra point. There are also enemies who you should avoid (they are getting more and more with each level).	Action collect/avoid	Before: 55/63 After:58 /64
19894	You shoot arrows at animals and aliens. The more you "kill" the higher is your score	Action Shooter	Before: 60/57 After:63/80
19455	Shift the space ship to avoid musical instruments and catch coins.	Action collect/avoid	Before: 10/9 After:13/11
4268	Shake your phone and tap the falling teacups, to save the tea party!	Action collect/avoid	Before: 5/13 After:12/18

13453	60 seconds to shoot as many aliens as you can. Click the gun to shoot.	Action Shooter	Before: 26/30 After:33/35
4792	Like flappy bird but with a raven who has to catch worms and flies and avoid bottles.	Action collect/avoid	Before: 118/80 After:124/84
3466	Race through Fireball Alley, collect diamonds, dodge opponent cars and fireballs. Tap screen to start. Tilt to move left right. Tap screen to boost your car's speed.	Action / Race	Before: 354/400 After: 379/445

Table 33: List of boys programs

b) sample content, a new template that attract specifically girls (combine adventure and storytelling challenges)

This template is the one we described in 2.1.7.1 Templates created in Austria – the template Adventure RPG. In addition, it is planned to add a template to customize your figure (enhancement of the 2nd scene of this template).

c) more sample media packages, and a redesign of the drawing app Pocket Paint

The redesign of the Pocket Paint app is currently in development. See first prototypes in Figure 45.

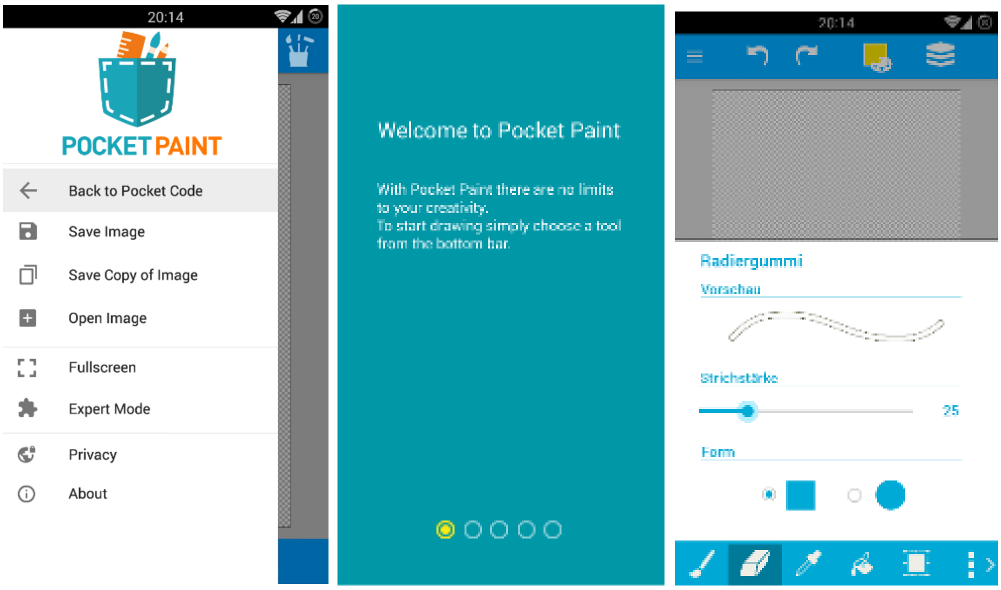


Figure 45: Prototype for the new Pocket paint app

The new version will have a short intro at the beginning and a menu to slide in and out. The whole UI refers now to the Android Guidelines. This was the test run to start the redesign for Pocket Code.

The research in Austria was dedicated to improve the Create@School app for girls to find new possibilities to make the app more attractive for them, which means providing them an environment and community that offers a safe and eye-catching place. Constructionist gaming and tools that encourage learning by doing have common features: They enable working in teams, allowing to express own ideas, and provide a visual programming language that is easy to understand and to learn. With a little more focus on girls, Create@School has not only the potential to teach students how to code, but also to teach girls' technical skills and empower them all over the world.

We want give students the chance to be creative and to draw their own graphics. But not all girls can draw. So we continuously expand our media library with themed graphics (e.g., carnival or Easter, see Figure 47), or create graphics to themes girls mentioned the most often, e.g., Magic. When students worked with the adventure RPG template we asked them if they need some graphics from us. Three students, all of them girls asked us for our help. See in Figure 46 the graphics they needed from us.

