Science simulation development with Scratch

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Introduction

This study focuses on exploring the use of Scratch for constructing science simulations with students of Senior High School in authentic classroom conditions. We implemented alternate teaching strategies as use of preconstructed Scratch projects and simulation development from scratch in order to support student inquiry and learning with models in science.

Aim

The aim of this study is

- to discuss basic parameters of an effective constructionist approach aimed at engaging students in simulation development as an interdisciplinary project.
- to provide the educational community with particular examples of practices for inspiration, implementation and reflection.

Objectives

- **to enable students cultivate science and computational concepts, practices and perspectives through designing, developing, exploring, reusing, remixing and sharing science simulations using Scratch environment.**

Implementation

The suggested approach was implemented in the framework of the "Project" course in an option class of the 1st grade of A΄ Arsakeio General Senior High School in Athens, Greece, during the first four-month period of the school year 2011-2012.

Participants: 20 students (7 girls - 13 boys). Students were separated in pairs per computer of their own choice. Students were not familiar with Scratch environment.

Duration: 2 hours class per week for 6 weeks.

Research setting

Research tools

- Scratch environment,
- activity worksheets, lesson plans, student worksheets,
- Scratch projects.

Data collection

- teachers' notes kept during each didactic hour,
- students' projects,
- filled in student worksheets,
- semi-structured interviews of students.

Data qualitative analysis

- modifications, interventions and changes in the ergonomics, the visual appearance and the functionalities of projects,
- dynamic formative reshaping of the activities, lesson plans and worksheets.

Motion Simulations

"Kinematics" are studied in the 1st grade of General Senior High School according to Greek curriculum. So, focus was on building motion simulations such as:

- Uniform linear motion
- Uniformly accelerated linear motion
- Free Fall

We proceeded to construct, remix and explore simulations increasing complexity and difficulty:

- Simple motion simulation
- Stroboscopic representation
- Combination with tables
- Combination with charts

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Connecting & Sharing Simulations

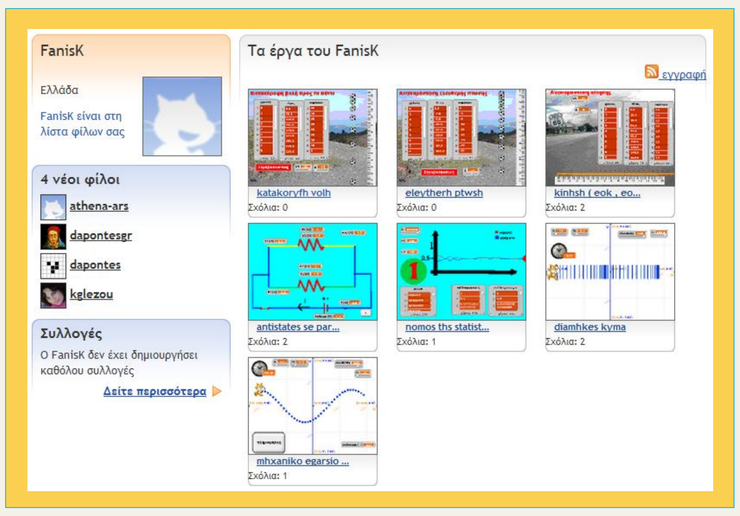

Figure 1: Scratch community student profile page (in Greek).

Reusing & Remixing Simulations

Figure 2: Examples of Reusing & Remixing Motion Simulations (in Greek).

