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WORLD OF PHYSICS

Deliverable Number	**Report I**
Deliverable Title	**Pilot Plan**
Intellectual Output Title	**Intellectual Output II: Virtual 3D World for Teaching Physics**
Activity description	**The plan that was produced to guide partners during their pilots at schools.**
Authors (per company, if more than one company provide it together)	**UCY**
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Executive Summary

The Piloting Plan describes the pilot activities and their parameters (e.g. training time schedule, form of training, content of training, evaluation etc.). Local pilots were organised and conducted by all partners in the project. Partners organised their local pilot with this plan as a guide in order to collect feedback from students and their Physics teachers. The Piloting Report and the Piloting Results Report discuss the overall and country specific results respectively.

The Piloting Plan is a deliverable of Intellectual Output 2. There were a number of related activities that needed to be considered while drafting the Piloting Plan. Partners contributed to these activities in the following manner:

- UCY created the questionnaire;
- CTE published an online version of the questionnaire and collected the results;
- CTE and UPAT offered technical support during the pilots;
- NE and CTE analysed the questionnaire results, which helped finalise the 3D Virtual World;
- UCY, NE and CTE prepared the Piloting Report and the Piloting Results Report with contributions from all the partners.

List of abbreviations

Abbreviation	Definition
3DVW	3D Virtual World

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Introduction (Project History)

A clear need to address students' Science and Physics performance and improve the quality of education in Europe was determined. Thus, in this project a specific action was taken towards this direction. The project aims to assist students in studying Physics with the utilisation of innovative technologies. Specifically, a 3D virtual reality educational environment (or 3D Virtual World – 3DVW) was developed possessing innovative educational infrastructure, and offering immersive and efficient learning opportunities, engaging students in various educational activities, learning scenarios and offering students an attractive, entertaining and efficient way to learn various topics in the challenging domain of physics. The expected outputs of the project were:

1. Reports on Physics Education in Schools around Europe and the state of the art in 3DVW.
2. 3DVW for Teaching Physics
3. Open Learning Resources for Trainers

1. Pilot Main Objectives

The results from the pilots contributed to the successful completion of Intellectual Output 2 of the project: **3DVW for Teaching Physics**.

The main objectives of the pilots were:

1. To evaluate students' experience and feelings when interacting in the 3DVW.
2. To evaluate students' learning experience in the 3DVW.

Considering the above main objectives, the goals of the pilots were:

- To identify the strengths and weaknesses in the design of the 3DVW for Physics Education.
- To determine any potential for further improvement.
- To investigate the learning curve that is required from students to interact in

the 3DVW in the domain of Physics.

- To evaluate the potential learning experience of students in through their interactions in a number of carefully selected Physics scenarios during the pilots.

2. Methodology

Pilots were held in the field (i.e. at the schools) with a total of 50 participants being the target for each partner country.

Multiple sessions with students were required in order to reach the total of 50 participants. In some cases, this required visiting more than one school in a country. Factors that influenced the number of sessions that were required to be conducted during a school visit were:

1. Number of machines (i.e. desktop computers/laptops) available to the students during the pilots for accessing the 3DVW environment.
2. Number of scenarios that were concurrently evaluated.
3. Other technical restrictions (e.g. number of users a 3DVW hosting server can accept simultaneously, network capabilities both at the client side and the server side, hosting server H/W capabilities and availability, etc.).

To understand how the factors above can influence the numbers of sessions needed for a pilot and to understand the notion of a session within this Pilot Plan, an example is presented. In the case of visiting **1 school** with **2 machines** (desktop computers/laptops) to evaluate **2 scenarios,** with **2 students collaborating per scenario,** one would need to conduct a total of 13 sessions in order to reach the target of 50 participants. Thus, flexibility in terms of number of schools visited, number of scenarios played and number of machines used influenced the time that was required to complete a pilot in a country.

