# The Virtual Classroom
## *A Pilot Case in Inquiry Based Learning*

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Abstract: This paper discusses a pilot case held in First Private Mathematical School, Sofia, Bulgaria that explores the Inquiry Based Learning through a specially developed virtual classroom. The paper describes the motivation for using Inquiry Based Learning and how it will be gradually implemented through several pilot experiments. It reveals the design and the educational concepts embedded in the software tool used in the pilots: virtual classroom. The paper concludes with a discussion about the results of the pilot and plans for the next round of experiments.



# 1 INTRODUCTION

Modern conception of learning (Brown and Adler, 2008; Kolb, 1984) presents the acquisition of new knowledge and skills as a result of social interactions and a practical solution of problems and tasks. Students interact with objects of the reality, formulate their statements and assumptions, and seek to justify, prove, or refute them. Unfortunately, the practice in most educational institutions does not comply with the requirements of the theory. Students at secondary schools and universities are mostly in a passive role in the classroom, and teachers are often in the role of mentors.

One approach to solve the problem with the gap between theory and practice is the inquiry-based science education (IBSE) approach, in which students play the role of explorers and scientists as they try to address issues set by themselves, while finding answers to these questions is challenged by their own curiosity. This approach leverages a meaningful context for students to learn concepts by linking them with their personal experiences and insights. It leads to collecting structured knowledge in the given field of education and development of skills to carry out effective research.

The project weSPOT (2012) aims at supporting the implementation of this approach through the design, development and testing of appropriate software tools that will enable students to:

- Customize their environment for IBSE;
- Build, share and research either individually or in collaboration with their peers.

Thus, weSPOT aims to enable the connection of everyday life with training in subjects related to natural sciences in schools through the use of ICT (Mikroyannidis et al, 2012).

From the perspective of European teachers, weSPOT project will enable both teachers and students to apply an inquiry learning approach based on experiments carried out in a real school environment. Such experiments can be supported by computer simulations, 3D animations and video allowing students to understand better the subject of natural sciences.

This paper presents the creation of one such tool and its application in a weSPOT pilot.

# 2 weSPOT PROJECT

## 2.1 weSPOT IBL Model

A new Inquiry-Based Learning (IBL) model is developed in the weSPOT project framework. It follows the real reseach cycle with emphasis to develop students' inquiry metaskills (Mikroyannidis et al, 2013). It shares many of the phases described by Mulholland et al (2012), but it is more detailed in the description of things that teachers and students


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should consider when doing inquiry.

The main phases of the weSPOT IBL model are:

- Question/hypothesis - students/learners decide on a topic or area of interest and try to formulate the questions or hypotheses that would like to pursue.
- Operationalisation - refers to the realisation of an idea with an aim to measure.
- Data collection - testing a hypothesis and seeing whether the real world behaves as predicted by the hypothesis.
- Data analysis - process of inspecting, cleaning, transforming and modelling data with the goal of highlighting useful information, suggesting conclusions and supporting decision making.
- Interpretation/discussion - describes the relevance of the results in relation to the question or hypothesis.
- Communication – reflection, sharing results.

## 2.2 Pilot Inquiry Scenario

Following the IBL model a pilot scenario "My classroom – energy efficient" was developed under the testbed "Energy effective buildings".

The scenario challenges the students with the question "How to make my classroom more energy efficient?"

During the Question/hypothesis phase the students should number factors influencing the energy consumption in the classroom (outside temperature, location of the room, heating, isolation, etc.). At the next stage they should decide what and how to measure and what additional data to collect to prove or reject their hypothesis. After data analysis and its interpretation the students should come to conclusions and present recommendations to the school principle. Their opinion should be scientifically proved by the elaborated data through public presentation in front of the school managers, parents, classmates and other stakeholders.

## 2.3 First Pilot Results

Three consecutive pilot runs of the scenario "My classroom – energy efficient" are planned. The first pilot during the spring of 2013 was used to validate the model. In this paper we describe the second pilot run in the autumn of 2013, in which the new software tool: Virtual Classroom simulation was used.

