Open Sim and Sloodle integration for pre-service foreign language teachers’ continuing professional development: A comparative analysis of learning effectiveness using the CoI model

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Abstract
A considerable interest in using three-dimensional (3D) multi-user virtual worlds for different educational disciplines has been widely observed. Despite the potential benefits of this technology, many questions still remain open, with the respect to the design activities in well-defined instructional design frameworks and their effectiveness on learning gain, with regard to pre-service foreign language teachers’ interactions. In this study, the results of three activities are presented, including foreign language teachers’ continuing professional development by blending Sloodle and Open Sim in order to develop and to learn basic concepts that are related to information technology literacy. Three learning activities of different classes were designed and carried out by one hundred thirty-five (n=135) pre-service foreign language teachers’ CPD, using CoI presence indicators (i.e. cognitive presence, teaching presence and social presence) as constructs of a theoretical framework, firstly to develop a constructivist instructional design approach and secondly to develop low-cost virtual learning environments. The study findings proved no significant variation between the pre-service teachers’ learning outcomes based on their different roles and their secondary education curriculum (i.e. school stream). A persistent pattern of high learning gain was identified, regardless of the activity’s class and learning goals which were held in Sloodle and Open Sim.

Keywords: Continuing professional development, CoI model, Instructional design framework, Open Sim, Sloodle
1. Introduction

Teachers’ continuing professional development (CPD) is defined as the process of maintaining and enhancing knowledge, according to the needs of their personal professionalism that can be provided in several training sessions using digital-oriented environments (Seezink & Poell, 2010). Nowadays, it is a common belief that CPD should provide teachers (pre-service or in-service) with new technological literacy skills using digital technologically-advanced environments, so that their instructional design development can respond to the demands of tomorrow’s educational practices (Huang et al., 2011). Specifically, the failure to prepare pre-service teachers in using innovative Web-based or Information and Communication Technologies (ICT) transactions has become a major problem. By integrating ICT transactions into pre-service teachers’ training, learning through situated social practices can be facilitated when it is based on their prior knowledge in a process of meaning-making and through a range of training modes (Kress & Selander, 2012).

Various instructional and technological obstacles for pre-service foreign language teachers’ CPD can be identified. Firstly, from an instructional perspective these are: a) lack of main instructor’s support in teachers’ training using contemporary Web-based sources or transactions (Singhal, 1997) and b) lack of technological infrastructure for users’ interaction in a common environment. This situation may negatively impact their participation without utilizing a-/synchronous communication tools (Correa et al., 2001). There are three typical problems that inhibit the successful interaction of teachers in utilizing online digital communities: a) lack of active membership contributions in online discussions (MacDonald & Poniatowska, 2011), b) lack of trust that may hinder communication among users in online communities (Kling & Courtright, 2003) and c) lack of users’ incentives. These can cause
misunderstandings of the content material, having no one to ask for help, and taking other priorities to fulfill (Dennen et al., 2005).

Secondly, from a technological perspective, many instructional technologists have described several problems that e-learning systems have. Some of the most crucial are the following (Callaghan et al., 2011; Cho et al., 2015; Wang et al., 2014):

a) lack of interaction, because many times the only available interactive activity is to click on “next” or “back” button of a web browser in order to get the learning material, b) lack of challenging activities can bring users’ dissatisfaction or disengagement at higher levels during the learning process, due to knowledge acquisition via unattractive text-based learning materials, c) lack of users’ awareness, when they expect to control the learning process, and lastly d) lack of social identity, when users are often spatially isolated from their peers, reducing the feeling of collaboration.