NOTE: To speed up the process of the pilot test, partners were therefore

advised to exploit the maximum number of machines available with respect to the number of available scenarios that were tested. E.g. If there were four scenarios being evaluated during a pilot study then four machines were recommended to be used. At each machine there had to be at least one or more students (in case of a group) playing/collaborating on the specific scenario. At the same time it was also advised that partners be careful with the number of scenarios being tested simultaneously. In other words, if there were six machines available to test six different scenarios simultaneously, they had to ensure that they could manage this process since they needed to observe and pay attention to the students playing all scenarios within a session.

A 15 minute briefing was presented by the partners to all students that participated in a pilot from a school. The briefing explained the purpose of the project, how and why school students were involved, and participants' consent was also collected during this time. It was very important that partners explained to students how they can interact within the 3D VW, thus they were explained the following:

- Basic user controls
- Interaction mechanisms with the 3DVW, its objects, bots and other avatars
- Basic functionality of the Firestorm/Kokua viewer
- Avatar movement options, camera control, and teleporting

The aim was to equip participants with adequate skills so that they can successfully complete their assigned scenario. Most students were shown to be very capable in this respect due to their gaming experiences.

Following the briefing, each session had an average duration of 25 minutes and included playing a Physics scenario (with learning activities) in the 3DVW and then completing a questionnaire at the end. Annex 6.3 exhibits the questionnaire. The tasks (steps) that a participant needed to perform in the 3DVW were pre-defined and were depended on the Physics scenario that the participant played. Annex 6.2 defines the steps for each of the scenarios that were evaluated in the pilots.

2.1. Methodology Application

An example of how the methodology was applied is presented below. The example represents the case of two scenarios been evaluated by two students per session in a pilot:

1. Partner visited a primary/high school before the pilot to set-up 2 machines (i.e. install viewer, register the user accounts) in the computer lab of the school from which participants could access the 3DVW (see Annex 6.1);
2. Partner visited the primary/high school on the day agreed for the pilot.
3. Partner presented a 15 minute briefing to all participants (students and their Physics teacher(s)). The purpose of the project and the students' involvement were discussed. Interaction within the 3DVW was explained and participants' consent was obtained;
4. The first 25 minute session began with 2 students. Each of the students was randomly assigned to play one of the two scenarios. Participants progressed through a series of steps to complete the scenario (see Annex 6.2). Once the 25 minutes had lapsed, students were then asked to complete a questionnaire to assess their experience and feelings from their interaction in the 3DVW as well as their potential learning experience from playing the assigned scenario;
5. While students were in the process of answering the questionnaire, a new pair of students was then asked to start their 25 minute session. This process was repeated until all of the students whom were participating from the selected school had conducted their sessions.

Breakdown of the time estimation per session:

- Briefing: 15 minutes;
- Exploring the 3DVW by following the steps to play a scenario: 25 minutes;
- Complete questionnaire: 10 minutes;

2.2. Scheduling of Pilots

To ensure that each partner conducted their pilots at different times (not simultaneously) because it would have been problematic in terms of accessing resources within the 3DVW and the hosting server, UCY with the collaboration of CTI and UPAT who host the 3DVW, developed and maintained an online document (on Google Drive) that served as the schedule for the Pilots. Each partner declared the time slots (day & time) for their pilots in this document in order to gain access to the 3DVW.

3. Scope and Parameters

Parameters that defined the general scope of a local pilot study were the following:

- **Location**: In the field (i.e. schools) or at partner premises. Pilots were conducted in each partner country (Cyprus, Greece, Romania, Italy, Slovakia);
- **Timelines**: Pilots were scheduled to be conducted 15 May 2018 – 30 September 2018.
- **Number of schools**: Aim was to visit more than one school to reach the target of 50 participants per country;
- **Classes involved**: Last classes of primary education and/or classes of secondary education;
- **Number of total students involved**: Aim was for at least 50;
- **Number of teachers involved**: Depended on the number of classes that were involved in order to reach the target of 50 student participants. Teachers of each class from which the students were recruited should have been considered for feedback;
- **Number of scenarios**: From the nine scenarios that will be ready the aim should be to evaluate as many as possible so a larger number of students can participate simultaneously;
- **Scenarios that could have been evaluated**: Electrification by friction; Electrification by conduction; Magnetic field; Photoelectric emission & X-rays;

Newton's first law of motion; Newton's third law of motion; Gravity; Radioactivity & ionizing radiation;

- **Number of sessions in a pilot**: It depended on the number of scenarios that were evaluated, the number of students per scenario and the number of machines that were available;
- **Time duration per session**: 25 minutes.