The idea to develop Virtual Classroom simulation was born during the first weSPOT pilot experiment (Stamenov and Dimitrova, 2013) in the First Private Mathematical School. The pilot was delivered in three classes in parallel with 6th graders in the frame of the subject Human and Nature. Its primary goal was to pilot the weSPOT IBL model.

Figure 1: A student measuring the outside temperature.

The students' research task was to figure out which factors influence the consumption of electricity in the classroom and to propose measures to preserve it. As a part of the pilot, students had to collect data for outside and inside temperature of their classrooms. In order to do this they had measured several months, three times daily, these temperatures and wrote down them in order to use data later for their inquiry (Figure 1).

The observations and conclusions from the first pilot are very encouraging. They are used to give feedback to the weSPOT researchers and developers.

One of the conclusions gathered from the pilot was that for such young students (12-13 years old) several months inquiry is too long and exhausting, leading to loose of motivation. That is why it would be perfect if it is possible to speed up data collection. For the 2013/2014 academic year it was suggested to develop software simulation. The benefits of such computer program are:

- Time and duration of the pilot is independent of the particular season: it is possible the experiments

Figure 2: The initial scene of the virtual classroom.

to start and finish at any time of the year and, in the same time, the students can explore all seasons.
- The experiment is repeatable and the dataset is reusable: it is possible to set up the same situation with the same input data and to observe if the output is the same and if the hypothesis is proven again.

# 3 THE VIRTUAL CLASSROOM

The core technological component developed for the pilot case is a specially designed virtual classroom. The software presents a room with windows and a door. The room is in an environment with specific weather conditions. There are several devices like thermometers, a wall clock, and air conditioners. Users may navigate within the scene examining different part of it. Figure 2 shows the initial screen of the virtual classroom.

Figure 3 shows the general architecture of the virtual classroom. A set of external factors (sun, moon, clouds, rain and snow) affect the external air temperature. This temperature together with the internal factors (door, windows, air conditioners and students) and the elapsed time determines the temperature inside the room.

There are three virtually analogue devices (two thermometers and a clock) that are both input and output devices. They provide a way for the students to observe and measure temperatures and time, as well as they allow the student to setup manually the temperatures and the time.

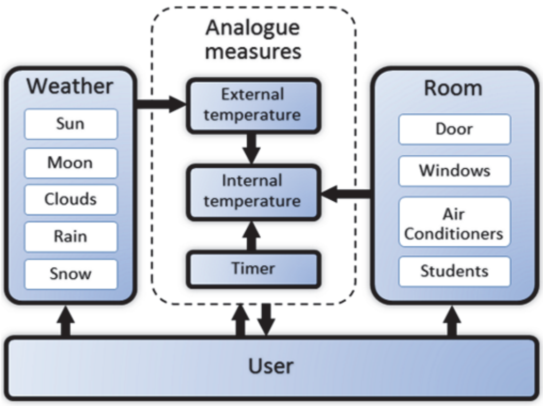


Figure 3: Simulation architecture.

The following subsections describe some basic concepts of the virtual classroom. Some of them refer to the functional design of the simulation (like weather condition, room configuration, thermal and temporal control), others refer to the educational design.

## 3.1 Functional Design

### 3.1.1 Weather

The virtual room model provides functionality to set up specific weather conditions, which are used to represent various inquiry scenarios.

There are two general modes, day and night, that are represented by a change of the light and the presence of an image of the Sun or the Moon. The weather conditions can be sequentially selected. The possible variations are to add clouds, rain or snow.

The modes together with the weather variations generate 10 combinations, which provide enough diversity of the external conditions. Each of these combinations has its own specific impact on the changes of the external environment. For example, if the outside temperature is 10°C and the users activate snowing, then the temperature will gradually drop down.

### 3.1.2 Room

The class room is the main object in the virtual room simulation. It can be modified by the user. There are four main elements that can be controlled – the door, the windows, the students and the air conditioners.

