NEW WAYS OF LEARNING:
SPAS – A GAME FOR LEARNING MATHEMATICAL STATISTICS

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Abstract: The authors' intention is to show that mathematical statistics can be learned by means of an adventure computer game. Probability and mathematical statistics provide students with the means for: 1) analyzing the environment, 2) establishing a mathematical model and 3) elaborating a prognosis. These 3 steps were transformed in levels of a serious game, called by us SPAS – Statistics and Probability for Alien Students. The main characters of the game emerged from an opinion poll realized with a second year BA group of students. The theoretical background required for completing the levels of the game is the knowledge corresponding to a second year course in Probability and Statistics. Thus, passing from one level to the other requires: the knowledge of the main classical distribution laws; the estimation of the parameters for these laws corresponding to given statistical series; and a deep understanding of the hypothesis tests involved in statistical modeling of the real world problems. The game is a single player quest. Its various levels include a shooting game, a card playing game and a volcano explosion adventure. The assets of the game include some theoretical material, but in order to successfully complete the game, the student has to rely on the knowledge acquired during the university course.

Keywords: e-learning games, mathematical statistics, environmental predictions

I. INTRODUCTION

Teaching and learning through game playing has proved to be a useful strategy in various domains. Just to recall some of them: teaching foreign languages to specialized people, teaching reading and writing to kindergarten children, making physical and chemical experiments in e-learning labs, teaching history and geography through interactive quizzes, learning music, photo and drawing. The previously mentioned examples belong to the educational category of games, in which teaching and learning are part of the game's content These games address an informed public whose desire for learning is axiomatic (a presupposed assumption). Nevertheless, an entirely different strategy is needed in order to address people who do not have a strong motivation for using games in enhancing their knowledge or understanding. Students wishing to pass an exam without investing too much time in learning or completing additional tasks (homework, projects) provide a good example. Students are too old for enthusiastically embracing any new game (as children do), yet not mature enough for appreciating the entertaining part of an otherwise serious e-learning course (as older adults are able to). Hence, attracting students towards science through gaming requires another angle of approach.

In order to create a game which could motivate a positive approach towards learning Probability and Mathematical Statistics, we addressed second year university students with an opened questionnaire concerning the main characters and the plot of such a game. The questionnaire itself was considered as an application of already learned techniques in statistics. The timing for the questionnaire was the end of the semester (and of the course in Probability and Mathematical Statistics), therefore students could analyze the steps they have accomplished in order to master the

knowledge. The present paper presents the experience of designing a game which emerged as a combination between the following objectives::

the teacher's aim – increasing students' motivation for learning by widening the area of day to day applications of probability and statistics;

the student's aim – making real the dream of accessing knowledge in a duty- free way and enjoying working on it.

Clearly such a game can be rather considered as an adventure game then an e-learning game. Although a correspondence can be established between the stages of a statistical project (analyzing, modelling, elaborating a prognosis) and the levels of the game, the last ones do not replace the actual testing of the formers. In fact, the game can be completed even without an extended knowledge of the statistical tests since the player is required to know only the type of test to be applied and not the mathematics behind it. We have to stress the fact that at the present moment only the first level of the game can be played, since creating game assets in 3d software and importing them in the game engine are time consuming and eventually difficult to solve problems.

The game creation was accomplished by using:
1. Unity 3d demo projects [9], [10], correspondingly adapted to our plot
2. 3d software [7], [8], [13]
3. mathematical soft [6]
4. references for the second year university course in Probability and Mathematical Statistics [1], [2], [3], [4], [5]
5. numerous tutorials from [10], [11], [12], [13] for creating the assets, exporting and importing them, as well as for animating with particles and creating special effects.

II. MAKING THE GAME: KNOWING YOUR PUBLIC

In order to create a game which could motivate a positive approach towards learning Probability and Mathematical Statistics, we addressed second year university students with an opened questionnaire concerning their preferences for the main characters and the plot of such an interactive game.

The questionnaire itself was a good example of an application of already learned techniques in statistics – namely the opinion poll.

The timing chosen for the questionnaire to be administered was the end of the semester (which coincides with the end of the course in Probability and Mathematical Statistics), therefore students had the chance to analyze the steps they have accomplished in mastering (order to master) their Mathematics knowledge.

Most students were happy to complete the survey and showed genuine interest in our future work.