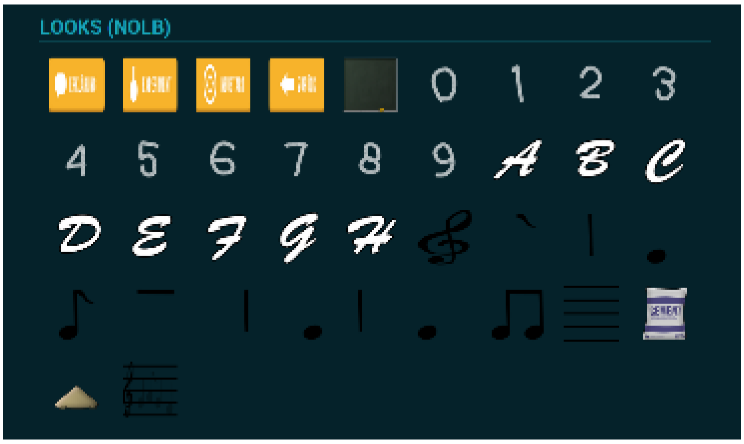


Figure 46: Graphics for the Adventure RPG template

Figure 47: Themed graphics in the media library

Finally, we come up with the idea to create a Pocket Code mascot: The Pocket Panda. At the end, we created a whole Pocket Code family, see Figure 48. They were broadly used by girls (and our target group as a whole).

Figure 48: Pocket Code family

4.5 *Results of the interviews and focus group discussions*

Two groups of female students in different age groups participated in the focus group after using Create@School app for their studies. The first interview session was conducted with 3 girls aged from 12 to 13 years in December 2016. The second group was made up of 5 girls aged 16-17 and the interviews with them were conducted in May 2017. The goal of the focus groups was to collect feedback about the app and retrieve information about teenage girls' interests and game preferences. The collected data was used in order to create girls-oriented template (Adventure RPG) and find a topic for a girls coding day.
The first focus group worked with the Quiz template during their arts class, they had previous experience with Create@School and did not use the app outside the class. It was allowed to build teams of two, but every student had to submit her own program at the end of the class. The second focus group created games with Create@School in context of their computer science class without using the templates. They did not have any Create@School experience, but they were allowed and encouraged to use the app during the Easter holiday's period to finish their games. There were 2 female teams, one consisting of 2 and another of 3 members. Two games, one from each team, were expected as an output of the computer science units.

Questions related to the app

- What was especially difficult and why?

First group: it was hard for the girls to use the program without the instructions or external help, as well as to handle the structure and the connections between the concepts of the Create@School scripts.
Second group: first team did not have any special difficulties using Create@School, one of the girls did the most programming, because she attended the programming classes at school before. Second team had difficulties with division of the tasks and merging of the scenes.

- Did something strike you as positive?

First group: one of the girls found it positive that it was possible to choose the images and sounds from the Create@School media library. The second girl praised the simplicity of the upload function. The third girl did not experience difficulties with copying the looks.
Second group: The girl who did programming in the first team said that it was easy to create own games from scratch. The second team mentioned that Create@School was relatively easy to use for people without programming experience.

- Would you use Create@School outside school?

First group: no, for different reasons. One girl said that she would need obstacles and levels to keep her motivation high to use the app. Another girl considered her knowledge of the app not deep enough to be able to create something on her own. The third girl said that such apps are for "Internetfreaks".
Second group: in the first team only the girl who did the programming could imagine using Create@School in her free time, she also spent time in the holidays programming the game for the class. Regarding the second team, two of three girls were ready to use the app in their free time, one of them used Create@School but could not succeed due to the diversity of the scenes created by the team members.

Questions related to the interests and game preferences

- Favorite fictional character

First group: two of the girls named the characters from Disney movies, one girl named Harry Potter as her absolute favorite.
Second group: three of the girls showed a lot of enthusiasm about Harry Potter characters and movies. Lord of the Rings movie was discussed in detail, but only one girl called herself a fan. All girls mentioned movies and characters from mystery and adventure genres, romance as a genre received negative reaction.

Apps and game preferences
First group: action games (Crossy road, Mario run). One of the girls did not play games in her free time. The appreciated qualities of the games are personalization, it should be possible to create the game background, change the appearance of the surroundings where the action takes place.
Second group: diverse games with completely different scenarios and genres without obvious common pattern, but the massively multi-player online games (MMOG) were preferred. One of the girls said that she prefers PlayStation and plays Battlefield. Two girls mentioned strategy games in which the player has to build their environment, one of them mentioned Clash of Clans and Guild of Heroes, another "Aufstieg von Berk" (at the same time she also mentioned Smash Hit as the game she started playing recently). Another girl plays Candy Crush in her spare time.