With the reconstitution and the enhancement of teachers’ CPD using candidate digital-oriented platforms and supporting online or blended instructional formats, many challenges have recently been raised. These challenges have brought a crucial extension to the educational and pedagogical results that enable teachers to develop an innovative knowledge domain to acquire technological literacy skills that are needed to align with the needs of the 21st century. In recent years, an active research interest in using Web applications of the second generation (Web 2.0), such as weblogs (blogs), wikis, and three-dimensional (3D) multi-user virtual worlds has also appeared. With these demands, instructional technologists and scholars need to rethink alternative options for the assimilation of the experiential knowledge in two-dimensional (2D) Learning management Systems (LMS) or 3D multi-user virtual worlds (Cho et al., 2015; Kallonis & Sampson, 2010). Previous studies’ results (Cho
et al., 2015; Kennedy-Clark, 2011) have come to the agreement that 3D multi-user virtual worlds have offered pre-service teachers increased learning opportunities and through this method supported their CPD.

Many pre- or in-service teachers do not have experience in 3D multi-user virtual worlds. As a result, they drop out from training sessions due to the negative cognitive overload (i.e., steep learning curve), which can appear during their introduction. In order to overcome this obstacle, a growing body of literature (Callaghan et al., 2011; Pellas & Kazanidis, 2014b) has already suggested alternative opportunities for interactive tasks by combining Moodle and Open Sim, with Sloodle (Second Life and Moodle) as a free plug-in module. The utilization of open source systems, like Moodle or Open Sim through Sloodle can expedite and more easily propose the fruitful execution of online collaborative courses, although transferability and interoperability issues in pedagogical and technological perspectives for teachers’ CPD need further investigation (Cho et al., 2015; Comas-Quinn et al., 2012).

Numerous studies (Callaghan et al., 2011; Kallonis & Sampson, 2010; Pellas & Kazanidis, 2014b) have used Sloodle’s tools, whilst there was little discussion about the effectiveness of an appropriate collaborative instructional design framework for pre-service teachers’ CPD in order to explore and implement innovative and contemporary learning methods for the development of 3D low-cost virtual learning environments.

To date, foreign language teachers’ CPD can be achieved meaningfully not only by utilizing technologically advanced environments, but also by implementing learning scenarios in well-designed instructional scenarios (Borg, 2003; Wang et al., 2014). The integration of innovative digital environments in CPD can provide purposeful aspects to the teaching and learning processes following constructivist-
oriented instructional frameworks. Nevertheless, pre-service teachers also need to be convinced of the great importance of creating instructional design frameworks and incorporating them into innovative learning environments (Slagter & Schwartz, 2012). During the last decade, previous studies (Akyol & Garrison, 2010; Arbaugh, 2004; Junco, 2011) have provided the effectiveness of learning in online environments, Web 2.0 social networking environments and in 3D multi-user virtual worlds (Burgess et al., 2010; Pellas & Kazanidis, 2014b; Traphagan et al., 2010) using community of inquiry (CoI) model presence indicators as components of a theoretical framework for the development of an organizational-instructional design framework with positive learning outcomes.

The CoI model consists of three presence indicators (Garrison et al., 2000): i) the cognitive presence (CP); ii) the social presence (SP); and iii) the teaching presence (TP). This model has been developed in furtherance of describing in detail the complex users’ interactions in collaborative and constructivist-oriented learning processes via digital (on-line) environments (Garrison et al., 2000). Despite the potential use of the CoI model in several online learning processes (Garrison et al., 2010; Joo et al., 2011), the verification, development, and acceptance of a theoretical framework of this model are today unknown, with a purpose of analyzing users’ interactions in 3D multi-user worlds. It is also important to mention the appropriate relationship among motivational and learning variables based on the CoI model presence indicators (Pellas & Kazanidis, 2014b). These are fundamental for teachers’ CPD, firstly because it can positively influence the acquisition of user’s motor and verbal skills, improving the retention and transfer of these skills beyond the initial learning situation, and secondly because they can enhance the educational activities, something that also increases their professionalism.
This study follows Garrison’s et al. (2000) statement. The authors of this study have previously underlined that without a well-structured instructional framework for support, collaborative activities in online settings may lack progress and direction, causing several misunderstandings or even conflicts of interest to all users. Few studies (Burgess et al., 2013; Pellas & Kazanidis, 2014a) have represented the learning situations through which users’ interactions can enhance the learning effectiveness using the CoI model, following a blended instructional format in 3D multi-user virtual worlds. Little research integrates the CoI presence indicators as components of an instructional approach into the context in blended synchronous learning environments (Szeto, 2015). In addition, it remains unknown whether pre-service teachers’ roles as users based on their activities affects their learning gain using Sloodle and Open Sim. Furthermore, pre-service teachers’ stream may also affect their learning gain differently because each one has a different manner of thinking.

