Virtual communities of inquiry (VCoI) for learning basic algorithmic structures with Open Simulator and Scratch4OS: A case study from the Secondary education in Greece

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ABSTRACT
The rapid penetration of “open source” virtual worlds (VWs) on the configuration and development of three-dimensional (3D) multi-user virtual platforms, in conjunction with interfaces of two-dimensional (2D) educational environments to learn novice users basic algorithmic structures were currently the central axis that exposed for investigation in our study. Notwithstanding the radical restructuring of instructional formats with VWs, like Open Simulator (Open Sim); however the disambiguation of students’ presence indicators which are positively correlated to their meaningful engagement in Computer Science courses in a virtual community of inquiry (VCoI) is still lacking. In fact, for the requirements of these courses we had configured specific collaborative virtual areas in order to be explored and utilized from students a variety of non-uniform geometric solids from Open Sim and to be constructed a 3D (assembled) “mind trap” puzzle. Alongside, each piece of this puzzle was programmed according to a specific serial sequence with Scratch for Open Sim (Scratch4OS). The current case study seeks to present firstly a valuable framework for the implementation of the teaching and learning process in a VW, and subsequently the results from linear correlations between the cognitive, social and teaching presence of a VCoI from eighty-one (81) students of the Greek Secondary Education. The study findings indicated that the social presence (communication and cohesiveness of a group) don’t only have a direct correlation with the cognitive presence (learning process for the construction of knowledge), but also has a positive association with the teaching presence (organization, planning and guidance of learning activities in the 3D space), and compulsory reinforced both of them. The added value of this study highlights the fundamental issues of the cooperation, socialization, retention and attendance rates between members of a VCoI which avouch multiple dimensions encircle or empower students’ managerial and learning responsibilities based on the affordances that a 3D technology-enhanced environment can replicate.

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Categories and Subject Descriptors
K.3.2 [Computers and Information Science Education]: Computers Science education Constructs and Features.

General Terms

Keywords
Open source virtual worlds, Secondary education, Virtual communities of inquiry.

1. INTRODUCTION
The exponential growth of Information and Communication Technologies (ICT) in different levels or disciplines of Education has substantially changed the expanded form and manner of operating means for the vast majority of learning processes. With the adaption of ICT, it is still growing the e-Education with new dimensions and new capabilities that bestow the exploitation and installation of system changes, especially in terms of learning environments that are commonly being used by the nascent Web (2.0) learning applications. Beneath this light, the steering axis integration in e-Education lies in the assistance that is provided as a “seminal” parameter for changing the entire educational application of dynamic ideas, and taking more into account users’ (students and teachers) needs or interests and provide a multi-dimensional learning approach for an innovative “knowledge field.”

In the last seven years it has begun a growing interest for students’ performances on courses with online or “blended” (hybrid) instructional formats by harnessing multi-user virtual worlds (VWs). The interactivity of these 3D computer-generated environments and social forms of modeling furnish the design of learning activities under the theoretical underpinnings of the Contemporary learning theories (see Papert’s Constructionism or other “descendants” of socio-cognitive learning theories, like the Situated Theory). The rich social multimedia features offer participants several communication channels to work together by utilizing various digital forms (synchronously or asynchronously) and sharing experiences in a common (3D) multi-user “space” or “place.” Users can also optimize the performance of graphics-intensive 2D and 3D applications that cause the sensation of coexistence in a (global) digital-oriented community [24].
Indeed, there is a widely held belief that the evolution of personal computers (PCs) and the “blogosphere” (Web) have provided an opportunity for educators and scholars to enrich learning activities between students through multi-user virtual environments, such as those of VWs with a “social” or “open source” technological infrastructure. A VW generally, includes an online, streaming (persistent) and 3D interactive environment, accessible simultaneously from many communities at the same time and in the same place. VWs can provide main characteristics of the 3D virtual technology (VR) which is suitable for the configuration of other nascent virtual learning platforms that can adequately cover perquisite needs of various teaching and learning procedures. Despite the fact that VWs was already introduced from 1997 or earlier as 2.5D text-based environments; the mass production and their impending success was emerged from social VWs, and especially from the Second Life (SL). In this VW many educational activities of Higher Education tailored from scholars and educational researchers from different disciplines, and thus by providing entrepreneurship and socialization between people from across the world, it became until recently the most well-known VW of e-Education [24] [26].