4. Measures of Assessment

A questionnaire was designed and translated in the partner's languages for the purpose of assessment. It focused on assessing and exploring the following points:

- Students' interest towards the subject of Physics.
- Students' videogaming experience and preferences.
- The usability of the Virtual 3D World as a tool to teach Physics (using the System Usability Scale).
- The overall potential learning experience that the tool can offer from the users' perspective.

5. Annexes

5.1. Creating Account and Connecting in the 3D Virtual World

ACCOUNT CREATION

You can create an avatar account (Firstname, Lastname, Password) here:
http://wopvr4stem.sch.gr:9000/wifi

3D VIEWER INSTALLATION

To connect to the 3D World with that avatar you need 3D Viewer Software such as Firestorm or Kokua. We recommend using Firestorm. You can download it here:
http://www.firestormviewer.org/downloads/
Select the Operating Version you use and then download the version that

indicates SL & Opensim(32bit or 64bit)

ADD THE WORLD-OF-PHYSICS 3D WORLD

Once you have downloaded, installed and opened Firestorm, here are some instructions to connect to the World of Physics 3D World:

1. Viewer -> Preferences -> OpenSim
2. Add new grid: http://wopvr4stem.sch.gr:9000 then click 'Apply' and 'OK'

CONNECT TO THE 3D WORLD

Use your username "Firstname Lastname" and password and select "WorldOfPhysics" grid from the drop down menu.

Click 'Log In' to enter.

5.2. Scenario Steps

Once the scenarios that were used in the pilot were determined, the steps that would guide the participants to progress through them were written. These supported participants in successfully completing the scenario that they were assigned to play. The steps were translated in the partner's languages.

5.2.1. Step-by-Step Execution of the Scenario: Electrification by Conduction

1. Read the presentation "***Electrification by Conduction***".
2. Approach the counter that is on the left side of the presentation.
3. Make sure your "***Conversation***" dialog box is open.
4. Read the instructions for the activity by clicking on your language flag on the pole.
5. Complete the activity. You will be informed in your "***Conversation***" dialog box when you have successfully completed the task.
6. Once you have completed the activity, you can answer the questionnaire.

5.2.2. Step-by-Step Execution of the Scenario: Electrification by friction

1. Read the presentation "***Electrification by friction***".

2. Approach the two counters that are on the left side of the presentation.
3. Make sure your "***Conversation***" dialog box is open.
4. Read the instructions for the activity by clicking on your language flag on the pole.
5. Complete the activity. You will be informed in your "***Conversation***" dialog box when you have successfully completed the task.
6. Once you have completed the activity, you can answer the questionnaire.

5.2.3. Step-by-Step Execution of the Scenario: Magnetic Fields

1. Read the presentation "***Magnetic Fields***".
2. Approach the counter on the right side of the presentation.
3. Make sure your "***Conversation***" dialog box is open.
4. Read the instructions for the activity by clicking on your language flag on the pole.
5. Complete the activity.
6. Enter the next room.
7. Read the presentation "***Current in a magnetic field***".
8. Approach the counter on the right side of the presentation.
9. Make sure your "***Conversation***" dialog box is open.
10. Read the instructions for the activity by clicking on your language flag on the pole.
11. Complete the activity.
12. Move across to the other end of the room and approach the counter.
13. Make sure your "***Conversation***" dialog box is open.
14. Read the instructions for the activity by clicking on your language flag on the pole
15. Complete the activity.
16. Once you have completed all 3 activities, you can answer the questionnaire.