The door and the windows contribute to the overall openness of the room. The door can be either open or closed, while the windows have several levels of openness, randomized within preset ranges. Each window can be completely or partially opened (either vertically or horizontally). Figure 4 displays the appearance of completely opened windows.

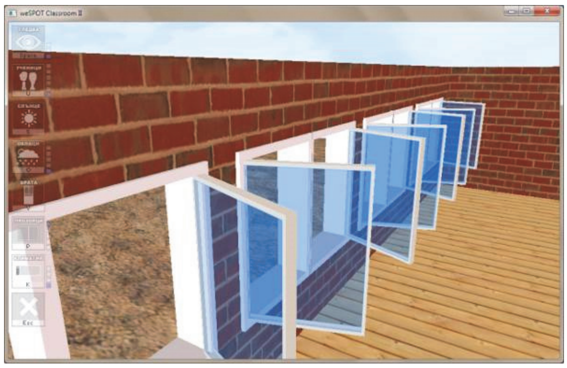

Figure 4: Fully opened windows.

The third controllable element in the classroom is the number of students. There are six predefined configurations ranging from an empty classroom (0 students) to an overcrowded one (40 students) shown in Figure 5.

Finally, there are two air conditioners in the room. Initially they are turned off. Users can switch them on to cooling mode (18°C), room temperature mode (22°C) or heating mode (26°C).

#### 3.1.3 Measures

The options for weather conditions and room configurations provide somewhat indirect control on the temperature inside the room.

The room, however, is equipped with two thermometers. One of the thermometers is attached to the outside of the room and measures the external temperature. The other is mounted inside the room; it measures the internal temperature. Both of the thermometers show the temperature analogue value.

Time is measured by using the wall clock. For most of the pilot cases the exact time is not quite important. Instead, students measure the amount of elapsed time. Figure 6 is a snapshot of the internal thermometer at 25°C and the clock at 6:09:49.

### 3.2 Educational Aspects

The design of the virtual classroom is based on a few iconoclastic decisions contributing substantially to successful pilot experiments:

- Continuous simulation;
- Dual purpose devices;
- Navigational freedom;
- Lack of internal description.

One of the most risky decisions is the implement continuous simulation. It starts immediately after the program is launched. There are no options to start, pause or stop the process of simulation.

Figure 5: Overcrowded classroom.

The side effect of this decision is that temperatures and time are changed during the configuration of the scenario. The rationale for this decision is to provide real-life experience. This also forces the students to both accept some level of inaccuracy, as well as to think ahead and act promptly when they set up their experiments.

To provide even further feeling of real-life experiments the measuring devices (the clock and both thermometers) show their values in an analogue manner. There is no option to get the temperature or the current time digitally. Students have to "convert" analogue measures into numbers in real-time.

Additionally, the devices are not only output devices, i.e. they display measured values, but are also input devices – students are able to interactively change the internal/external temperatures and the current time. This decision aims at simplifying the interface and increasing the functionality.

While using the virtual classroom the students can navigate to any place around or inside the room. This design decision provides a feel of freedom. Students often spend some time just walking within the virtual scene and investigating every place. There is no documentation describing what exactly to do, where to go, how to measure, what is the impact of the weather, etc. Students are expected to explore not only a specific science problem, but also to explore the virtual world and the software.

## 4 A VIRTUAL CLASSROOM USED IN A REAL CLASSROOM

The experiments with the virtual classroom were held again with three classes of $6^{th}$ graders in First Private Mathematical School in Sofia, Bulgaria. The weSPOT pilot itself started a week earlier, when the teacher in Human and Nature defined the research question to the students.

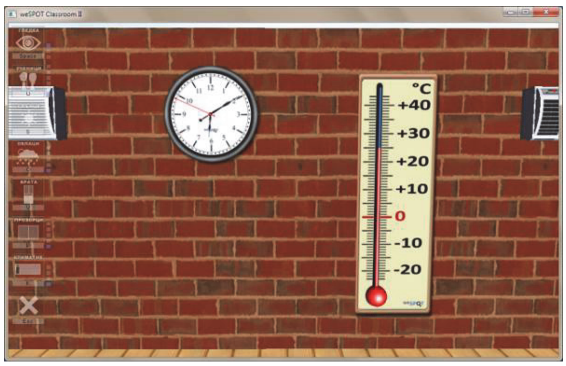


Figure 6: The internal thermometer and the wall clock.