In a more technological-functional field, social VWs can truly equip a wide field-class distribution through virtual “islands” (grids), where instructors can exploit them for the needs of their courses by paying a specific fee. Nonetheless, we should behold some crucial boundaries, such as: (i) the maintenance cost, (ii) the non-autonomous (standalone) support, (iii) the allocation of operating or postulating learning resources for the better managerial responsibilities of students’ activities that shifted the academic research interest to use “open code” multi-user 3D VWs, such as Open Simulator® (Open Sim). [36] argued that communication and social interactions that occur in VWs may contribute to a learning process, but these findings need further investigation. In fact, it was revealed that communication and social interactions would be the key to having better learning outcomes in the e-Education by leveraging multi-user VWs. However, the configuration, coordination, deployment and management of a virtual community in these circumstances require considerable time and effort from all of its members [6]. Both learning and teaching processes should not have an impersonal nature, but it should be designed more efficient to expand the students’ exploration with various learning strategies or team-based learning techniques that can be implemented from the community. Social interactions and organizational tasks have a radical formalization through human relationships settings within a virtual community where its members can conquer the new “knowledge field” with the basic principles of Education, such as cooperativeness, trust, community’s cohesiveness and mutual support. Hence, first of all it must be taken seriously into account the development and management of a community that requires considerable time and effort. In these lines, a teaching procedure should not provide a strict-faceless character, but must be designed to explore more adequately both structural and learning strategies that can be performed for better coherence of the community.

The communication via computers (computer-mediated communication, CMC) that is emerging in all computer-generated environments as a communicative transaction has been firmly used in recent years from many instructors in various training programs, towards building members’ awareness [17] [18]. Regarding the use of CMC in supporting the learning experience, [14] have developed a model (or a framework) for researchers to analyze students’ interactions in CMC technologies. The community of inquiry (CoI) model identifies three interlocked elements: i) the cognitive presence (CP), ii) the social presence (SP), and iii) the teaching presence (TP).

The current model was on the research area of [12], and for more than twelve years its educational-transactional nature discussed within other academic research rounds. The analysis of the user’s presence in learning environments was based on the models of critical thinking and empirical research. Learning, thereof is enounced thoroughly on a communicative and interactive method that averaged between students-instructor and premier division of the framework described through the above three concepts.

The existing framework consists of the knowledge construction as a result of a teamwork between active participants in learning communities in which they interact with other peers and the instructor (cognitive presence), reflecting an educational instrumentation suitable for online environments (teaching presence), and in this vein encouraging the collaborative climate between users (social presence). More analytically, the teaching presence (TP) is a well-organized plan for the facilitation ratio, direct instruction [14], and expression behaviors that may lead to valuable inquiry-based learning outcomes [30] [31]. The social presence (SP) represents an “online speech” that promotes positive influence, interaction and cohesion [33]. Last but not least, the cognitive presence (CP) defined as the degree in which participants in a community of inquiry are able to construct concepts through the constant communication forms that each learning environment is able to provide.

Despite the fact that the implementation of the CoI framework has thoroughly be used in 2D learning environments with positive results [11] [14] and on 3D VWs [21] [34], where positive views of stakeholders focused mainly on the communication tools that reduce the students’ “extraneous” cognitive load within communities of inquiry; undoubtedly even today there is still a paucity from a research about the intrinsic correlations concerning a community of inquiry presence indicators (cognitive, teaching and social) in VWs, and especially for students of the Secondary education. The research question (RQ) that is emerging in this notion referred as: Is there any significant linear correlation (positive or negative) between the social presence, the cognitive presence and the teaching presence indicators in a virtual community of inquiry?

The aim of the current study seeks to explore the correlations that emerged between presence indicators (cognitive, social and teaching) in a virtual community of inquiry (VCoI), where students construct their own “knowledge field” for learning basic serial programming structures with the co-manipulation and co-construction of a 3D mind-trap puzzle through Open Sim. The findings presented from a case study in Nea Artaki of Evia.