This paper seeks to investigate:

- pre-service foreign language teachers’ learning gains after their intervention in learning activities using the 3D multi-user virtual world of Open Sim and Sloodle,
- whether pre-service foreign language teachers with lower pre-test scores benefited from the activity at least to the same extent with pre-service teachers that had higher pre-test scores,
- whether pre-service teachers’ learning performance was affected by their secondary education stream, and
- whether pre-service foreign language teachers’ learning performance was affected by their different assigned roles.
The present study has developed an organizational-instructional design framework based on CoI model presence indicators. This study was directed to explore the comparative perspectives about the effectiveness of Sloodle and Open Sim as a unique 3D web-based platform for pre-service foreign language teachers’ CPD, using the CoI model as theoretical framework. Thence, the following questions need to be answered:

- Did the activities conducted in Open Sim combined with Sloodle improve pre-service foreign language teachers’ performance?
- Did pre-service foreign language teachers with lower pre-test scores take benefits from the activities at least to the same extent as others with higher pre-test scores?
- Did pre-service foreign language teachers’ roles in the learning tasks, using Sloodle and Open Sim affect their learning gain?

2. Theoretical Underpinnings

2.1. The Community of Inquiry (CoI) model

Buraphadeja and Dawson (2008) have mentioned three models for the analysis of users’ interactions in order to describe educational processes, by utilizing online digital environments (i-the model of content analysis of Newman, Webb and Cochrane, ii-the model of Interaction Analysis of Gunawardena, et al. and iii-the CoI model of Garrison, Anderson and Archer). The Garrison et al. (2000) model was stated by the same authors as the most appropriate for analyzing users’ interactions, because of the following reasons: (a) the current literature has recognized the contribution of the CoI model, in terms of creating a valid organizational-pedagogical framework for the investigation of users’ interactions in communities (Arbaugh et al., 2008), (b) previous models have only offered the analysis of users’ endogenous
interactions, but a theoretical framework for the development not in well-organized instructional contexts, in contrast to Garrison’s et al. (2000) model and (c) the role and purpose of a theoretical framework was not indicated in previous models in order to describe the context of teaching and learning activities, based on constructivist pedagogical underpinnings (Pellas & Kazanidis, 2014b). The CoI model presence indicators are focused on the construction of knowledge as a result of teamwork and interaction among active participants (CP) using an instructional-organizational framework in an online digital environment (TP). The meaningful knowledge acquisition is delivered within a collaborative climate among all members (SP). TP is the main instruction that can facilitate the teaching process, where participants can express their opinions with a view of having valuable conclusions for the community’s cohesion (De La Varre et al., 2011). SP represents the interactive participation of all members, having a positive effect on users’ interaction and taking place in a functional collaborative environment (Gunawardena, 1995). CP is regarded as the core of the constructivist learning process and it is focused on the outcome of the investigation through an ongoing argument that affects the entire community (Garrison et al., 2000). This model aims at designing and analyzing educational activities in online environments which are focused on the development of a community of inquiry. It includes three interrelated components (Garrison et al., 2000): i) the content, ideas, arguments or opinions of members (CP), ii) interaction among members (SP) and iii) users’ roles and teaching initiatives from the instructor (TP) to conduct with his/her trainee users.

Notable studies that implemented the CoI model using LMS have revealed the following fundamental results:
(a) Shea and Bidjerano (2010) have utilized the CoI model, in order to describe and to explain differences for the anticipated outcomes using hybrid and fully online course delivery methods. They found that the CoI model is relevant for measuring users’ (students and instructors) interactions regardless their gender or age. It was also proved that users who participated in hybrid course delivery methods provided higher levels of social presence, compared to those who participated in fully online.

