EARTH COURSE Pilot: NEWTON Project Support for STEM Education

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Abstract— **This paper presents NEWTON Earth Course large scale pilot developed and deployed as part of the NEWTON Project. The pilot consists of a number of innovative applications that teach STEM topics part of the primary school curriculum. A demo of the Earth Course Pilot will be provided during the presentation session.**

Keywords: STEM Education; technology enhanced learning; augmented reality; game based learning.

I. INTRODUCTION

Technology-Enhanced Learning (TEL) methods are currently one of the proposed teaching solutions for the increasing lack of interest in science, technology, engineering and mathematic (STEM) subjects. These subjects are perceived as boring and difficult to be studied. Therefore, many students seem to become disengaged in such topics, especially if they are struggling to understand certain complex concepts leading to diminishing grades. TEL solutions offer various teaching approaches that help students to understand better STEM topics, thus increasing their interest and engagement. It has been observed in primary schools the majority of students are interested in STEM topics and it is important to continue fostering students' interest in these throughout their education, from primary to secondary and third-level institutions.

The NEWTON project [1] is an EU Horizon 2020-funded project involving 14 partners from seven countries. The main objectives of the project include building a networked platform to facilitate integration and dissemination of many technology-enhanced learning (TEL) materials and innovative learning approaches. NEWTON also investigates the impact of using various forms TEL materials, such as serious games, virtual labs, fabrication labs, augmented reality, virtual reality, and innovative learning approaches, such as problem-based learning, on students' learning outcome and affective states. Various courses covering STEM subjects were developed and deployed in European educational institutions [2]-[4].

II. EARTH COURSE PILOT

Earth Course is one of the NEWTON Project's large-scale pilots that focuses on primary school education and it was carried out across Europe in Ireland, Slovakia and Romania, 172 students have participated in the study. The Earth Course pilot includes a set of educational applications developed in an effort to attract children to STEM subject. The educational applications cover a set of topics part of four main areas: Atmosphere, Geosphere, Biosphere and Astronomy. The applications use various technologies and innovative pedagogical methods (e.g., Augmented and Virtual Reality, gamification, game-based learning and problem-based learning) to achieve the learning objectives specific to the primary school curriculum specific to the 5th grade and 6th grade and to improve learning satisfaction. The applications are also suitable for children with special educational needs, specifically hearing impairments.

The main applications (see Fig.1) employed in this pilot are:

- *Water Cycle in Nature*, focusing on precipitation formation and related topics, such as vaporisation, evaporation and condensation;
- *Wildlife*, focusing on a set of terrestrial animals, such as deer, brown bear, lynx, wolf, wild boar, fox, hare and moose;
- *Sea-Life*, focusing on the aquatic world and presenting educational material on sea creatures such as sharks, stingrays, dolphins, puffer fish, jellyfish, octopus, orc, turtle, clownfish, seahorse;
- *Final Frontier* game, presenting the rocky planets, the giant gas planets and an astronomical bodies such as the Moon part of the Solar System;
- *Geography* application, focusing on educational content about Ireland and United Kingdom, including its monuments and archaeological sites.

The deployment of the Earth Course pilot was done using the online NEWTON project platform called NEWTELP (NEWTON Technology Enhanced Learning Platform) and it involved all applications, knowledge tests and questionnaires for assessing learner experience, usability of the platform and applications as well as knowledge gain evaluation. The pilot was deployed in three European schools and results presented in various papers [4]-[7]. Eight separate learning sessions were carried out employing digital educational content developed as part of the NEWTON project.

Focus groups and interviews were carried out with learners and teachers, in order to assess the effect and benefits of the pilot. Noteworthy is that the children participating in this course enjoyed each session, and got excited every time when the NEWTON team was setting up the classroom for another Earth Course session. Some children already came up with ideas on other applications and what other interesting subjects they might like to learn.

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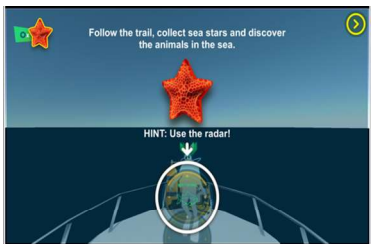
Water Cycle in Nature application (Nature Environment

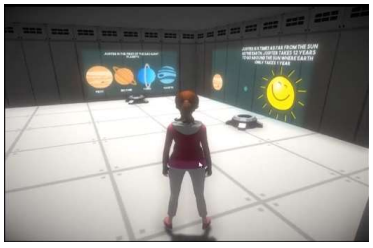
Water Cycle in Nature application (Virtual Lab - Boiling Experiment)



Sea-life Application – Nature Environment

Sea-life application – Virtual Lab

Final Frontier Game - Venus



Final Frontier game – Virtual Library

Figure 1. Water Cycle, Final Frontier and Sea-life applications part of the NEWTON Earth Course Pilot

The overall feedback from teachers that applied the Earth Course pilot in their class was positive. They all noted the enjoyment students exhibited during these sessions as well as their engagement in each topic. Teachers are very open to using novel technologies seeing the benefits of the NEWTON-based lessons. However, schools' infrastructure were sometimes lacking the necessary equipment. Teachers also noted that it is imperative to have a more established communication between TEL designers and teachers, emphasizing the need to improve teachers' familiarity and involvement with TEL approaches.

In terms of learner satisfaction, the majority of the students who exhibited positive learning satisfaction following NEWTON-based lessons were students who already have positive attitudes to school and they were used to employing technology as well as those students who do not have issues with STEM subjects. It is notable the fact that students who do not like school reported significant improvements in knowledge assessment tests, specifically preferring to use NEWTON apps when learning STEM topics and an increased enjoyment level during NEWTON-based lessons compared to their usual STEM classes.

III. CONCLUSIONS

Summarizing, learner's experience and knowledge results analysis show that the NEWTON approach lessons applied in primary schools increased children's interest in Technology Enhanced Learning, which also improved their engagement in STEM subjects. NEWTON approach also provided a beneficial support in terms of knowledge acquisition and can be employed by teachers as an aiding tool to better illustrate to children various STEM concepts.

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