2. THEORETICAL UNDERPINNINGS

2.1. The community of inquiry (CoI) model
The first step towards a more careful planning of instructional pace should have been first of all taken seriously into account the instructor’s guidance, and then students’ opinions or ideas in order to be developed and configured a learning community that associated with users’ requirements, demands, and needs for

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1 http://opensimulator.org/wiki/Main_Page
better understanding learning materials and reaching common course goals. The user's presence is a basic element in any community as a core of an alternative “constructive” approach to achieve a higher level of relationship or interaction between students, and thus by promoting the development of students’ skills (communication, collaboration, leadership or socio-cognitive) generating several positive effects on the learning procedure [12] [17]. To better support the learning experience, [14] developed a model, in which researchers have identified key indicators of the users’ presence and analyze their interactions in electronic learning environments. There are some research efforts successfully carried out on the CoI model, through activities implemented in the area of VWs by providing social and collaborative activities among its members with various learning scenarios and positive results [6] [7] [21] [34].

The CoI model dimensions were focussed on the knowledge’s construction as a result of teamwork and interaction among active participants (cognitive presence), reflecting to the educational organization and the appropriate infrastructure for online environments (teaching presence) and on the cooperation and communication between all members (social presence). The teaching presence (TP) is a well-structured plan to facilitate the teaching process [8], where students express views and behaviors that may lead to valuable conclusions for the community cohesion [30]. The social presence (SP) represents the interactive expression of all members, promoting positive effect on users’ interaction and this frequently recapitulated in a functional collaborative environment [20]. The cognitive presence (CP) regards as the core of the constructive learning process and reflects on the outcome of the investigation through an ongoing concern that affects the whole community [25].

[12] has presented a new framework for designing and analyzing educational activities in e-learning environments, which focuses on developing a community of inquiry and encapsulating by three interrelated components: i) the message content, ideas, arguments and views of members (CP), ii) the interaction among members (SP) and iii) the sharing roles or teaching initiatives that principally emanated from the instructor (TP).

2.2. The virtual community of inquiry (VCoI) model

In these circumstances, it is important and should be noticed at the outset of the inquiry-based learning procedures within communities [12] that stressed to the analysis of interactions in 2D asynchronous learning systems (Learning Management Systems-LMS). However, an interpretation which would fit in the case of these communities with the “transfer” of knowledge in 3D VWs is the term “virtual”. We add this term because users engaged in a common virtual place in which they predominantly use for 3D modeling applications in order to design visual artifacts, and thus their coordination can be accomplished with various communication channels (synchronous or asynchronous forms with voice chat or note cards, important messages, and gestures respectively) inside to the community of inquiry origins.

The multiple facets of collegiality and social aspects which are assumed through the designing and modeling in a 3D environment are attracting in nowadays many stakeholders to understand their meaningful value. Incidentally, students seem not totally isolated in front of a personal computer screen, but their actions acquire some beneficial features of the “persistent co-presence”. This concept is intermittently envisioned in the contexts of a collaborative effort with the users’ coexistence and “co-preservation” in virtual communities, while in the case of the latter it still exists, even if the user removed from the world. Although, the co-manipulation and modification of the 3D pre-constructed virtual place is continuing by other peers.

The interactivity and the social formation of modeling as significant elements of this procedure can also influence the design of learning activities, according to the contemporary learning theories. Hence, the theoretical foundation of a VCoI can be based: (a) on the socio-cultural principles of Cognitive Apprenticeship [19] for the spatial configuration of various learning processes to “engage” users in communities of practice to the learning process in authentic conditions for the design and implementation of educational activities, and (b) another similarly noteworthy theoretical background could be the Constructionism of [23] for prototyping virtual objects and models in a 3D “micro-worlds”. Ensuring the successful simulation of a VCoI in VWs, we should probably investigate and amplify factors affecting the imperative need of the better adoption of the learning process with the most important of them to be the collaborative climate, communication, members’ involvement, and the facilitating role of the instructor in order to be achieved the learning goal.