(b) Gorsky et al. (2012) have made a comparative study that analyzed users’ behaviors in blended sessions and presented their positive attitudes in different collaborative tasks.

(c) Garrison et al. (2010) have examined the interaction among the constructs of presence indicators and alternative learning disciplines that make more understandable other sub-categories of main presences.

(d) Joo et al. (2011) have proven that learners’ satisfaction and their persistence in the learning process are considered as critical factors of success for online university-level programs.

Besides the existing utilization of a digital-oriented environment, Joo (2011) has suggested that social, organizational and cultural factors of the learning context using the CoI model are the most important elements for the effective use of 2D asynchronous learning environments in educational practices and not the intermediary technology itself. Additionally, Akyol and Garrison (2010) have indicated that activities in online learning environments are not successful if there is no proper instructional framework, and familiarity with this technology as well is regarded. Findings from other studies (Szeto & Cheng, 2014; Szeto, 2015) have indicated that social and emotional connections using CoI model cannot be taken for granted;
however, they are necessary for teachers in order to encourage and foster their engagement in blended synchronous learning environments.

2.2. Using the CoI model in 3D multi-user virtual worlds

3D multi-user virtual worlds have generally provided serious opportunities for the implementation of instructional formats. Thence, a widespread need to measure factors that may affect user’s engagement has always appeared. Based on the above, Burgess et al. (2010) have used the CoI model for an exploratory study in Second Life and in a “Multi-User Virtual Environment Education Tool” (MUVEET), for the observation and assessment of the perceptual data among graduate students. Both the CoI instrument and MUVEET survey results have shown that experienced participants were easily involved in a community of inquiry that was held in Second Life.

In the Traphagan et al. (2010) study, the CoI model was used in contemplation of comparing the nature of learning experiences in Second Life and in another text/voice-based learning environment without graphics (TeachNet). By utilizing a mixed method of frequency code and graphic consistency, the results of cognitive codes indicated that students’ discussions inside TeachNet were at high levels and that the cognitive presence (CP) was at higher levels than in Second Life. However, it seemed that students were able to reduce their cognitive load by using built-in tools and a-/synchronous communication tools, such as voice and text chat. Lastly, from a pedagogical-psychological perspective, Pellas and Kazanidis (2014b) have studied the answers of one hundred thirty-five (135) participants who participated in several online sessions through Second Life, and they have revealed that situational interest was the only significant predictor of SP. However, a major obstacle occurred if the context and objectives of the activity could not be well-defined and could not promote
communication among users using 3D multi-user virtual worlds (Dalgarno & Lee, 2011; Pellas & Kazanidis, 2014a). Learning and teaching processes should not have an impersonal nature, and the strict faceless character must be avoided so that users can adequately explore the in-world learning material as members of a community. Social interactions in well-designed learning tasks must include the basic principles of e-Education, like cooperativeness, trust, community’s cohesiveness and mutual support for their activities.

2.3. Potential benefits of using 3D multi-user virtual worlds in education

The use of 3D multi-user virtual worlds in e-Education cannot be limited simply to the use of tools that may facilitate only communication among users (in synchronous or asynchronous channels). The creation and implementation of an instructional design framework in 3D multi-user virtual worlds can generate an additional advantage to the conventional web-based technologies, promoting easier users’ interaction in a common online persistent environment. The potential benefits of using 3D multi-user virtual worlds in education are the following (Dalgarno & Lee, 2010; Pellas & Kazanidis, 2014a):

