Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

Bachelor Thesis

Course Unit: 252-0500-00
10 ECTS credits

Project Description

Topic

Gotscha! Meet an interactive learning environment with focus on object identification and classification. It supports the teacher by challenging pupils on their respective level. Concentrate on the mass whilst foster on an individual level!

Student

Franz Knobel (10-932-879), enrolled in the Computer Science Bachelor Programme at ETH Zurich.

Supervision & Grading

Responsible Lecturer: Prof. Dr. Juraj Hromkovič
Supervisor: Dr. Elizabeta Cavar

Time-Frame

Assignment date: Wednesday, July 31, 2019
Submission due: Friday, January 31, 2020

Motivation

As the importance of computer science is rising, certain games that support the develoepement of abstract thinking, analytical skills and decision making, are becoming more and more interesting at an early age. Through identification and describing relationships between items, children develop a foundation to early math skills and basic concepts of computer science (e.g. combinatorics of finite affine and projective spaces, the theory of error-correcting codes, etc.) [3]. The pupils individual learning speed and lack of concentration, if not receiving the right amount of attention, is another challenge by itself. Without individual fostering, children are at high risk of losing interest. Through this thesis the teachers should receive a tool for their pupils. Focused on classification of objects with certain properties, the pupils get introduced to a computer-based learning environment. There they can individually train and improve themselves in this field. In the mean time the teachers can concentrate on the majority of their pupils and have the opportunity to work with pupils on an individual basis, without feeling the pressure of having to support everyone at once.

Background

The key contribution of computer science to general school education is rooted in the concept of *algorithmic thinking* [1]. One way of introducing kindergarten and primary school pupils to algorithmic thinking and it's concepts consists in making them solve problems with and without computers. This can be achieved using age- and knowledge-appropriate learning materials. Several papers with corresponding online learning environments have been proposed [4, 12, 13, 14]. This work is going to be added to the implementation of "INFORMATIK BIBER in KG und 1/2" by Jil Weber [14]. The focus of this work will not solely lie on the translation of the existing teaching material to a computer-based learning environment, but also on introducing learning methods in a gamified environment which not only complements the teachers with their teachings but also assisting them.

Goals of the Thesis

The main objective of this thesis consists of planning, analyzing, implementing and testing a computer-based learning environment on the topic of classification. The student studies the already existing implementations of "INFORMATIK BIBER in KG und 1/2", analyses the capabilities of kindergarten kids and first graders, develops an interactive classification tool, implements it then on a platform compatible with the implementation of "INFORMATIK BIBER in KG und 1/2" and conducts an evaluation with test subjects. We expect the student to find a suitable implementation that integrates neatly into our existing system mentioned before. The outcome of this thesis is a well-documented, stable and reliable prototype, providing the functional elements to be used in schools.

Tasks

As part of the Bachelor Thesis, the student is expected to perform the following main tasks and their subtasks:

1. Concept
   a) Analyze the teaching material concerning classification currently available for kindergarten to 2nd grade.
   b) Familiarize yourself with web technology.
   c) Study the relevant publications of the Chair of Information Technology and Education in didactics of computer science.
   d) Investigate related work on the topic of teaching children to classify and identify properties and explore different designs.
   e) Explore how children react to existing learning-based games (Using a pre-test)
   f) Explore what requirements and demands arise when children are confronted individually or in groups with your environment (see 3a and 3b).
2. Design and implementation
   a) Propose a suitable environment for your computer-based learning platform. (e.g. AngularJS, a game-framework, python, etc.)
   b) Implement and document a maintainable interactive evironment.
   c) Add gamification elements (e.g. a reward system, different levels)
   d) Integrate your work into Jil Weber's environment "INFORMATIK BIBER in KG und 1/2" [14].
   e) Test your final product in class (see 3c).
3. Evaluation
   a) Conduct a preliminary study evaluating the success rate of primary school children and kindergarten children in interacting with your learning enviroment individually and in groups.
   b) Investigate how the reward system affects the social interaction between pupils.
   c) Final evaluation. Find out whether your application can fulfill it's purpose.
4. Deliverables
   a) Elaborate on your work in a well-documented report.
   b) Demonstrate the application.
   c) Give a presentation of the thesis.

Deliverables

The student is expected to manage the project, comply with rigorous scientific standards, and to apply sound software engineering procedures in order to successfully design, develop and test the platform.
We expect an extensive and detailed documentation of all steps of the project. The student provides both a high-level documentation (i.e., a description of the inner workings and communication protocol used in the extension) as well as a low-level documentation in the form of suitable comments in the source code.

Grading Criteria

The Bachelor Thesis will be graded according to the *Guidelines Bachelor's Thesis* [2]. Major emphasis will be placed on the quality of *objectives and scope*, *scientific approach*, *design*, *implementation*, *reflection*, *autonomy*, *learning aptitude*, *creativity*, *documentation*, *presentation*, and *time management*.

References

[1] Juraj Hromkovič, Tobias Kohn, Dennis Komm, Giovanni Serafini: *Algorithmic Thinking from the Start*, Bulletin of EATCS, Vol. 1, Number 121, 2017.

[2] Department of Computer Science: *Guidelines Bachelor's Thesis*, available at `https://www.inf.ethz.ch/studies/forms-and-documents.html`

[3] Davis, Benjamin Lent, and Maclagan, Diane: *The card game set*, the Mathematical Intelligencer, 25, No. 3, 2003, 33-40, available at `http://homepages.warwick.ac.uk/staff/D.Maclagan/papers/set.pdf` (last visit: July 31, 2019).

[4] Blum, Sonja Tabea: *A platform independent, computer-based learning environment to a textbook for computer science*. Master Thesis, ETH Zurich, Department of Computer Science, 2018, available at `https://doi.org/10.3929/ethz-b-000312911` (last visit: July 31, 2019).

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[6] Elshiekh, R. and Butgerit, L. (2017) *Using Gamification to Teach Students Programming Concepts*. Open Access Library Journal, 4: e3803. `https://doi.org/10.4236/oalib.1103803` (last visit: July 31, 2019)

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[12] Kamp, Sarah Eleonora: *A platform independent, computer-based learning environment.* Bachelor Thesis, ETH Zurich, Department of Computer Science, 2019

[13] Tang, Kevin: *Graphs, trees and discrete optimizations: Computer-based learning environment about combinatorial problems for secondary education.* Bachelor Thesis, ETH Zurich, Department of Computer Science, 2019

[14] Weber, Jil: *Eine interaktive Lernplattform für algorithmisches Denken, für 4-8 jährige Kinder.* Master Thesis, ETH Zurich, Department of Computer Science, 2019

Zurich, January 20, 2020

Franz Knobel | Dr. Elizabeta Cavar | Prof. Dr. Juraj Hromkovič