Chapter 45
Using Social Simulations in Interdisciplinary Primary Education: An Expert Appraisal

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Abstract Many people recognize that teaching basic skills in primary schools (reading, writing, and arithmetic) is no longer sufficient for pupils in the digital age. Therefore, governments now increasingly ask schools to add other skills (oral, digital) and to create connections between subjects (e.g., use mathematics in history lessons). In this study, we explored how social simulations can be used in primary education to meet these new goals. We conducted an expert appraisal (a qualitative Delphi method) with four experts specializing in innovating primary education. We selected three simulations that were freely available on the web, relevant for pupils' lives and had a limited number of parameters. They dealt with segregation, gossip spread and population dynamics. We asked the experts to critically discuss these. Afterward, we analyzed the videotaped discussions in terms of affordances and constraints. The results showed that the affordances of social simulations include their broad appeal to students and their capacity to help users explore relevant concerns through an integrative approach (e.g., interpreting graphs, reasoning with parameters, predicting). Also, the experts warned that social simulations can touch on ethical issues that might be stressful for some pupils. If well-orchestrated, the use of social simulations has great potential to fulfill the new primary school goals.

Keywords Expert appraisal · Interdisciplinary primary education · Social simulations in schools

45.1 Introduction

In primary schools all over the world, pupils learn to read, write, and calculate. These three basic skills were considered important when compulsory education was established. More than a century later, many people question whether these are still

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sufficient and whether other skills (reasoning, presenting, visualizing data, computing, etc.) should be added. Moreover, some have observed that compartmentalizing the teaching of these basic skills does not foster the emergence of higher-order reasoning required for complex problems [1]. Such compartmentalization can also create dissonance because people seem to "forget" their skills when confronted with out-of-school problems [2].

In many countries, educational ministries are trying to remedy this situation and improve learning outcomes. The Norwegian Ministry of Education and Research [3] has framed five basic skills (oral skills, reading, writing, digital skills, and numeracy) and requires these to be intertwined in teaching. For example, visual-numeric representations (e.g., bar charts) should be part of social subjects (history, geography, and religious education). Also, learning experiences should be interactive (hands-on), related to out-of-school life, and ask pupils for higher-order reasoning and solving complex problems. Against this background, we were inspired by the decades of work by Uri Wilensky and colleagues [4, 5], who demonstrated that pupil's interaction with digital simulations of complex systems offers valuable learning experiences. However, their focus is on (1) "learning to code" (e.g., making robots move) and (2) connecting simulations to learning concepts of the natural sciences. Alternatively, we focus on (1) students' meta-knowledge (knowing about) of simulations, which entails understanding aims, limitations, and when/where/for what purposes they can be used (or not), and (2) simulations of social phenomena.

Social simulations can connect themes from pupil's lives to representations of change (e.g., simulating how a group of kids share news and how the spread increases and fades). We hypothesized that through social simulations, pupils' learning experiences could meet the government's educational goals. Therefore, we started a study on the use of social simulations with 10–13-year-old pupils. Applying a sociocultural perspective, we framed pupils as actors within (1) school and (2) out-of-school activities. In schools, pupils' activities are prompted by designed tasks, and simulations can be tools, which have affordances (what it offers and provides, subjectively perceived by a user) and constraints (the conditions which guide and limit the activities) [6]. Our research question was: what are affordances and constraints in using social simulations in primary education to meet the government's goals?

45.2 Materials and Participants

We organized an expert appraisal (a qualitative Delphi method) in a session of 3 hours. The program entailed: (1) introduction and goals of the project, (2) viewing and critically discussing three selected digital simulations, and (3) a general discussion. We selected three agent-based simulations on the criteria: freely available on the web, connecting to pupil's lives, and having a limited number of parameters (sliders).