(a) 2D environments have spatio-temporal drawbacks in their digital contexts, in which all users can communicate only asynchronously via text-based forms in a faceless window-based environment. On the contrary, 3D multi-user virtual worlds have provided the opportunity for (a/-) synchronous, real-time interaction of all users in a common 3D virtual environment. 3D multi-user virtual worlds provide a high level of accuracy and representational fidelity for the illustration of realistic situations. Thus, users can take the appropriate feedback from their instructor or other team members in real-time, in pursuance of solving a problem at the time that is observed in online settings, and not only in class supported (face-to-face) settings,
(b) the variety of interactive activities that emerge in a 3D persistent multimedia environment can lead to a simultaneous co-existence of users, on the part of implementing visually-rich simulations/experiments. These approaches can be enhanced through realistic metaphors or artifacts that combined for the implementation of simulations, in which knowledge acquisition is based on social dynamic interactions that can improve the learning process,

(c) the synchronous real-time activities, the feedback from other peers or the instructor, and the flexibility of time and space sense for the execution of different learning tasks according to users’ needs or demands, are regarded as significant issues that are missing from the other simulation-based environments,

(d) a/-synchronous communication tools (VoIP, IM for verbal, or chat text, gestures for non-verbal) promote the development of learning tasks at a distance. This is already well-known to users who play other 3D multi-user role-playing games or environments (MMORPGs), as they study with others cooperatively from all over the world,

(e) the metaphors of visually-rich abstract concepts can assist real functional needs, which cannot have a persistent continuity or replicate real life’s settings, because of the spatial or space constraints in 2D settings. On the contrary, the sense of co-presence in 3D multi-user virtual worlds can allow distributed (or not) users to study remotely in the same virtual environment (grid) so that users will not be passive receivers of instructor’s information or observers of others’ experiments. Users can participate in experiments or simulations with others in a common virtual place, they are engaged in these tasks without unreasonable financial cost, and they can also avoid dangerous complications which often occur in real life.
Many research findings (Comas-Quinn et al. 2012; Lan et al., 2013; Wigham & Chanier, 2015) have shown that 3D multi-user virtual worlds are of great value for foreign language courses, because of the following differences from other candidate platforms: (a) can encourage the reflective learning of all group members constructivist-oriented instructional formats; (b) can enhance users’ cognitive skills (analysis, evaluation and creation) and higher-order thinking skills in collaborative activities; (c) can promote the change from superficial to deeper learning in order to facilitate the knowledge acquisition process. As a result, 3D multi-user virtual worlds can contribute to the development of technological skills that are cultivated in learning platforms for the implementation of different instructional approaches in foreign language courses.

More specifically for teachers’ CPD, Kennedy-Clark (2011) has presented pre-service teachers’ views on the potential advantages, benefits, problems and other issues of using 3D multi-user virtual worlds in a classroom setting. Advantages were mainly focused on visualization, interactivity and collaboration which can enhance users’ motivation and participation. A six-dimension affordance model supporting the paradigm of experiential learning for the implementation of collaborative constructivist-oriented courses was proposed by Gamage et al. (2011). It seemed that teachers’ training based on role-play scenarios and issues like the dimensions of flow, awareness and co-presence, emotional connection in authentic or 3D artificial experiences positively affected their engagement. Although the encouraging results and the increasing utilization of 3D multi-user virtual worlds for collaborative learning activities are really significant, the question remains open as to how effectively they can be integrated into the educational process and what are the learning gains (benefits) for the pre-service teachers’ CPD.
2.4. Open Sim and Sloodle configuration

The most recent “conventional” educational practices using 2D LMS or MOOCs (Massive Open Online Courses) in Higher education are primarily based on the oral or written forms of communication for the knowledge acquisition. Knowledge of different disciplines that include answers to theoretical problems are usually transferred by the main instructor, who acts as an “expert” on the one side, while one the other users cannot recall or take the appropriate feedback in real-time.

The highest response of Open Sim’s functionalities can contribute to the collaboration of distributed users (Berns et al., 2013). The common belief of instructional designers is related to certain characteristics which are the following: (a) the low cost of creating a learning context in contrast to the use of Second Life, (b) the virtual grid that can be easily modified by any authorized user at any time, (c) the use of a standalone mode offers portability and transferability, so users can have a “back up” of their items in a common virtual environment allowing them to share everything with other teammates and (d) the macroscopic and microscopic configuration of visual and realistic objects, primitives or artifacts.