2.3. Game-based learning with Open Sim and Scratch(4OS)

VWs due to their inherent technological infrastructure can enhance interactive activities involve and motivate all members of a community in the learning procedure. A growing literature body of scholars and researchers [11] [29] [25] [35] have shown that the VW of Open Sim may provide the necessary multimedia tools and grant the creation of new means in a potential “engaging” 3D environment, where members are able to interact collaboratively in group-based activities, construct or combine multimedia 3D visual artifacts from standard geometric solids (virtual prototyping), and posing foundations of a more “constructive” learning approach that positively contribute into the radically restructuring of the traditional “status quo” of e-Education.

One of the most widespread categories of VWs is those of “open-source” (see Open Sim, Reaction Grid etc.), where each user can use them only with a fast Internet connection to download a client-viewer or create an autonomous virtual space (standalone grid) through a private server in order to have the exclusive control as an administrator. It also offers the creative prospect of an interactive virtual community, in which users communicate and collaborate as cyber entities (avatars) in a 3D VW. Open Sim is considered as the most well-established "open" code and 3D (multi-user) VW. It can also be used to create one or more virtual "islets" (Sims), whilst it simultaneously can be derived and reformed from different authorized users. Results from previous case studies [5] [15] [35] have shown that “open code” VWs can support various types of educational activities, escaping from the most “conventional” and shifting to an innovative framework for acquiring the knowledge with "constructive" approaches. Given the above view, exploring the potential affordances from the integration of VWs with blended course delivery method seems to become more relevant and essential for “transferring the knowledge” in VWs, and mainly for students of a High school.

There are also several convictions that VWs can enhance learner’s experiences with the design of game-like applications significantly increase students. Consequently, VWs can provide new opportunities to promote “edutainment” (education + entertainment) learning situations. Despite that there has been an
aloofness and reluctance of computer games usage as “learning tools” [22], there are still in the spotlight, since many researchers have emphasized to their educational dynamic dimensions [10] [16] [27] [37].

Contrary to the SL islets that are inhabitable renting lands by paying a specific fee, the (server) grid-based world of Open Sim enables users to create free, customizable applications from 3D artifacts with the Open Sim Scripting Language (OSSL) and construct different landscapes, if a typical user authorized by the administrator. Furthermore, since the source code of the application server Open Sim is “open” and easily modifiable from each user, everyone can make the necessary changes, depending on the needs and requirements that can obviously be raised, regardless the operating system (Windows, Linux or Mac OS).

In the case of 2D interfaces as free plug-in modules in 3D VWs, Scratch is a unique exception and it is probably the most popular educational software giving to user’s screen a two-dimensional (2D) graphical (Logo-like) interface and furnishing the free constructing programming concepts available in multiple languages. Apparently, Scratch offers to non-programmers (novice) users, aged from 8 to 16 years old a game-based environment to create animations, and interactive games in different c-syntax colored puzzle pieces. The compilation of tracks for the development of concurrent algorithm variables is based on the “drag and drop” technique. The vast majority of learning scenarios (particularly in problem-based learning) situations have infused the participatory process among teachers who want to include innovative forms of ICT for teaching programming concepts [9] [28].

Scratch for Open Sim (Scratch4OS) is an alternative and innovative project for users that want to simultaneously work in two different environments (a learning two-dimensional and a modified three-dimensional) as a unique platform and welding the process that substantially separated into puzzle programming structures, where someone can add behaviors and interactivity into 3D visual objects or artifacts. The graphical user interface (GUI) of Scratch4OS has low computational hardware requirements; however the conjunction with Open Sim, encapsulating it with high-impact capabilities and a wide range of applications to empower the “technology literacy” and the production of an interactive content. It was designed to be more easily accessible (low-floor) novice-oriented, but at the same time powerfully complex-expressive (high-ceiling) programming language by providing multiple opportunities for users to construct, explore and investigate complex algorithmic commands in 3D tangible and interactive “thinking” (low-threshold) objects or artifacts.

The core of Scratch4OS is based on the 2D GUI of Scratch and its basic choices focused on a graphical programming language that yields to the initial writing of concurrent or serial programming languages with colored puzzle-based blocks that are visible and playable through Open Sim. Thence, by snapping together graphical blocks for constructing, modifying and utilizing visual artifacts (virtual prototyping), users can see the effects of their work in a common place. The puzzle-based configuration promotes a direct 3D visual feedback to students at the same time that they interact with the VW and consequences of these actions can become clearly qualified. In this notion, Scratch4OS in other words can motivate users’ imagination, curiosity, control statements cooperation, competition and recognition of false both via the system’s or the teacher’s feedback.

