Utilizing a serious game via Open Sim standalone server and Scratch4OS for introductory programming courses in Secondary education: Their effect on student engagement

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Abstract—This study suggests a constructionist-learning framework to amplify students’ engagement in introductory programming courses via a serious game that was held in Open Sim standalone server integrated with Scratch4OS. Fifty five (\(n=55\)) voluntary students from three different High schools have participated and experienced in Co.Co.I.A., a 3D mind-trap puzzle game. The empirical study findings indicated that behavioral engagement (attention, retention and energy expenditure for activity completion) does not only have a linear correlation with cognitive engagement (learning for the construction of the knowledge domain), but it also has a positive nexus with emotional engagement (positive emotions and achievement orientation) in collaborative learning tasks, causing the reinforcement of the other two factors too.

Keywords—Serious games; Open Sim; Scratch4OS; Co.Co.I.A.

I. INTRODUCTION

International curricula about Computer Science courses have already acknowledged the need for students to understand the contemporary functions of a learning environment based on constructionism settings. Perhaps an interesting research challenge is the creation of a visually-rich serious game (SG) that can be combined with the open source virtual world (VW) Open Sim and Scratch4OS in order to provide introductory programming courses.

The motivation for this study comes from the contribution emanated from the conjunction of VWs with Scratch in order to provide various engaging programming tasks due to [1,2]: a) a low cost persistent workflow assisting the implementation of different instructional formats (blended/online), b) the technological infrastructure replicates real-time feedback on users’ interactions to create and syntax multiple codes, c) the a-/synchronous communication tools and realistic aesthetics of a 3D virtual grid allow users to engage in situations mimic those of real life, and lastly d) the flexibility and adaptability are unique issues of a 3D grid for users to create at the beginning a learning platform, according to their needs or demands, helping them to organize/coordinate their teams and enhancing in these circumstances the sense of co-presence.

Undoubtedly, the effectiveness of a SG is not the only part of the problem. Student engagement in VWs is a contemporary concept that has taken central role in education as an inextricably term linked with participatory activities that may result to the meaningful acquisition of knowledge. The investigation of behavioral (BE), positive conduct and students’ participation, cognitive (CE) ascribed to self-regulation and effective investment in learning activities) and emotional (EE), stimulated interest and positive attitudes about learning performed as indicators of student engagement [3]. These factors may assist educators and scholars to better understand the value of a SG as a candidate learning platform in 3D open source VWs for participatory activities. Therefore, a research question (RQ) that emerged is if there is any significant linear correlation (positive or negative) between students’ emotional, cognitive and behavioral engagement indicators who enrolled in introductory programming courses that held in SGs via Open Sim combined with Scratch4OS?

The purpose of this study seeks to explore the correlation between students’ engagement indicators. According to the experimental setup students tried to learn basic serial sequence programming commands by co-manipulating, co-constructing assembled primitives in a 3D mind-trap puzzle held in Open Sim and finalizing their experiment by programming these primitives with Scratch4OS.

II. RESEARCH DESIGN & METHOD

A SG in Open Sim entitled Co.Co.I.A (Collaborative Construction of Interactive Artifacts) was implemented to measure student engagement factors. This paper presents a brief overview of this game and proposes a constructionist didactic framework (see Figure 1) in order to help educators and scholars to understand students’ interactions and to empirically measure the results of their engagement. The core of the present game was threefold: i) the increase of...
students’ motivation and engagement for learning serial sequence commands, ii) the acquisition of collaborative or communication skills and iii) the coordination of teams in blended and supplementary online instructional formats. The instructor’s role was to guide students in all weekly meetings and encourage them to think, explore, discover and manage the learning materials in order to solve problems in a constructionist theoretical framework.

Participants of this study were 55 students (28 male and 27 female) from three Greek high schools (aged 14-15 years old) after the signed consent of their parents. They had no previous experience in VWs. The construction of the main 57-item instrument was adopted for the programming courses according to [3], translated in the Greek language and it was kept the anonymity of each participant.

According to Table 2, we noticed a statistically strong positive correlation between BE and CE indicators with a coefficient of linear correlation (r=0.643). By increasing social and emotional competences in an activity, simultaneously it is increasing the index of CE via exploratory and collaborative activities. Summing up the aforementioned, we also observed that there is a positive linear correlation between the two indices. Furthermore, it appeared that there was a linear correlation of BE and EE (r=0.558). This link brought to the front the users’ sociality feelings. It was also increased the initiatives that students can get into an organizational-teaching framework that facilitated the acquisition of basic programming commands. After the completion of activities in the VW, it was ascertained that in our case BE had a positive linear correlation with indices of CE and EE.

A positive aspect from the study results was that eventually students started to be engaged in participatory learning tasks associated with serial sequence programming courses and collectively co-created, experimented and programmed 3D puzzles in complex problem-based settings. This experiment enhanced their positive conduct and behavior (BE). Students acquainted in collaborative learning tasks via a constructionist underpin (CE). Lastly, the students’ roles always formed in a collaborative climate and increased their positive attitudes to collaborate with other peers (EE). The hybrid instructional format was assisted them to become gradually seekers of knowledge and not passive recipients of the instructor’s guidance.

The student engagement in 3D technologically-advanced environments should be further combined in a broader context through their participation and motivation with other peers in a collaborative learning activity. The results have shown that BE (students’ on-task behaviors) was significantly correlated with the CE (expression of students’ solutions in problem-based tasks) and EE (students’ on-task satisfaction). These correlations brought a thought that a linking part between performances in-/extra-curricular class-oriented strategies in problem-based activities are particularly important when group members utilized artifacts and tools in a 3D VW. We can convincingly understand that students’ engagement in a SG via 3D VWs can be considered as a valuable parameter for more successful learning outcomes in introductory programming courses.

### REFERENCES

