EXPLORISTICA - ADENTURES IN STATISTICS WITH AUGMENTED REALITY

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Exploristica - Adventures in Statistics - is an itinerant exhibition designed to teach the fundamentals and practice of Statistics and Probability intended for students of upper basic and secondary school (12 to 17 years). Describing five important phases of the statistical process - Select, Collect, Describe, Estimate and Interpret. Exploristica, is organized in several modules that present the main statistical concepts in the form of games and other interactive experiences. Exploristica was created in 2013 by the Portuguese Statistical Society, and has already traveled thousands of kilometres, running in three languages (Portuguese, English and Spanish). In this work, we will present the new developments of Exploristica, including an upgrade of the physical exhibition into a game played with virtual reality goggles.

INTRODUCTION

Although there is not a consensus on whether there are specific benefits on undergraduate research experiences (Linn, et al., 2015), there are many situations where educators use practical experiments with manipulatives in the teaching of Biology, Chemistry, Physics, and Mathematics. However, there are not many physical materials available for teaching Statistics. One can use effectively dice as statistics manipulatives (Learning Resources, 2017)), cards, or domino.

Exploristica (www.exploristica.com) is an itinerant exploratory exhibition, running since 2013, consisting of various interactive modules with the aim of bringing the fundamentals of Statistics and Probability to basic and secondary schools (Campos, 2014). The main concepts to be taught are survey samples and census, location and dispersion measures (mean, median, standard deviation), graphs (box and whiskers, bar plots, histograms), random and non-random sampling, relative frequency, and probability. Describing five important phases of the statistical process - Select, Collect, Describe, Estimate and Interpret –, Exploristica is organized in six modules that present their contents in the form of games and other interactive experiences.

In the Interactive Submarine, participants perform a journey through an underwater ecosystem where they need to collect a sample of a new species of reptile. In this work, we present the interactive submarine and the recent extensions regarding a full virtualization of the game, played with the participant sitting in a chair, using computer connected virtual reality glasses and manual joysticks.

TEACHING AND LEARNING STATISTICS WITH EXPLORISTICA

Exploristica - Adventures in Statistics - is an itinerant exhibition designed to teach the fundamentals and practice of Statistics and Probability intended for students of upper basic and secondary school (12 to 17 years). The exhibition aims at providing students and teachers in schools and universities with the fundamental concepts that enrich their statistical literacy and numeracy. It has been created in 2013 and traveled to many different places, in Portugal, Spain and Ireland since then, and has been displayed mainly in primary and secondary schools, local public libraries, conference centers, museums and universities. The exhibition has been visited by more than 3000 people, among teachers, students, researchers, and general public. Exploristica contains six different modules with games and interactive experiences, having different goals, from descriptive statistics, to sampling, to inference. Furthermore, each module focuses in one or more of the phases of the statistical process: Select, Collect, Describe, Estimate and Interpret.

One important issue in Exploristica is that students are not limited to conducting experiments. They also have to take some time to interpret the results. So that may benefit from an orientation that integrates their beliefs and expectations with the realities of the research experience. In that sense, the videos and screens are made in such a way, that participants have time to read the concepts and have no chance to skip it. In addition, in the welcome module of

Exploristica, students are provided with the Explorer Sheet, that serves both as a guide and also for reporting and analysing the results.

THE INTERACTIVE SUBMARINE

In the Interactive Submarine, there is a new species of reptile being studied in a lake. Participants start by seeing a movie in the right part of the module where they are trained about the goal of the game, and the statistical concepts being learned. Then, they have to capture as many specimens as they can, using a joystick in the left part of the module, in order to analyze the main characteristics of the reptiles. A balance, a ruler and a camera are ready to measure weight, age, size and sex in the laboratory at the right part of the module. A 4D (augmented reality) device is installed in the module so that participants can rotate a small piece of vinyl and see the image of the reptile "alive" on the screen (see Fig. 1 and 2).

Figure 1. Participants rotate a small piece of vinyl and see the a 4D projection of the "living" image of the reptile on the screen
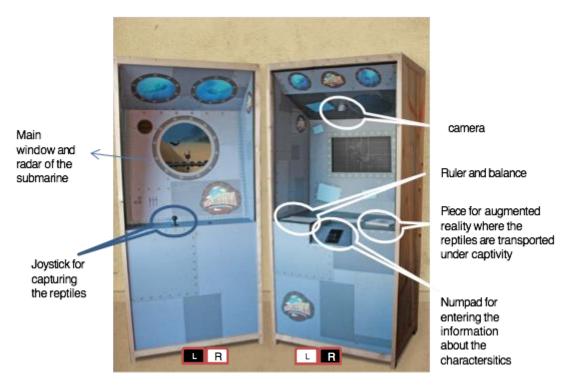

Figure 2. Left part (main submarine window with a radar and a joystick) and right part (laboratory) of the Interactive Submarine

The goal of this game is to determine the subspecies of the reptile, based on data of reptiles been captured. In statistical terms, the goals of the module are twofold: on one hand, we aim at teaching location and dispersion measures related to the data about the animals. On the other hand,

we introduce the notion of likelihood, by using Boxplots. Boxplots are an excellent way to analyse distributions because they allow us to compare corresponding percentiles.

THE NEW VIRTUAL SUBMARINE

The New Virtual Submarine is played with the participant sitting in a chair, using computer-connected virtual reality glasses and manual joysticks; in this way, the player feels as if he were in the cockpit of a submarine and capable of a 360º view; the player may conduct the submarine to capture specimens of a lizard for further observation in the submarine's laboratory. In this laboratory, participants can count the spines on the back of lizards (to estimate their age), as well as determine sex, weigh and measure them. Based on the collected data and some history, the computer provides the median and quartiles of the height, weight and age of collected lizards.

There are two versions of this virtualized version of the interactive submarine. One, more expensive, as it requires virtual reality glasses and a reasonable computer with a good graphics card. A second version, that aims to be generalized to a wider audience requires an app and a mobile phone.

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