Computational Skills with sCool

Alexander Steinmaurer, Johanna Pirker, Christian Gütl
Graz University of Technology

Overview and Motivation

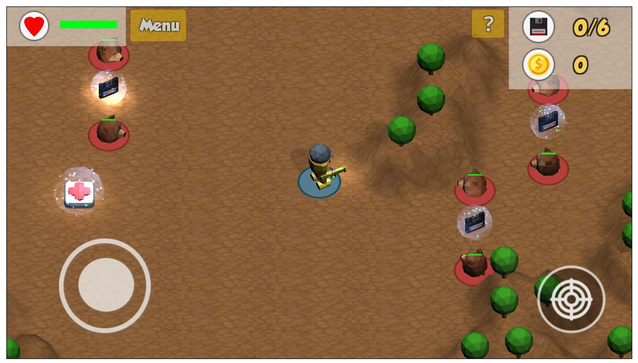
Computational thinking is becoming increasingly important in society today. This is not only a skill related to computer science. Computational thinking enables people to recognize problems and solve them in efficient ways. It involves algorithmic thinking, evaluation, decomposition, abstraction and generalisation. The mobile video game 'sCool' [1] is a game-based learning tool that should cover these skills. There are two different parts of the game, that pursue different objectives. In the concept-learning mode the players learn new concepts and in the practical mode they have to be applied in different missions. The game's content is highly adaptive and can easily be changed over a web platform to reach a high level of flexibility according the educators needs. It was developed in a research collaboration between Graz University of Technology and Westminster University, UK.

Objectives and Goals

- Introducing the educational game 'sCool' as a tool for beginners in computer science.
- Use 'sCool' as a game-based learning tool for computational skill teaching.
- Engaging students for STEM subjects in a playful way.

Concept-Learning Mode

In the concept-learning mode the students are charged with the mission of discovering a hostile planet. The aim is to collect different pieces of information in the form of disks. These disks contain different information that is needed to escape the planet. Both the game maps and the playground are generated based on procedural content generation algorithms (Cellular Automata and Perlin noise) so that they are different every time, which makes the game more re-playable. The level of difficulty can be pre-defined at the web platform, so the missions will get more complex. After successfully passing a mission a new concept is presented in a textual form. The player has to go through this text and answer a following single choice question. When this question is answered correct, the mission qualified as passed, otherwise the whole level has to be repeated until it is done right. In this way the learning concepts are worked out by completing the levels.



Defeat the enemies to collect all disks.

Practical Mode

In the practical mode the players have to apply the previous learned concepts. The playground is represented as a squared chessboard where the robot is placed. Out of this position the player's goal is to reach the disk by giving the robot certain instructions. The robot can be controlled via different command blocks that get dropped into a code editor. Each block represents an instruction in Python that is executed by the robot. There are four different block types: print, variable declaration, move and control structures. It is also possible to change the code in the editor via a virtual keyboard to generate custom output. Depending on the player's progress the level of difficulty can also be increased.

Leading the robot over the playfield to collect the disk.

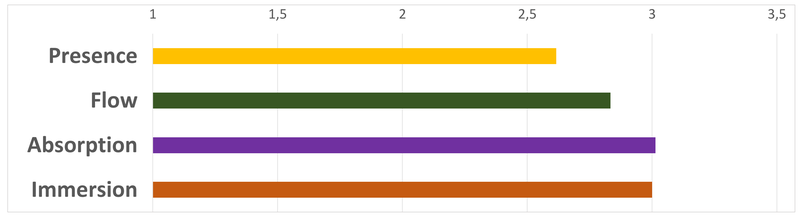
Web Platform

The .NET-based web application is a specially designed tool for educators. Teachers can use it to provide new educational contents, create new courses or edit existing courses. Each course is represented as hierarchical skill-tree. These skills are superior elements for all concept-learning and practical tasks. Different concepts can be mapped to a specific skill-tree. The content and the degree of difficulty can be declared in the web application and the maps are generated based on these parameters. A distinction is also made between concept-learning and practical tasks on the web platform. In the concept-learning part educators can define learning contents and the corresponding single choice question for the players. Additionally, the difficulty level for the exploration mode is appointed, so the map is generated according to that value. For the practical tasks, educators can define the goal of the task and its reference output. This solution represents the expected output of the Python code to successfully finish the level. In this section it is also possible to define the accessible blocks/commands in the levels.

The web platform also provides an assessment and analytics tool for educators to analyse the learning process of the students and for gaining a detailed evaluation of the course. The mobile app communicates with the server via a JSON API. It fetches the provided course contents and also sends user-related data for analysis purposes.

Experiments and Results

The game 'sCool' was evaluated [2] in two Austrian Secondary Schools (New Secondary School and Academic Secondary School). We conducted the experiments in two school lessons (á 50 minutes) for each school type with overall 30 pupils (17 girls and 13 boys) between the ages 12-15 years. In groups of two they had to accomplish five concept-learning missions where they learned main principles of programming (printing a text, repeating a command and arithmetic). After they solved these levels successfully, they had to accomplish three practical missions, based on the previous learned concepts. At the end of the lesson the pupils had to solve a practical worksheet to transfer the learned skills to a similar task. After the experiments different factors regarding game engagement, emotions and motivation were queried with different questionnaires. The results of the Game Engagement Questionnaire [3] showed that the pupils were highly engaged while playing the game. An important factor concerning motivation and learning is the level of flow (M=2.83). Another thematic priority was the perception of the female participants. 83% agreed that they enjoyed playing the game and 72% enjoyed programming with 'sCool'. The performance of the girls was similar to that of the boys and they were even faster than the boys in the practical missions.



Game engagement according to GEQ [3] while playing the game.

Conclusion

The mobile video game 'sCool' is a tool that allows educators to create highly adaptive courses for different STEM subjects. Due to its both gaming modes and its narrative the game is highly motivating. Another major advantage is that the game enables microlearning beyond usual learning situations and so students can learn during their daily routine. The game addresses both boys and girls and so it can be a great enrichment in different educational ways.

References

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Contact Information

Website: https://www.tugraz.at/institutes/isds/home/
E-Mail: a.steinmaurer@student.tugraz.at; {johanna.pirker, c.guetl}@tugraz.at;