Our basic concern is the successful conceptual and practical didactic understanding of programming structures that acquires by the same students “the modeling of 3D visual prototypes” via artifacts in order to present two interactive applications using the Scratch4OS in Open Sim that can be promoted: a) as a “stylus” for drawing 3D objects, as the 3D space is becoming free-stylish “canvas” or b) as a “programming” environment where students creating “objects-to-think with” by integrating behaviors and interactions with artifacts. The pedagogical value of Scratch4OS emanated from a unique platform which can reinforce the student’s visual-spatial and perceptual abilities in a common virtual space, something that appears as a prerequisite factor for a good response to the requirements of basic laboratory activities in future-driven teaching plans.

2.4. A rationale behind this study

The widespread integration of ICT unveiled a novel curriculum for Computer Science courses in the Greek Secondary education by proposing a framework mainly with two interdependent components that deserve teacher’s attention: a) the use of ICT transactions as learning-cognitive tools that can mostly be used in problem-solving activities and b) the establishment of a theoretical background based on “constructive” (Papert's constructionism) pedagogical approaches with the basic authorities of the investigation, interaction, cooperation, self-motivation and creativity. The above was influenced the Greek curriculum, and its entire “philosophy” in which learning cannot be instigated with a simple transfer of knowledge, but it should exhorting students to rebuild or strengthen the preexisting knowledge, where it continues as the construction of a new one that is emerging collaboratively with other teammates.

In these circumstances, a rationale behind the utilization of Scratch in Computer Science courses is due to the students’ response for the easy acquisition of knowledge of basic algorithmic structures generally, and specifically from lessons like the serial sequence structure, selection structure, the debugging and repetition process. The logical conjunction between Open Sim and Scratch4OS emanates from: (a) the easily manageable and scalable infrastructure of the whole platform, which can be built on authentic or at least realistic conditions by using one client server and internet connection, (b) the interconnection with external media server with the Open Sim client viewer, which can positively affect students’ attitudes to enhance experiential learning processes, (c) the 3D interactive and flexible persistent workflow where students and teachers can collaborate as avatars (digital alter-egos) to achieve common goals in a multi-user virtual 'space' or 'place', (d) the student groups can get in real-time and in a common place visual-feedback from their actions, something that can encourage them to explore and experiment with 3D tools or objects, and (e) finally, the lack of “invasion” risk to unwanted users during the teaching process at no additional charge.

A learning process through Scratch4OS can be adopted in a VW with a “socio-constructive” pedagogical background, and facilitating the cooperation and semantic-algorithmic infrastructure in team-based procedures. We currently need to understand correctly that the use of Scratch of learning basic algorithmic structures in a playful 2D environment is in nowadays indispensable for the Greek school reality. However, it is still lacking a research for the exploitation, creation and implementation of a 3D programming puzzle game-based game constructed by the same users. The main objective of this treatment was the measurement of presence indicators in order to
be identified students’ algorithmic thinking in collaborative learning activities.

3. RESEARCH METHODOLOGY

We have implemented a case study to measure students’ interactions and correlations in a VCoI with a close-ended questionnaire at the end of the educational intervention. The current research was deemed as the most appropriate for researchers in order to evaluate a learning activity. Participants were 81 High school students of New Artaki in Evia, Greece. Throughout the research process was involved a researcher and another one Computer Science professor.

3.1. Instrumentation and data collection tool

The questionnaire of [31] was used for the data collection; because it combines all data from antecedents’ studies [4] [33] and can help us to examine the presence indicators in a VCoI. The instrument consisted of 34 closed-ended Likert-scale questions (from 1=strongly disagree to 5=strongly agree) and translated into Greek. The questions were organized as follows: a) 9-item for SP, b) 13-item for TP and c) 12-item for the CP. This questionnaire [31] is the most important tool in the social sciences area to study the students’ presence and their interaction with the environment in a community of inquiry, while in our case this was utilized at the first time for students of the Secondary education.