The introduction of the Virtual Classroom simulation to the students was observed and

Figure 7: A student proving hypothesis.

documented by the Sofia University researchers, taking care for the Bulgarian pilots and providing support to teachers and students. The weSPOT pilots continue and their final results will be presented in next papers, but first observations and conclusions are presented below.



## 4.1 First Reactions

The Virtual Classroom was introduced to the students by teachers in Information Technologies, who are also members of the weSPOT school team. They presented the simulation only with several sentences, introducing it as a tool, which will support the students in their inquiry project for the Human and Nature discipline. In addition, teachers shared with students the fact, that the simulation is specially developed for their needs and purposes of the given inquiry. Then the students were left to discover the software functionalities.

Immediately each student started own inquiry with great power of observation in many different directions. Their reactions like: "*Great graphics*!", "*A-a-a, there is sun also!*", *"Oh! What students!*", "*The temperature drops very quickly when windows are widely open! Let's open them in the other direction.*" confirm this.

Each of the inquiries provoked the students' curiosity - they asked questions and defined their own hypothesis.

## 4.2 Open Questions and Hypotheses

Some of the questions like "*Why the room is without roof? Would this cause the outside and inside temperatures to mix?*" shows that the students expect the simulation to be completely realistic. Other questions like "*Why the classroom is on Mars*?" provided researchers with new ideas: to think about future use of Virtual Classroom for simulation of conditions at other planets.

However most of the questions were really dedicated to the inquiry, which students have worked on. In one of the cases students opened the door and all the windows of the Virtual Classroom, set the outside temperature at minimum and made the hypothesis that inside temperature will fall down quickly. But according to the simulation, the inside temperature has even slightly increased. "*Why?*" asked a student. Then the teacher invoked him to look carefully what factor could influence the temperature. "*Oh!*" was next reaction. "*In the room there are 40 pupils! Let's them go out and then check the temperature again.*" Through several experiments this student proved newly appeared hypothesis (Figure 7).

In some of the cases students had seemingly opposite hypotheses: If the door and the windows are open then: a) the room gets colder (Figure 8, top); b) the room gets warmer (Figure 8, bottom).

Two teams of students tried to argue who is right and why. Then they discovered that it is one and the same hypothesis, because in the first case the outside temperature was lower than the inside one; in the second case the outside temperature was higher than the inside one.

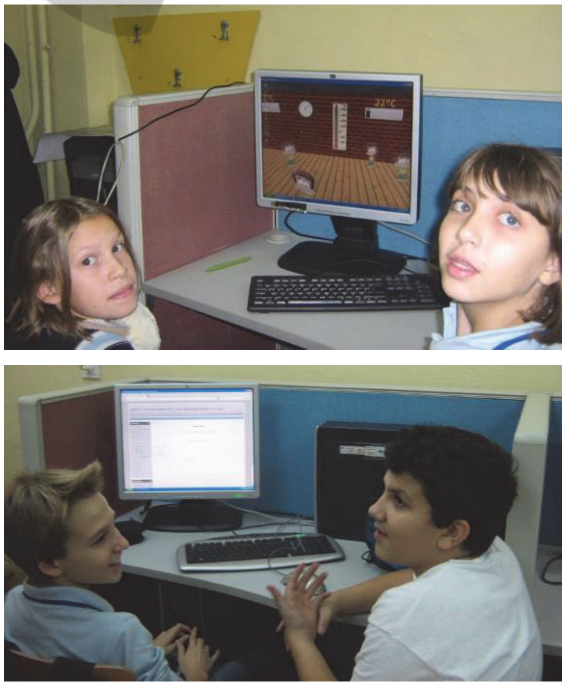

Figure 8: Students with first hypothesis (top photo) and students with "opposite" hypothesis (bottom photo).

