An Augmented Reality Solution for the Positive Behaviour Intervention and Support

Mariella Farella[1(✉)], Marco Arrigo[1], Crispino Tosto[1], Davide Taibi[1], Luciano Seta[1], Antonella Chifari[1], Sui Lin Goei[2], Jeroen Pronk[2,3], Eleni Mangina[4], Paola Denaro[1], Doriana Dhrami[1], and Giuseppe Chiazzese[1]

[1] National Research Council of Italy - Institute for Educational Technology, Palermo, Italy
mariella.farella@itd.cnr.it
[2] Faculty of Behavioural and Movement Sciences, Vrije Universiteit Amsterdam, Amsterdam, Netherlands
[3] Department of Child Health, The Netherlands Organization for Applied Scientific Research, Leiden, The Netherlands
[4] School of Computer Science, University College Dublin, Dublin, Ireland

Abstract. The spread of Augmented Reality (AR) and the recent technological developments, provide innovative techniques and tools that show a growing potential in education. One of the pilots of the European Horizon 2020 project ARETE (Augmented Reality Interactive Educational System) aims to investigate and evaluate for the first time the introduction of an AR solution to support a behavioral lesson in schools where the Positive Behaviour Intervention and Support (PBIS) methodology is adopted. Specifically in this paper, we describe the architectural design and implementation of a PBIS-AR application as a component of the ARETE ecosystem. It describes the functionality of the system and the teaching process that the AR solution will support.

Keywords: Augmented Reality · Positive Behaviour · Behavioural learning

1 Introduction

Augmented Reality (AR) is changing the way people experience physical and virtual environments. In particular, AR has expanded widely in the field of education. The concept of AR dates back to the 1960 s s and is focused on improving user perception and interaction with the real world. According to [2], AR combines the real world and virtual objects and provides simultaneous interaction between them. Through AR, users in real time can see their environment enriched with virtual elements (textual information, images, videos or 3D elements) through the camera of the device used, either it is a mobile device, a

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headset or a smart glasses specifically designed for AR. Several studies demonstrated that Augmented Reality has the potential to enhance student motivation and make learning a more engaging, challenging, and dynamic activity [7,13]. In addition, it can stimulate creativity, collaborative skills, and critical thinking in students. In the context of behavioral education, which is related to the study of how the environment stimulates changes in students' behavior, AR technologies have been integrated into interventions delivered in school and clinical settings to teach social skills (e.g. [1,10]). However, the use cases of AR in school-based behavioral education are very few.

In the Horizon 2020 European project ARETE[1](Augmented Reality Interactive Educational System), the use of Augmented Reality in behavioral education is explored for the first time [12]. Specifically, the project pilot #3 aims for the first time at developing and testing an AR system that supports teachers during behavioral lessons in teaching and practicing behavioral expectations following the guidelines provided by the Positive Behaviour Intervention and Support (PBIS) framework[2]. First, a short introduction of the PBIS framework is given; following, the design process of the AR based application to support teachers during behavioral lessons is described.

2 The PBIS Framework

School-Wide Positive Behaviour Intervention and Support (SWPBIS) is a school-wide educational approach aimed at supporting students' behavior and school outcomes by stimulating the creation of safe learning environments [11]. Specifically, SWPBIS provides schools with a framework for implementing evidence-based educational interventions that promote students' (and all school stakeholders') prosocial behaviour, thus contributing to the emergence of a positive and safe school climate.

SWPBIS interventions delivered at the primary-tier level are usually applied to all school members and across all school settings (e.g. classroom, hallway, corridor, et cetera) to create and guide a positive social culture. This primary interventions get the foundation for delivering regular, proactive support and preventing unwanted behaviors. SWPBIS interventions also includes systematic rewards of students' accuracy in adhering to the defined behavioral expectations and systematic interventions to address problem behaviours [9]. At the same time, second-tier interventions are still delivered as group interventions but are designed to address problem behaviour of those students who do not positively respond to first-tier interventions. Finally, the third tier comprises interventions specifically designed to be delivered individually to students who exhibit exceptionally challenging behavior and do not profit from interventions delivered in the first two tiers. Safer and more positive learning environments at school, as promoted by SPWPBIS interventions, have been proved to account for a set of positive outcomes, including reduced problem behavior [4] and improved school

[1] https://www.areteproject.eu/.
[2] https://www.pbis.org/.

climate [3] among others; more in general, literature has extensively confirmed the effectiveness of SWPBIS in improving students' learning engagement and educational outcomes across different grade levels [8].

3 Design of the AR Based Application for PBIS

In the framework of pilot #3 of the ARETE project, named Augmented Reality for promoting Positive Behaviour Intervention and Support, an application is designed to support educational interventions delivered within the first tier of a multi-tiered system of support [5].

The research and development process towards universal implementation of PBIS-AR was based on data collection through focus groups with stakeholders (i.e., PBIS experts and PBIS teachers). The design process envisaged the involvement of the stakeholders in construction and validation of the ARETE PBIS Behavioural Expectation matrix and PBIS-AR application content. In this way, the design phase would take into account the needs highlighted by the PBIS teachers. This process was affected by the pandemic phase from covid-19 forcing the application of contingency plans to complete the process. Therefore, a review was created to the literature on PBIS school values, behavioral expectations, common school contexts, and reinforcement systems as a contingency plan. In addition, an online questionnaire was created and administered to students (N = 209) and teachers (N = 135), which results allowed the selection of behavioral expectations, settings, and values for the construction of AR lesson content.