Statistical analyses of the data were performed by SPSS (ver. 21). To check the reliability of each factorial structure for the three thematic areas, the Cronbach’s alpha index was used and calculated prices considered as satisfactory with α>0.7 αemp=0.85, αCP=0.82 and αTP=0.84 (see recommendations from Singh, 2007). To test the RQ a series of statistical analyzes (Sample Kolmogorov-Smirnov test and linear correlation coefficients of Pearson) was also followed.

3.2. Sample

The participants of this study were 81 students (43 male and 38 female) from a Greek High School in Nea Artaki of Evia aged 14-15 years old who participated in the current survey with the signed permission of their parents. All students had a little experience from both environments (Scratch4OS and Open Sim) and the effort of setting it up with a probability sampling was done in mid-January to early February of 2013.

3.3. Treatment and experimental setup

The process lasted two weeks with a total of six (6) teaching hours (~40 minutes) educational activities and took place in the second quarter of the school year 2012-2013. Before the beginning of the research process, it was deemed appropriate to work with a “blended” learning method in two classes of third-grade students with voluntary participation. The teaching of basic programming structures like those of serial sequence variables took place in the computer lab, but there were also supplementary courses when it was necessary from a distance. Initially, even before the beginning of the pilot project, the following issues were investigated: (a) the access and navigation in Open Sim, where purely technical issues resolved in the laboratory, and (b) the connection to the VW from their home that should probably be established for students (mainly for online sessions).

In the experimental setup students need to efficiently collaborate and work on the VW, where they must first of all develop eighteen (18) 3D “interlocked” puzzles in a shared virtual space.

Trainees in Open Sim should firstly construct and place the 3D “assembled” mind-trap pieces (i.e. modified visual primitives) in a co-manipulation task, where they must be able to communicate (verbally or text-based brainstorming) and exchange spatial information, such positioning a visual object, and programming every “interlocked” piece with a serial sequence programming structure in order to construct each side of the 3D cube nets. We conducted this experiment because students should manipulate the contents in a shared virtual space to understand how can construct a common spatial representation. The participants were asked to perform in two-dyads a co-manipulation task.

Moreover, some crucial constraints were introduced to prevent partners from sharing implicitly the same viewpoint and from having a direct access to their partner’s field of view. Each user’s starting viewpoint was different from his/her partner’s starting viewpoint for each new 3D prototype. Then, users were freely modified their viewpoints during the task, whilst something this helped them to avoid complex mental rotations to co-manipulate the virtual objects. However, no feedback was given about the other’s viewpoint. Additionally, several constraints were introduced to prevent the quadrads from being used as contextual references instead of the stable lateralized visual landmark: (i) all quadrads should have fairly dissimilar geometric shapes, but all of them have the same color as their team has, and (ii) all quadrads were not lateralized, analogous to their right, left, front, or back sides are always dependent on each student’s position that wants to start programming and placing each piece in the nets of the 3D puzzle.

The “transfer” of the serial sequence programming course with Scratch4OS was implemented in configurable virtual learning spaces for the independent creation, management and operation of groups in a standalone mode, where the teacher was the main administrator. For this reason it is crucial to set out some of the serious decisions that define the perspective of an added educational value of this environment, including: (a) the use of cyber-entities (avatars); VWs provide to students the opportunity to exploit both the “sense of presence” within the body composition of a digital anthropomorphic entity and functions of face-to-face or written text “speech” like in a “natural” environment with a “continuous workflow” (persistent) that still exists and growths from trainees, stimulating sufficiently their interest, (b) free-but often manageable through administrator’s interventions-navigation in a wider area where students divided into totally 20 heterogeneous groups of three or four avatars respectively, as they would have a specific workplace to create their own workspace in identical attractive communication and cooperative conditions, (c) the VW can directly become potential for a variety of activities related to the integration of individual programs and their effortful or insightful use in a 3D public place, (d) the continuous operation of Open Sim and Scratch4OS admit the students’ meetings outside the traditional instruction hours under the administration of both researcher’s or teacher’s guide, and to better coordinate students’ activities or to solve any queries, and (e) the issue of security was ensured from the outset, as the server hosting the VW created according to the demands or needs of the experimental learning operation and does not accept the entrance to unauthorized users, but only those from each class. The development, configuration and exploitation of 3D puzzle-based cube surely may help students to handle the functionality and “objects-to-think-with” assembled primitives in puzzle-solving situations as “design exploration metaphors”. Similarly noteworthy, trainees were also able to compromise the strength of designing puzzle-based games in a VW. In addition, puzzles
denote a playable exploration by leveraging basic characteristics a “solving a 3D playful mind trap puzzle” as an educational opportunity to learn students basic algorithmic commands. Puzzle-assembled primitives comprise the several tools-smiths; permitting users to create interactively their workshops, control the problem-solving strategy and report visually the content of design puzzles. Puzzle-based procedures in this stage established as 3D metaphorical experiences rather than simple mechanisms of 2D design puzzle-based representations. Figure 1 depicts one example a virtual prototype 3D “assembled collage” in the front nets of the cube.