5.2.4. Step-by-Step Execution of the Scenario: Newton's First Law of Motion

1. Read the presentation "***Newton's Law of Motion***".
2. Walk across the room to find the presentation "***1st Law of Motion***" and read it as well.
3. Read the instructions for the activity by clicking on your language flag on the pole to your left.
4. Complete the activity.
5. Once you have completed the activity, you can answer the questionnaire.

5.2.5. Step-by-Step Execution of the Scenario: Newton's Third Law of Motion

1. Read the presentation "***Newton's Law of Motion***".
2. Walk across to the next the room to find the presentation "***3rd Law of Motion***" and read it as well.
3. Read the instructions for the activity by clicking on your language flag on the pole to your right.
4. Complete the activity. Zoom out to get a better view of the activity.
5. Once you have completed the activity, you can answer the questionnaire.

5.2.6. Step-by-Step Execution of the Scenario: Gravity

1. Read the presentation "***Gravity***".
2. Approach the scale on the opposite side of the presentation.
3. Make sure your "***Conversation***" dialog box is open.
4. Read the instructions for the activity by clicking on your language flag on the pole.
5. Complete the activity.
6. Once you have completed the activity, you can answer the questionnaire.

5.2.7. Step-by-Step Execution of the Scenario: Photoelectric emission & X-rays

1. Read the presentation "***Photoelectric emission***".
2. Go up the staircase on the right of the presentation.
3. Make sure your "***Conversation***" dialog box is open.
4. Read the instructions for the activity by clicking on your language flag on the pole.
5. Complete the activity.
6. Once you have completed the activity, you can answer the questionnaire.

5.2.8. Step-by-Step Execution of the Scenario: Radioactivity & ionizing radiation

1. Read the presentation "***Radioactivity***".
2. Watch the video on the right of the presentation. Note you can open this video in your browser too.
3. Enter the next area through the open passage door on the right of the video.
4. Read the presentation "***Health hazards of ionizing radiation exposure***".

5. Make sure your "***Conversation***" dialog box is open.
6. Read the instructions for the activity by clicking on your language flag on the pole, which is to the right of the presentation.
7. Complete the activity.
8. Read the presentation "***Ionizing vs Non-ionizing***".
9. Watch the video on the left of the presentation. Note you can open this video in your browser too.
10. Move left towards the board to sort the types of radiation. Read the instructions for the activity by clicking on your language flag on the pole,
11. Complete the activity.
12. Once you have completed the activity, you can answer the questionnaire.

5.3. Questionnaire

SECTION A: BIOGRAPHICAL DATA

1. Gender
    a. Male
    b. Female
    c. Prefer not to say

2. Age Group
    a. 9->11
    b. 12->15
    c. 15 ->17

3. Country
    a. Cyprus
    b. Italy
    c. Slovakia
    d. Greece
    e. Romania

4. Rate from 1 to 7 how much you like Physics:

1 (Not at all)	**2**	**3**	**4**	**5**	**6**	**7** (Very much)
○	○	○	○	○	○	○

5. Rate from 1 to 7 how much you'd like to attend/participate in a physics event or competition:

1 (Not at all)	**2**	**3**	**4**	**5**	**6**	**7** (Very much)
○	○	○	○	○	○	○

6. Rate from 1 to 7 how much you would like to attend the Nasa “Meet an Astronaut” event:

1 (Not at all)	**2**	**3**	**4**	**5**	**6**	**7** (Very much)
○	○	○	○	○	○	○

7. Rate from 1 to 7 how much you would like compete in the annual Physics Olympics:

1 (Not at all)	**2**	**3**	**4**	**5**	**6**	**7** (Very much)
○	○	○	○	○	○	○

8. A 7-point Likert scale ranging from 1 to 7 is used to evaluate how often you play videogames and which types of videogames you prefer.