Taking into consideration the requests of PBIS teachers and the outputs obtained from the various focus groups, an app for smart devices (mobile phone and tablet) was designed specifically oriented to support PBIS practice of students and teachers during the behavioural lesson. This application aims to support the definition, modeling and practice of expected behaviors and to provide support for the recognition and reinforcement of students' compliance with expected behaviors. Students are guided through a learning path that, leads them toward practicing PBIS methodology in a real environment, to finally reinforce their experience with PBIS. In order to interleave the effects of the PBIS behaviours with the real context in which students actually are, the Augmented Reality technology has been leveraged.

3.1 PBIS-AR Application Architecture

The architecture of the PBIS-AR application integrates different modules, each of them devoted to a specific functionality. Users of the application are students or groups of students (depending on the number of available devices). An App Controller module manages activities, user profile and data synchronization and interacts with:

– the tracking system, which is responsible for managing the AR-content tracking.

– the data controller to manage user data and leader board. It takes care of the authentication procedure and manages the reward system including the leader board system.
– the xAPI for learning analytics.
– the student module, to control interactions during the PBIS phases (teach, practice and reinforce) performed by students through the application.

Moreover, the 3D objects as well as 3D animations, are stored in a repository of a ARETE Moodle[3] server using ARLEM[4] standards. Finally, the Orkestra library will be used as a multi-user orchestrator.

3.2 AR Objects for the PBIS-AR App

A series of virtual characters were designed and developed to show students the execution of expected behaviors. The main character is an alien, Arpro, from the space who is completely unfamiliar with life on Earth, so that he can be considered as a neutral behavioral coach. In fact, an alien is new to planet Earth and must explicitly learn all the values, procedures and routines. The alien is only one of the characters that can be involved in creating examples and non-examples of a behavioral routine in the PBIS-AR application. In fact, at school it should have relationships with other characters, such as teachers, the administrator, and classmates.

3.3 Students' Activities in the PBIS-AR App

The PBIS-AR application supports students during the training, practice and reinforcement activities. Taking into account the outline of the PBIS framework, the functionalities that the PBIS-AR application will have to offer to its users have been identified and will be implemented using Augmented Reality:

– Interactive introduction to the system in which the main character, the alien Arpro, is introduced to the student through an interactive presentation. The interactive dialogue will be developed in AR mode using the balloon system and allowing students to become familiar with the user interface of the application and making them more involved in the learning process.
– Setting up of the environment where the user will be led to a simple configuration of the working environment by entering a nickname that will be used to anonymously track all student interactions and to set the necessary parameters to launch the application in a personalized way.
– Reproduction of behavioral routines related to the school environment and specific setting. Content will be offered through 3D AR animations directly in the school environment in which students are about to learn.

[3] https://arete.ucd.ie.
[4] https://standards.ieee.org/ieee/1589/6073/.

- Behavioral AR reflection game where a gamification learning content will be provided to students. Using this feature, students participate in a behavioral reflection game in AR. Through a series of markers located in various settings, examples and non-examples of behavior are shown to students to facilitate learning of expected behaviors.
- Multi-user interactive behavioral activity where students will have the opportunity to practice behavioral tasks through augmented reality, using 3D objects and characters to interact with in a mixed environment. An in-development library, the Orkestra library, will be used for the implementation, allowing the application to create a multi-user behavioral activity.
- Leaderboards and rewards where the student will be able to view leaderboards, and combined points according to different behavioral expectations experienced in the AR environment.

3.4 Behaviour Tracking with xAPI

PBIS behavioral lessons will be developed and piloted to investigate the efficacy of integrating AR technology within PBIS interventions and supports to encourage expected behaviors at the school and classroom level. The learning process will be monitored through the integration of the Experience API[5] (xAPI) standard that will send the data to a Learning Locker platform that is a Learning Record Store (LRS). The activities described in the Sect. 3.3, create xAPI statements to track the student's interaction with the system and are sent to the chosen LRS to store them.

The use of the xAPI standard provides an interoperable layer to track student activities and to simplify the design of learning analytics tools that support teachers in making decisions about educational processes in school settings. One of the advantages of the xAPI standard is the ability to define specific profiles related to a domain of interest. This also makes it appropriate in our context where innovative AR-based approaches are used in learning and practice of the PBIS framework. As described in [6], the use of xAPI standards promote the development of Learning Analytics approaches to monitor PBIS experiences. A comprehensive xAPI vocabulary will be defined for modeling the AR-based PBIS experience.

4 Conclusion and Future Steps

This paper presents the architecture of the PBIS-AR application prototype. It is an application designed to support a behavioural lesson with the use of AR learning contents. The main effort to obtain an innovative app able to involve and engage children and young students is devoted to encourage the adoption of the PBIS methodology and sustain teachers and students in the behavioural teaching and learning process. This result will be pursued by adopting new

[5] https://xapi.com.

AR standards and technologies permitting the authoring of context-aware and purpose-aware AR objects and animations, the tracking of the user's experience with AR learning objects and the use of AR multi-users interactions learning activities. The next steps include the development of the application prototype and the testing of PBIS-AR application with children in the age group of 9–12 in the school year 2022–2023.

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