Constructing Free Fall Simulation

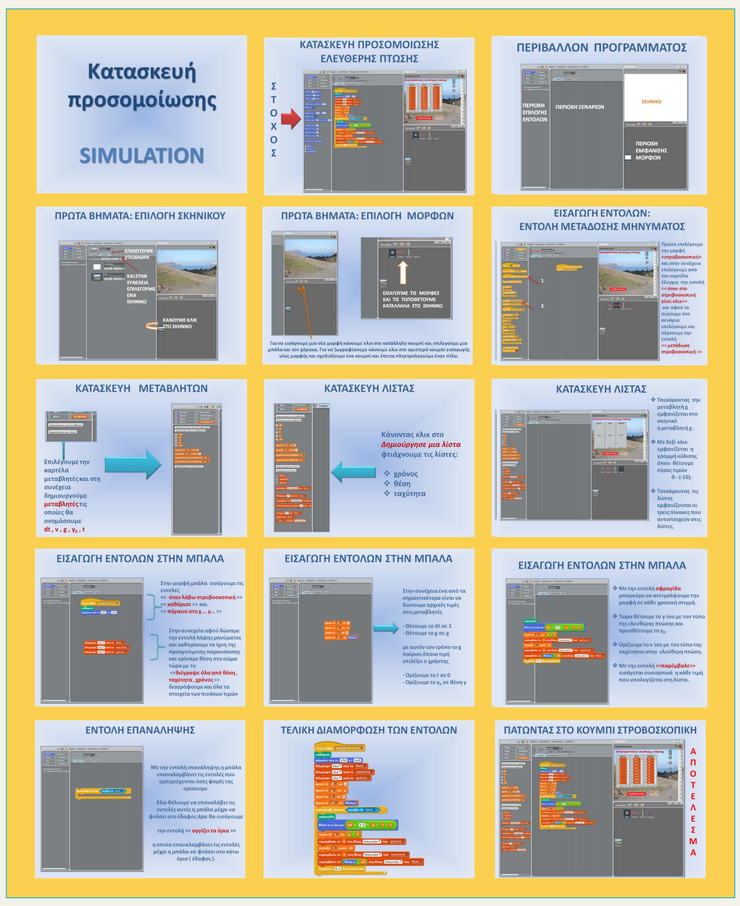

Figure 3: Presentation Slides of Guidelines from students to students - Steps of Free Fall Simulation Construction (in Greek).

Results

The students showed special interest in their interaction with Scratch and remained active during the lessons, especially in the phases where they had to create and debug their own projects.

The process had a positive effect on students differing in extent and understanding depth.

Students in all ability levels made gains in cultivating:

- **Science Concepts (motion, velocity, acceleration, displacement, time)**
- **Computational Concepts (sequence, iteration, conditionals, variables, event handling, data structures, synchronization)**
- **Problem-Solving Skills (identifying, formulating, analyzing, decomposing & debugging problems)**
- **Design Skills (imagining, creating, tinkering, evaluating, remixing)**
- **Social-Emotional Skills (collaborating, sharing, persevering, reflecting)**

Conclusion

Scratch cultivates creativity, gives the teacher pedagogical freedom and supports the students' active engagement and learning.

Exploring and remixing preconstructed simulations and developing new ones promotes new perspectives and understanding of science, computational concepts and practices.

Discussion

- The use and re-use of preconstructed projects for the creation of new artifacts with a gradually increasing degree of complexity encourages the systematization of knowledge and bridges the gap between the simple and the more complex, especially effective in scaffolding simulation development.
- Sample projects can inspire, operate as starting points for building on them, changing them or decomposing parts of them in order to construct a new artifact. Attention needed for sample projects use in order to function as a challenge and not as a barrier to free open experimentation.

Recommendations

- A well structured series of sample projects and activities characterized by a gradual increase in complexity and difficulty function as scaffolding during the gradual familiarization with Scratch and simulation development.
- An appropriate environment for novice learners should be developed in gradual steps and according to their previous and acquired experience.
- The teacher needs to proceed in subtle handlings, in order to accommodate the students with no more support than what they need.
- Some students, especially the nonpersevering, might need additional attention or support.
- Comments in code or/and in project notes prove very helpful for further understanding as well as documenting processes.
- Scratch and ScratchEd community offers multiple opportunities to teachers and students on connecting, sharing, collaborating.

Future Work

Our future research plans focus on exploring the use of Scratch and other modeling paradigms as well, by implementing alternative teaching strategies in order to support student engagement in simulation development, computational thinking, knowledge and/through artifact construction and collaboration.

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