### 4.3 Observations

The simulation provoked students' interest. Most of them expressed their expectation to run the program at home. The Virtual Classroom created atmosphere in which all the students worked intensively, but each one of them in own direction, according personal perception of the world, with own pace.

The students were excited by the simulation functionality, especially by the possibility to manipulate objects and phenomena. They gradually discovered, in different order, functionality of the Virtual Classroom elements: the status of the buttons, the change of the temperature, the rotation of the building with the Virtual classroom, going into the classroom and outside it, changing the number of pupils inside, etc.

The initial enthusiasm established better conditions for successful inquiry learning activities. After that, the students started collection of data through subsequent experiments, systematically proving their hypothesis and recording the data and conclusions in Moodle, where the special course for the purpose of the pilot was running.

## 5 CONCLUSIONS

The analysis of the results of the second pilot experiment shows that the Virtual Classroom simulation plays successfully its role in the weSPOT project. To what extend the software simulation contributes to the core science experiment objectives will be possible to conclude later, after the third pilot experiment, but even at this stage it was proven that students learn some of the important lessons like:

- If you have hypothesis, through collection of data you could prove or reject it.
- If you would like to confirm that given result is not accidental, then you need to receive the same result with the same data when recreating the same experiment.

During the next year the weSPOT inquiry workflow engine will be fully developed, providing opportunity to conduct inquiry, fully supported by technology, collecting and sharing in electronic form data and evidences. The third pilot will use the inquiry workflow engine together with the simulation and specially developed validating instruments. In this way we will be able to implement the whole inquiry cycle and application of the weSPOT model for IBL, and to evaluate its real contribution to learning.

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## REFERENCES

Brown, J., Adler, R., 2008. Minds on Fire: Open Education, the Long Tail, and Learning 2.0, *EDUCAUSE Review, vol. 43*, pp. 16-32.

Kolb, D., 1984. *Experiential learning: experience as the source of learning and development*. Englewood Cliffs, NJ: Prentice Hall.

Mikroyannidis, A., Okada, A., Scott, P., Rusman, E., Specht, M., Stefanov, K., Protopsaltis, A., Held, P., Hetzner, S., 2012. weSPOT: A Cloud-based Approach for Personal and Social Inquiry, *WCLOUD 2012 Workshop on Cloud Education Environments*, editors: Alexander Mikroyannidis, Rocael Hernandez Rizzardini, Hans-Christian Schmitz, published in:Sun SITE Central Europe, 2012, pp. 7-11, Ref: http://ceur-ws.org/Vol-945/ws.org/Vol-945/

Mikroyannidis, A., Okada, A., Scott, P., Rusman, E., Specht, M., Stefanov, K., Boytchev, P., Protopsaltis, A., Held, P., Hetzner, S., Kikis-Papadakis, K., Chaimala, F., 2013, weSPOT: A Personal and Social Approach to Inquiry-Based Learning, *Journal of Universal Computer Science (JUCS),* vol. 19, no. 14 (2013), pp. 2093-2111.

Mulholland, P., S. Anastopoulou, T. Collins, M. Feisst, M. Gaved, L. Kerawalla, M. Paxton, E. Scanlon, M. Sharples, and M. Wright, 2012. nQuire: technological support for personal inquiry learning. *IEEE Transactions on Learning Technologies*, 5 (2), pp. 157-169.

Stamenov, Sv., Dimitrova, T., 2013. My classroom – Energy Effective: Inquiry-based Science Education in the Classroom, *EDULEARN13 Proceedings of 5th International Conference on Education and New Learning Technologies*, 1-3 July, 2013, Barcelona, Spain, Edited by L. Gomez Chova, A. Lopez Martinez, I. Candel Torres, International Association of Technology, Education and Development, Published by International Association of Technology, Education and Development (IATED), Barcelona, Spain, pp. 5475-5483.

weSPOT, 2012. Working Environment with Social and Personal Open Tools for inquiry based learning, Research project funded from EC under FP7, 2012-2015, contract number 318499, http://portal.ou.nl /web/wespot.