Sloodle (Sloodle=Simulation Linked Object Oriented Dynamic Learning Environment) is a software package which integrates the Moodle web-based virtual learning environment and the 3D virtual world platform of Second Life or Open Sim. It contributes to the combination of Moodle and Open Sim in a blended 3D/web virtual learning environment as a free plug-in. Many studies (Callaghan et al., 2011; Kemp et al, 2009; Pellas, 2014a) have utilized it for different courses as a candidate learning platform for the following reasons:

- Moodle's web-based tools (e.g. Web-intercom, Quiz chair, Registration booth, Toolbar and Presenter etc.) can be used to support in-world classes
• Open Sim can be used to promote engagement and immersion in practice-based activities within Moodle’s online course activities.

The conjunction of Sloodle with Open Sim can be defined as an open source virtual learning environment, in which users develop, share, and create visual tools for educational purposes, making the “knowledge transfer” easier. The establishment of their use as candidate platforms in the last decade is combined with the realistic depiction of real life situations that can be a further inspiration for creating learning scenarios.

2.5. The combination of Open Sim and Sloodle

The virtual platform of Open Sim (OS grid) was entirely produced on a single Open Simulator server (standalone mode). The persistent database SQLite supported our research with the assistance of Freeswitch\(^1\) voice server in the interest of promoting verbal and non-verbal communication among members. The standalone mode was kept in order to protect and block away any misbehaving user, but the staff was free to conduct and teleport to other regions, for collecting the appropriate learning material (Figure 1). As can be observed in Figure 1 below: i) the main instructor was responsible for the progress and time schedule of the entire process, ii) all participants (pre-service teachers) engaged in different activities via Open Sim and Sloodle, and last but not least iii) the main researcher created and distributed the virtual tools or artifacts which became beneficial not only for the development of low-cost virtual learning environments, but also for teachers’ CPD.

\(^1\) [http://opensimulator.org/wiki/Freeswitch_Module](http://opensimulator.org/wiki/Freeswitch_Module)
Based on the above, before users’ first-time entry, it was necessary to demonstrate all required learning grids for experiential learning. The pre-constructed spaces were important not only for the life cycle of a community of inquiry, but also for the successful construction of projects (Pellas, 2014b). In this notion, the risks are minimized and interactive applications are produced that enrich users’ perspectives during the further process. In this phase, four different workplaces are proposed for the knowledge acquisition in a 3D multi-user “open source” virtual world (Table 1):

Table 1: Virtual workplaces in an Open Sim standalone server

<table>
<thead>
<tr>
<th>Name of grids in an Open Sim standalone server</th>
<th>Purpose of using virtual grids</th>
</tr>
</thead>
<tbody>
<tr>
<td>The meeting grid</td>
<td>The meeting grid had an ergonomic design for all pre-service teachers, during their first time entrance in order to collaborate with their teammates and utilize Sloodle and Open Sim transactions.</td>
</tr>
<tr>
<td>The instructor’s grid</td>
<td>The instructor’s grid was the virtual environment in which pre-service teachers took feedback and support from the main</td>
</tr>
</tbody>
</table>

Figure 1. The architecture function of the connection between Open Sim (OS grid) and Sloodle
instructor to create their virtual learning environments.

<table>
<thead>
<tr>
<th>The collaboration grid</th>
<th>The collaboration grid was designed for all users and it was specifically used to assign all pre-service teachers’ roles before the beginning of the project.</th>
</tr>
</thead>
<tbody>
<tr>
<td>The simulation grid</td>
<td>The simulation grid was the virtual place in which all teachers learned how to use virtual artifacts and built-in tools of Open Sim in order to collaborate a-/synchronously with other team members to create and design their virtual learning environments.</td>
</tr>
</tbody>
</table>