4.6 *Future efforts*

Enabling girls to gain positive experience in coding, we are convinced this will influence their attitude towards - and more important their planning of, a STEM related career.
For the future, the following efforts are planned:

1. recommending programs which girls like

Not only content based but also with a real recommender system (e.g., perform a user clustering analysis and to detect certain patterns in user performance)

2. testing via long term studies in cooperation with schools

See section 3.1.2.1 Future Work with teachers.

3. Promote girls content

According to our focus group interviews and created games by girls, we investigated that the following topics are from special interest for girls: magic, vampires, detective stories, pets and animals, fairytale, and monster/zombies.

Finally, we want to perform special Girls Coding Days, see next section.

4.6.1 Girls Coding Days

In 2015, we held our first game Jam during the European Code Week and the International Computer Science Education Week. The game jam aimed to engage female teenagers and introducing them to programming in a playful way. By choosing the theme "Alice in Wonderland" we aimed to appeal as many girls as possible and furthermore we had the chance to work together with the British Library for the 150th anniversary of this novel. To reach a wider audience, this event has been a cooperation with the Scratch Foundation. Results show that 46% of the participants were female, and 44% had already some previous knowledge in programming. We observed that the topic was well accepted through girls but since it was an event outside school (and also outside a setting at all) we decided that we will not follow this approach in the future.

Now we will focus on Girls Coding Days or in future also Coding Clubs. These days will be performed outside of the regular school setting. The reason is that towards programming, different styles exist among genders but also within same gender groups. As discussed in 4.2.1.3 Related work, schools and teachers mainly focus on computer instruction and therefore may discourage students from actively participating. Interests in STEM areas start with first performances in mathematics and science. It is important to encourage female students explicitly: For instance, we observe that if schools offer our Pocket Code units on voluntary basis for all students, the majority of participants consisted of boys. We believe that girls must be invited, and there must be a space for them to express themselves.

These activities will especially emphasize creativity thus, allowing girls to explore science and technology as fun and it spark initial and long-term interest. To get girls interested in technology the author will asking them to design games rather than to focus on the learning of specific programming skills. Girls involved in the "Coding days" will represent those who are vulnerable learners in terms of risk of exclusion. Using inclusive technology in a game-making environment is a revolutionary approach that will support social inclusion and empowerment from childhood to make a real change in the life of girls.

The first trial is planned for 23/24th of August 2017 with the girls who participated in the Austria pilot. On the first day girls between 12 and 14 years will participate and on the second day girls between 15 and 17 years. We expected 15-20 girls per course. The topic for this event will be "Magic". The flyer is pictured in Figure 49.

Figure 49: Flyer for the girls coding day

5 CONCLUSIONS

In Austria, we have achieved our objectives and initiated corresponding measures during the project's period. The feasibility study helped us to identify students' and teachers' specific needs, defined the range of capabilities that can be measured through gaming analytics, and provided a list of barriers and difficulties in using Pocket Code. The results of the feasibility suggested improvements not only regarding the Pocket Code app itself but also the style of teacher training/support, preparation of tutorials and lesson content, and the backing of the course. During the 1st cycle we evaluated preliminary results and continue working with Pocket Code. Further, the team started preparing to adopt Pocket Code to the New Generation of Pocket Code called Create@School. The new parts of the app included 1) Accessibility Preferences, 2) Analytics Data and Visualization, 3) Project Management Dashboard (PMD), 4) Game Modules, and 5) Usability Improvements and Feature Completeness.

In October 2016, we released Create@School, which was tested and evaluated in the 2nd cycle of the project. During this period, the app has been reviewed at an iterative basis. Further interviews, focus group discussions, and again a survey was conducted with the help of the AttrackDiff tool which provides usability and design evaluation. During the 2nd cycle, background material and information about female teenagers has been gathered, both from the literature as well as through interviews and focus group discussions with teenage girls in Austria. New implementations and action steps are planned to optimize the user experience for girls.

In Section 4.4, we explained the importance to show girls that STEM related subjects are not only reserved for men by providing them ways to explore, allowing creative and collaborative styles, and try to unlock their full potential. Constructionist gaming and tools that encourage learning by doing have common features: They enable working in teams, allowing to express own ideas, and provide a visual programming language that is easy to understand and to learn. With a little more focus on girls, Create@School has not only the potential to teach students how to code, but also to teach girls' technical skills and empower them all over the world.

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