We will sum here the principal points stressed by the students. According to the great majority of opinions, the game's design should rely on the following elements:
- ❖ the student's avatar and the teacher's avatar should be adversaries, competing for the final exam
- ❖ the game should be a game of chance, to which probability can be applied
- ❖ the student's avatar should have less experience, but much greater speed
- ❖ the teacher's avatar should have a lot of knowledge, less speed and quite a lot of malicious intentions(!)
- ❖ student and teacher should be able to change roles after completing a certain level
- ❖ points and scores should be transferable to the course' s activities

There were of course certain demands made by the students which our game could not and would not fulfill:
- teach the students how to win a chance game (roulette)
- teach the students how to take the best decision in acceptance of sampling
- choose as avatars famous show-biz people, or successful business men or women

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Students' answers were sorted, tagged and archived and we then proceeded to studying them in order to conceive the best game design.

Nevertheless, there were left some unresolved (opened) questions (e g :concerning the accomplishment of the game's mission), which shall be further tested with next year' s students, as our game is in continue development and improvement.

III. MAKING THE GAME: CONNECTING SCIENCE TO IMAGINATION

Our game should be considered rather an adventure -edu- game than a classic e-learning game.

Although a correspondence may be established between the stages of a statistical project (analyzing, modelling, elaborating a prognosis) and the levels of the game, the last ones do not replace the actual testing of the formers. In fact, the game can be completed even without an extended knowledge of the statistical tests since the player is required to know only the type of test to be applied in a given game situation and not the explicit characteristics of the so called *testing of hypothesis*.

Designing the game was an exercise of imagination, as we had to try bringing the applications of mathematical statistics and probability theory closer to the high-tech, adventurous daily-life of our students.

Therefore, the collectable objects from the game's first level are books and dvd-roms containing the characteristics of certain distribution laws, while the information to be accessed in the TechIt's computer is based on tests of statistical hypotheses.

Thus, the first level can be termed as a short reminder of the principal notions encountered during the one semester course in Probability and Mathematical Statistics.

### IV. MAKING THE GAME: THE PLOT

Let us briefly present the game's content and plot.

As we have already mentioned in the introduction, the plot and the main characters of our game have been to fit most of the students' requirements.

Our hero is AS, the alien student. As students suggested, he should be a little bit *strange* to the course and especially to the final exam.


He has accidentally entered the office of TechIt and discovered, by glancing at an animated globe displaying the map of active volcanoes within the world, that TechIt is trying to engender a volcano explosion on TXAM Island, in order to obtain some very rare minerals necessary for high tech industry.
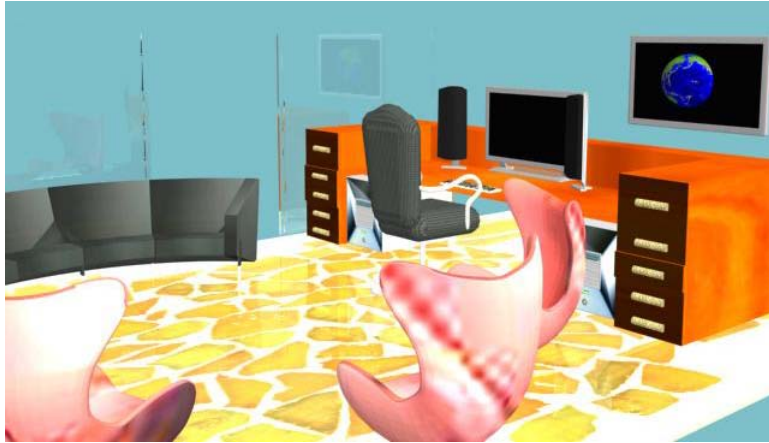
Among the tasks of our hero we can enumerate:
- to collect some information from the computer and TechIt's desk in order to stop the volcano's explosion (level one)
- to teleport himself to a spaceship with which, after escaping some asteroids bombing, to reach the volcano island (level two)
- to fight some robots guarding the place where the device for producing the volcano's explosion is located (level three)
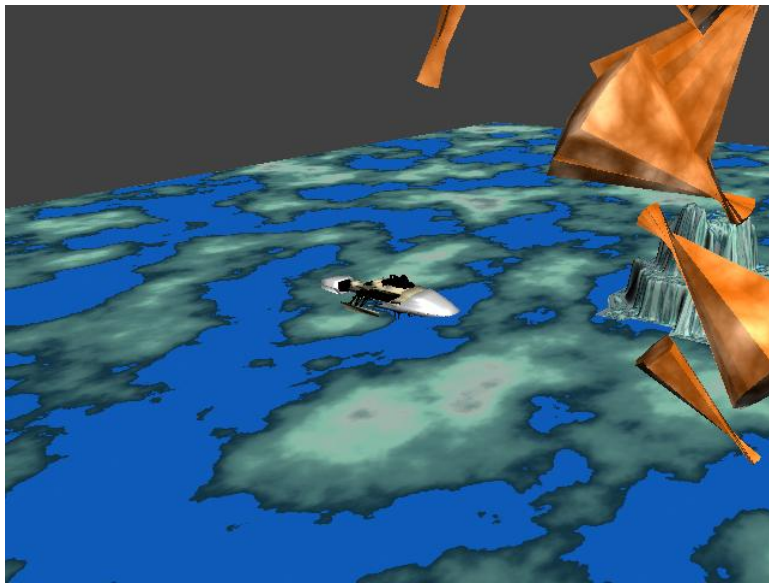
The hero must also avoid some traps placed by TechIt in his office to discourage intruders. Furthermore, like in any game, AS has to cope with surprise-obstacles in order to pass from one level to the next. We can disclose here one of the obstacles: a sphinx asking three probability questions!