	1 (never)	**2**	**3**	**4**	**5**	**6**	**7** (daily)
a. How often do you play videogames?	○	○	○	○	○	○	○
b. How much do you like **First person shooters (FPS) games** (e.g. Call of Duty (Black Ops) sagas, Borderlands, Halo or Bioshock)?	○	○	○	○	○	○	○
c. How much do you like **Adventure or thriller games** (e.g. Uncharted sagas, Heavy Rain, Resident Evil or Assassin's Creed)?	○	○	○	○	○	○	○
d. How much do you like **Singing, dancing or playing instruments games** (e.g. Guitar Hero sagas, Sing Star or Just Dance)?	○	○	○	○	○	○	○
e. How much do you like **Fighting games** (e.g. Tekken sagas, Mortal Kombat or Street Fighter)?	○	○	○	○	○	○	○
f. How much do you like **Intelligence and quiz/trivia games** (e.g. Brain Training, Trivial or Brain Academy)?	○	○	○	○	○	○	○
g. How much do you like **Strategy games** (e.g. Civilization sagas, Age of Empires or Starcraft)?	○	○	○	○	○	○	○
h. How much do you like **Internet collaborative games** (e.g. FIFA, PES, NBA Live, Gran Turismo or Need for Speed)?	○	○	○	○	○	○	○
i. How much do you like **Super Mario, Mario Kart or Wii Sports**?	○	○	○	○	○	○	○
j. How much do you like **Sports, Racing or simulation** (e.g. World of Warcraft or Farmville)?	○	○	○	○	○	○	○

9. Based on your answers in question 7, how would you rate your expertise with computer-based games?
    a. No experience
    b. Novice
    c. Intermediate
    d. Advanced
    e. Expert

10. How would you rate your expertise with virtual 3D world environments?

a. No experience
b. Novice
c. Intermediate
d. Advanced
e. Expert

SECTION B: TOOL EVALUATION

1. A 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree) is used to evaluate the users' subjective impressions regarding the system and their degrees of satisfaction.

	1 strongly disagree	**2**	**3**	**4**	**5** strongly agree
a. I think that I would like to use this Virtual 3D World frequently	○	○	○	○	○
b. I found the Virtual 3D World unnecessarily complex	○	○	○	○	○
c. I thought the Virtual 3D World was easy to use	○	○	○	○	○
d. I think that I would need the support of a technical person to be able to use this Virtual 3D World	○	○	○	○	○
e. I found the various functions in this Virtual 3D World were well integrated	○	○	○	○	○
f. I thought there was too much inconsistency in this Virtual 3D World	○	○	○	○	○
g. I would imagine that most people would learn to use this Virtual 3D World very quickly	○	○	○	○	○
h. I found the Virtual 3D World very cumbersome to use	○	○	○	○	○
i. I felt very confident using the Virtual 3D World	○	○	○	○	○

2. Please tick the box that best represents how you feel about the 3D virtual environment as a learning tool to study Physics

	1	**2**	**3**	**4**	**5**	
a. I do **NOT** feel comfortable using this learning tool	○	○	○	○	○	I feel **comfortable** using this learning tool
b. I feel that the learning tool had a **negative** impact on my learning performance	○	○	○	○	○	I feel that the learning tool had a **positive** impact on my learning performance
c. I feel that the learning tool has **NOT** helped me to improve my knowledge on the Physics topic of the scenario	○	○	○	○	○	I feel that the learning tool has **helped** me to improve my knowledge on the Physics topic of the scenario
d. I would **NOT recommend** this learning tool to a friend	○	○	○	○	○	I would **recommend** this learning tool to a friend
e. I do **NOT** feel that the scenario offers a good learning experience	○	○	○	○	○	I feel that the scenario offers a **good** learning experience
f. I feel that the learning tool has **NOT** changed my opinion for the Physics topic	○	○	○	○	○	I feel that the learning tool **positively** changed my opinion for the Physics topic

	1	**2**	**3**	**4**	**5**	
g. I feel that the learning tool has **NOT** raised my interest in Physics	○	○	○	○	○	I feel that the learning tool **raised my interest** in physics
h. I feel that the learning tool has **NOT** motivated me to learn more on Physics	○	○	○	○	○	I feel that the learning tool has definitely **motivated** me to learn more on Physics
i. I feel that the tool will **NOT** increase my chances of performing better in my Physics class	○	○	○	○	○	I feel that the tool will increase my chances of **performing better** in my Physics class

Comments for improvement: