

EXPERIMENT DESIGN AND PROCEDURE

This section is devoted to experimentation and procedure.

First, we describe the adopted methodology, and then, in the following two subsections, we will describe the two phases of our experiment made in the partner countries. Teachers have been involved in making the app's experience to be tested in their classes.

The activity was carried out in 3 steps:

step 1. Control test before the introduction of the game.

step 2. Using the game in a formal learning context.

step 3. Control test after the introduction of the game.

This embedded case study's adopted methodology aims to include a specific educational situation and consider its uniqueness and specificity.

The students' mathematical competencies were monitored by an initial and a final test. The analyzed factors by documents distributed to the teachers are: ● participation of students in the educational dialogue; ● student performances in math; ● involvement in the educational discussion of weak students; ● the usefulness of serious games in educational practices. The factors analyzed testing the students are: ● improvement of the mathematical abilities; ● improvement of motivation to study mathematics.

Our students were involved in the testing activity, showing persistent and persevering behavior when exploring the game, although there were moments when they felt frustrated due to solving the calculations.

The experimentation of "Clash of Wizardry" was performed at IIS "Da Vinci-Nitti", in Potenza and Brienza (a little town near Potenza). The classes involved were 10. The students who experimented with the game in their classes were divided into small groups by testing the various game modes such as training, challenging each other in duels, or organizing in rooms for about an hour at different times. They were guided and monitored by the school's project team teachers, who told them how to download the game to their smartphones at home before the test. After the sections

test, their teachers had the task of explaining the innovations made to the game to the students for the correct use of it.

The teachers give them (Students) two tests: the first was made on December 17th, 2019, and the second was made on May 17th, 2020. The tests were taken from "I.N.V.A.L.S.I." ("Italian National Institute for the Evaluation of the Education and Training System" section Numbers). Indeed, among the four possibilities into which the I.N.V.A.L.S.I. tests are divided (Numbers, Spaces and Figures, Data and Forecasts, Relations and Functions), "Numbers" has been selected. We compare the results before and after using the app in the classroom.

Another empirical evidence of the experiment is that students seemed little attracted by the first version of the game. The added value of Clash of Wizardry seems to derive precisely from the fact that the game was built for students together with students.

It seems that the use of Clash of Wizardry has not only motivated the students but improved their math skills. These data seem to be confirmed and strengthened by students' results in improving mathematical skills. They were comparing both the results of December and May, a marked improvement in the students of group A is underlined, where the game has been used, compared to group B, whose teachers have not encouraged the use of the game. More precisely, group B's average score went from 6.38 obtained in December 2019 to 5.61 in May 2020, while the average score obtained by group A went from 6.04 brought in December to 7.17 in May. This result is due not only thanks to the training of the mathematical skills by "Clash of Wizardry", but also and above all, thanks to teachers' different approach as they decide to modify their proposal teaching, getting closer to how children interact with others using network and social games. In an unstructured interview, teachers stated that their students, as proved by tests carried out during the year, improved their mathematical skills. Above all, most of them showed more interest in the discipline study. In their opinion, students also achieved the following skills: ● using the techniques and procedures of arithmetic and algebraic calculation by representing them in graphic form. ● Identifying appropriate strategies for problem solving. Moreover, the teachers said that, after using the game, most of the students could calculate arithmetic expressions, solve the first-degree equations, verify the correctness of the procedures, and understand the concept of an equation.

Regarding the following research question: Does the use of serious games allow the teacher reflective action on their teaching methodologies to encourage effective teaching of mathematics?

Many teachers, initially perplexed about using serious games in the classroom, have already changed their minds after the first experimentation. Some teachers were skeptical of the prototype presented because, according to them, there was no relationship between the game and the mathematical skills that the students should have acquired. Subsequently, their contribution was decisive in modifying the game appropriately to adapt it to students' training needs. Thus, each spell's action in the game was matched by a well-defined equation, the resolution of which would have made the player acquire points: a more powerful spell corresponded to an equation of a more complex solution.