V. DEVELOPING THE GAME: CHALLENGES AND OBSTACLES

The game creation was accomplished by using:
❖ Unity 3D demo projects [9], [10], correspondingly adapted to our plot
❖ 3D software [7], [8], [13]
❖ mathematical soft [6]
❖ references for the second year university course in Probability and Mathematical Statistics [1], [2], [3], [4], [5]

❖ numerous tutorials from [10], [11], [12], [13] for creating the assets, exporting and importing them, as well as for animating with particle system (3ds Max) and creating special effects (like fire and explosion).

   Creating game assets in 3D software and importing them in the game engine are time consuming and eventually difficult to solve problems. Therefore, we have to stress the fact that at the present moment only the first level and a part of the third level of the game were built.

   The first level of the game is already fully functional and ready to be tested by players.

   While most of the assets for levels two and three have been created and are ready to be introduced, script writing for obtaining the desired effects in these levels is still on the way. Another obstacle is implementing e-learning content connected to pollution and sampling in the third level, since we do not have to forget that the game's aim is to show students that modeling with mathematical statistics goes far beyond the basics of the second year course.

VI. CONCLUSIONS

   Introducing e-learning content in an adventure game and creating the elements (plot, characters and events) for sustaining it are far more difficult than the regular testing of the students' level of knowledge.

   Even if we do not know yet whether we have succeeded in creating a game which would motivate students in their approach of the university course, we look forward continuing our research.
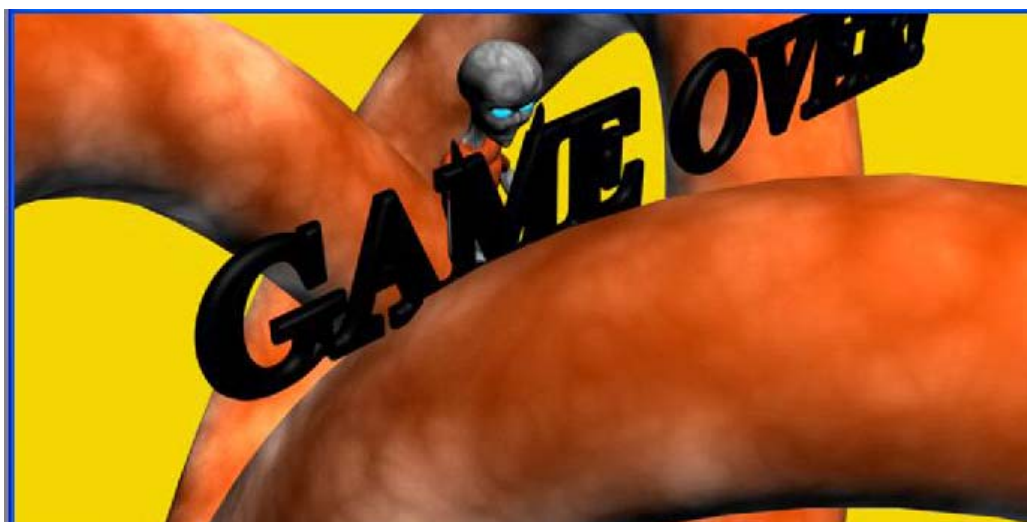
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