4. RESULTS AND DISCUSSION
The Pearson’s correlation coefficient considered as the most well-established in order to test the RQ about the data regularity. More specifically, the sample of 81 students was regarded as essential to provide information on such testing. Consequently from the descriptive data obtained through correlations of the test normality Kolmogorov-Smirnov (Table 1) and it was observed that the average (Mean) of the three presence indicators were at high levels (Mean\(_{SP}\)= 4.22, Mean\(_{CP}\)=3.94, Mean\(_{TP}\)=3.88).

**Table 1: Descriptive results and normality test**

<table>
<thead>
<tr>
<th></th>
<th>SP</th>
<th>CP</th>
<th>TP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal Parameters</td>
<td>Mean</td>
<td>4.22</td>
<td>3.94</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>.74</td>
<td>.65</td>
<td>.71</td>
</tr>
<tr>
<td>Most Absolute Difference</td>
<td>.112</td>
<td>.135</td>
<td>.154</td>
</tr>
<tr>
<td>Extreme Positive</td>
<td>.084</td>
<td>.121</td>
<td>.441</td>
</tr>
<tr>
<td>Differences Negative</td>
<td>-.245</td>
<td>-.074</td>
<td>-.254</td>
</tr>
<tr>
<td>Kolmogorov-Smirnov Z</td>
<td>.841</td>
<td>.522</td>
<td>.884</td>
</tr>
<tr>
<td>Asymp. Sig. (2-tailed)</td>
<td>.412*</td>
<td>.284*</td>
<td>.147*</td>
</tr>
</tbody>
</table>

* Significant at p<.05

The statistical significance (p-value) for all variables was higher than 0.05 (p\(_{SP}\)=.412, p\(_{CP}\)=.284 and p\(_{TP}\)=.147). Consequently, there are indications that the measurements of study’s variables followed the normal distribution. For the next stage of testing the linear regression of Pearson’s analysis was used (Table 2).

**Table 2: Pearson’s linear correlations**

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<th>SP</th>
<th>CP</th>
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<tbody>
<tr>
<td>SP</td>
<td>r</td>
<td></td>
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<tr>
<td></td>
<td>.612**</td>
<td>.548*</td>
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<tr>
<td>P</td>
<td>.002</td>
<td>.053</td>
<td></td>
</tr>
<tr>
<td>r(^2)</td>
<td>.623</td>
<td>.089</td>
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<tr>
<td>CP</td>
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<td>r(^2)</td>
<td>.623</td>
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<tr>
<td>TP</td>
<td>r</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TP</td>
<td>.548*</td>
<td>.178</td>
<td>1</td>
</tr>
<tr>
<td>P</td>
<td>.053</td>
<td>.083</td>
<td></td>
</tr>
<tr>
<td>r(^2)</td>
<td>.089</td>
<td>.078</td>
<td></td>
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</tbody>
</table>

* Significant at p<.05; ** Significant at p<.01

According to the Table 2, we remarked a statistically significant positive linear correlation between the indicators of the SP and CP, with a coefficient of linear correlation (r=.612) suggesting that by increasing social and emotional competence of engaging in an activity, simultaneously it is increasing the index of CP, through exploratory and collaborative activities in the VW. The conclusion is that there is a positive linear correlation between the two indices in the VCoI. Furthermore, it appears that there is a
linear correlation of SP and TP ($r=.548$). This association brings to the front the conclusion that increasing the feeling of the user’s socialism it is also increasing initiatives that can get them into an organizational - teaching framework and facilitate the acquisition of knowledge. After the completion of activities in the VW, we ascertained that in our case the community’s SP had a positive linear correlation with indices of the CP and the TP.