1. A simulation of Schelling's segregation model with four sliders (similar, red/blue, empty, size), which can connect to pupils' experience of peer group clusters and the inclusion or exclusion of people; see Fig. 45.1 (top left). Available from http://nifty.stanford.edu/2014/mccown-schelling-model-segregation/.
2. A gossip simulation with three sliders (speed, message loss, number of initial messages), which connects to how information spreads among a group; see Fig. 45.1 (top right), http://brucespang.com/bimodal/simulation/.
3. A population dynamics simulation with three graphical representations (a social network, a population tree, and a time graph), one slider (fertility); see Fig. 45.1 (bottom). The simulation can connect to the pupils' experience of population growth and family life. Available from https://runthemodel.com/models/1633/.

Four experts (two women, two men) participated; they will be indicated as P1–P4. They were selected because of their educational experience with (1) the age group, (2) educational use of digital tools, (3) inquiry-based learning, and (4) innovating education. The discussions were open and only slightly guided to keep the focus on the goals of the project. The experts sat together with one laptop, on which their activities were screen-captured. Additionally, we filmed facial expressions and gestures. We analyzed transcripts on affordances and constraints of including the simulations into primary education. The affordances and constraints pertained to activities within school (using, reasoning, and understanding) and to connecting to pupil's out-of-school life.

45.3 Results

Space only allows us to summarize results. First, we found that the experts needed more time than anticipated (approx. 30′) to familiarize themselves with the simulations. This revealed a constraint for first-time users. As for the number of variables (100 or 900 agents in a simulation), the participants did not appear to be thrown off by higher numbers. However, a simulation with only one slider was considered too simple (one can easily see its effect), two sliders were more challenging, while a simulation with four sliders was considered complex and required more guidance. Another constraint was the abstractness of parameters: for example, fertility would better connect to pupil's imagination if expressed as "average number of children per woman" rather than as "number of births per 1000 inhabitants." As for the title of the simulations, they rather had the gossip simulation have the name "information spread simulation" as the term gossip has a negative connotation (slandering). Regarding the interface, the experts preferred one field showing the agents moving or changing color; multiple graphical representations within one window was considered a constraint.