An additional positive aspect also resulted from [34] study and confirmed in our research, is that eventually, in a VCoI students:

(a) had the opportunity to collectively co-create, experiment and programming complex 3D objects puzzle with innovative tools offered by Open Sim and Scratch4OS intended for practicing both in the terms of visual effects arising from the application of serial sequence, and enhance their ICT knowledge field to meet the immediate demands of the course, (b) there were assigned tasks for each team to get acquaint or develop cooperative strategies for solving problems, and finally (c) the facilitating role of the teacher during the learning procedure, where each student had a specific role, but they always formed in a collaborative climate of mutual assistance and support. Moreover, it was revealed that with the "hybrid" instructional format students were excited by their personal involvement in active construction of knowledge in a community where students were able to better understand learning materials offered through specific activities and become gradually "seekers of knowledge", rather than passive recipients of the teacher’s instructions or commands.

Antecedents research efforts [6] [21] that described and evaluated the process of a CoI framework in VWs have already revealed the high level of the students’ satisfaction and acceptance on various activities, as moreover the core of these actions organized within the CoI framework considered as significant to support the effective conduct of training courses and mainly solved organizational complexity and managerial responsibilities problems that usually occurred during the first introduction of users in a VW. This distinction clearly indicates that VWs can be transformed into innovative educational platforms where students may strengthen algorithmic skills, and on this notion created a common ground for positive implications that can be used in future-driven workshops.

5. CONCLUNDING REMARKS

In this study we tried to measure the effect of SP correlation with the CP and TP that governed in a VCoI. The results have shown that the SP was significantly correlated with the CP and the TP. These correlations brought a thought that a linking part between performance and the “sense of belonging” to a VCoI is particularly important when group members utilize artifacts and tools in a 3D VW. Although, in the end results it should be reflected not only to all members increased performances, but at the same time to the performance of each student that it was also independently increased. Furthermore, the interaction among members (SP) seems to be directly correlated with the CP by determining the exploration, collaboration, teaching plan organization and construction knowledge from community members. Currently, this becomes more peculiar for further enhancement of the novelty and the contribution of a VCoI focused on students’ interactions in a 3D multi-dimensional environment.

Finally we can understand that the success of a VCoI can be primarily considered as valuable due to the formation of a well-structured and multi-factorial framework analysis of users’ interactions that can lead to the refinement of the cooperation, communication and community members’ engagement. From a theoretical applied-teaching level, the main socio-cognitive approach was achieved by studying three interrelated presence indicators, as it has been successfully presented by a substantial number of other scholars and academic researchers [2] [31]. Additionally, based on the findings of the small sample of a single school-with an age-homogeneous, but also heterogeneous on their cognitive domain (specifically in algorithmic thinking); we can truly believe that the framework of presence indicators can give a first-impact and special emphasis on the role of students’ interactions in 3D VWs. Nevertheless, it should be noted that these preliminary findings of this study unveiled to front serious pedagogical issues, such as the sense of sociability, interactivity and team collaboration (namely as the principles of the SP) that developed among students which can contribute and serve new forms of presence indicators and their impact in a VCoI.

Inevitably, some notable limitations that should be considered when interpreting the current findings are as follows: (a) the sample size was voluntary (81, i.e. 86.5% correspondents of the total 94 students) from the Greek Secondary School in Evia with up to middle response; (b) the availability of the current lesson was limited only in two weeks; (c) this study was deployed and students were taught with a systematic support in a blended session, and teacher’s feedback was sufficient and daily; and (d) the students’ characteristics may differ from other schools, and thus the results of the present study cannot be generalized.

According to the aforementioned reasons indicative future studies will seek to answer several queries about the predisposing factors that might affect collaborative learning processes in a VCoI and investigating further the predictive association of presence indicators with the students’ motivation, metacognition, and engagement factors (cognitive, behavioral, and affective).

6. REFERENCES