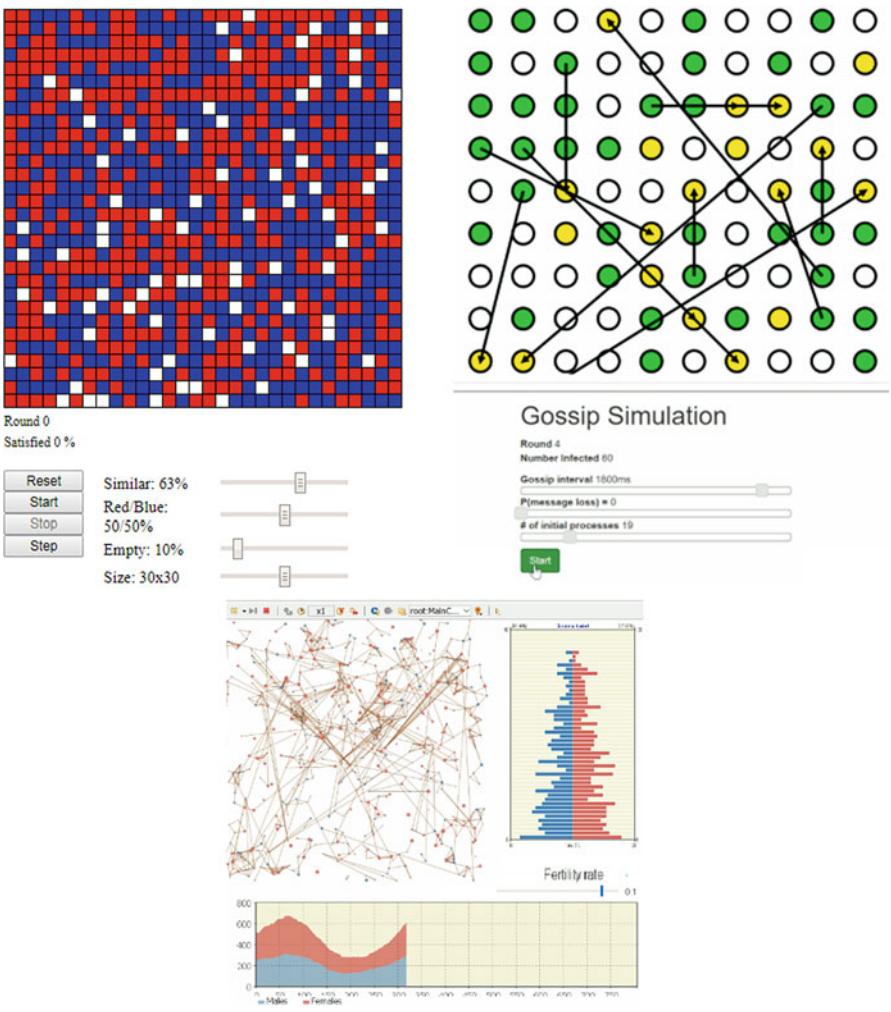

Fig. 45.1 The interface of the segregation simulation (top left), the gossip simulation (top right), and the population dynamics simulation (bottom)

The simulations afforded a connection between pupil's lives and the social subjects in schools. The experts discussed whether a clear connection to mathematics could be made, since mathematics is *black boxed* [7] in simulations (in part because sliders are more user-friendly handles for parameters). Thus, traditional school mathematics is not visible at a surface level in the simulations. However, P3 observed that any simulation has a time scale, which allows for tasks that ask for quantitative reasoning and making predictions (e.g., "how long does it take to . . . ?"). Also, the experts noted that the simulations offer opportunities for interpreting visual representations of change; for example, pupils' reasoning about a "decreasing

increase" is a precursor to intuitive understanding of the second derivative. Thus, the simulations afforded interdisciplinary thinking (combining social sciences and quantitative reasoning).

The experts also considered social simulations to be appealing to a wide group of pupils (girls, pupils from disadvantaged backgrounds, etc.), reaching beyond the pupils who have an interest in science and technology. They indicated a preference for the "lighter" themes of information spread and fertility over themes such as segregation, considering the age of the pupils. The latter theme triggered discussion:

P3: But, what in a multicultural classroom some of them will not be motivated at all (..) It will be confronting.
P1: Yes, also if it is with neighbors rich and poor.
P3: Maybe, ... introduce first something which is safe like ... hm ... are you supporter of this soccer team or that soccer team or ... (..) If you look how many do a certain sport ... if 60% do the same ...

The experts worried that themes touching on social or racial discrimination could wound pupils. They argued that teachers should be aware of delicate issues, use care when handling ethical themes in classrooms, or begin with less controversial themes, for example, by replacing racial segregation by rivalry between sports fans.

45.4 Conclusions, Discussion, and Recommendations

In this study, we explored some of the affordances and constraints related to the use of social simulations in primary education. Through an expert appraisal, we found that social simulations afford the creation of connections between pupils' out-of-school experiences and school tasks and between different school subjects (social subjects, mathematics). An overarching value of adding social simulation to the curriculum at primary schools is that they are appealing to many pupils, including underrepresented groups in science and technology. However, the experts also identified some potential constraints: the usability of the tools (e.g., ease of understanding the interface), the need for didactical task design (e.g., connecting the subject of mathematics to simulations), and the importance of carefully handling ethical themes (e.g., discussing segregation could be risky for some pupils).

We should use caution in interpreting these results because our study was small-scale and explorative. Clearly, more research is needed especially into the way in which simulation could be used to facilitate higher-order thinking, how to scaffold activities, and what transfer takes place from understanding simulations to understanding real-world scenarios. We argue that social simulations can support the government's educational goals, but their implementation will require careful orchestration. Since primary education is still currently compartmentalized, teachers will need assistance and professional development as they make the transition and explore new integrative pedagogical approaches.

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