The main goal of utilizing interactive visual artifacts was imperative to optimize the learning process, so that support teachers: a) firstly to construct low-cost virtual learning environments and implement collaborative learning scenarios into them, based on well-designed instructional formats, and b) secondly to coordinate and evaluate collaborative tasks based on users’ interactions. Open Sim grid in a “standalone” mode, was not equipped with the appropriate tools (apart from these that a client viewer offered) and it was not sufficient as a virtual environment for constructivist learning activities. Users should take advantage of the Open Sim grid scripting language (OSSL) or the construction of primary virtual artifacts. Below, Table 2 presents two separated lists. The first one is for Sloodle’s modules and the second one for visual artifacts. These tools are to be implemented during the implementation of the CoI model in Open Sim (Table 2):

**Table 2: Sloodle modules and virtual artifacts**

<table>
<thead>
<tr>
<th>Sloodle Modules</th>
<th>Virtual Artifacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Web – intercom. A chat – room can combine Moodle’s chat room and Second Life (or Open Sim) text-based chat in order to communicate together all users asynchronously.</td>
<td>Presentation Board: It is the main board in which users can present their work to other members by uploading JPEG or video files.</td>
</tr>
<tr>
<td>Sloodle Registration Booth. One of the most fundamental tasks of Sloodle, is when a user clicks on the registration booth to log in it with his/her avatar’s name, while he/she is prompted to visit a Moodle registration page simultaneously.</td>
<td>Sticky Dashboard: This dashboard helps students to stick colored note cards and remember exactly what they need to do.</td>
</tr>
<tr>
<td><strong>Sloodle Modules</strong></td>
<td><strong>Virtual Artifacts</strong></td>
</tr>
<tr>
<td>-----------------------------------------------------------------------------------</td>
<td>----------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Multi-function Sloodle Toolbar. It includes a range of gestures and it allows the main instructor to get a list of users’ names from Moodle to Second Life (or Open Sim).</td>
<td>Interactive touch screen: This in-world screen presents students’ machinimas (editing video that present in-world educational activities).</td>
</tr>
<tr>
<td>Postcard Blogger. It is an additional plug-in that users have to send photo as “postcards” from Second Life (or Open Sim) and text to other members automatically when they uploaded something in Moodle.</td>
<td>Joystick: It is a multi-touch tool that allow users to simultaneously control two screens, one that they upload machinima video and another one that can be configured according to their daily announcements.</td>
</tr>
<tr>
<td>Quiz chair &amp; Pile-on Quiz. The quiz tools assist the instructor to provide quizzes in Moodle and then to present them in the 3D environment.</td>
<td>Light pen: It is a simple visual highlighting pen that the main instructor uses to write in the announcement board.</td>
</tr>
<tr>
<td>QuizHUD: The QuizHUD provides a web-based authoring environment for the creation of educational content in Second Life and a user-interface HUD (Head-up Display). Students can explore custom built-in tools of Open Sim in order to learn about aspects of this environment by clicking on objects or artifacts. Quizzes can be built which include mixtures of multiple choices questions (answered using tabs on the QuizHUD object itself) or questions that can be answered by identifying and clicking on objects in the 3D multi-user environment.</td>
<td>Tablet: Student’s tablet is a personal calendar and storage of activities for each teacher. Open Sim grid docs: Almost all pre-service teachers already knew and worked with Google docs, as they wanted to create a source that is connected to the Internet (a “copy-paste” process from the note cards).</td>
</tr>
</tbody>
</table>

Many activities have designed in order to depict ways of collaboration, according to the provided figure (Fig. 2).
2.6. CoI model as a theoretical model for the development of an instructional design framework

In this study, CoI presence indicators are proposed for the development of an instructional design framework. SP was initially implemented, so that users could create their virtual learning grids by utilizing visual artifacts of Sloodle and Open Sim in the direction of introducing themselves to exchange ideas, comments or questions. Interaction among users was encouraged through team-based presentations of their work and weekly postings in Sloodle that required responses to virtual class members. In-world team-based presentations in which four to five participants took part via face-to-face and online applications, required a collaborative study and the use of a/synchronous communication tools.

CP was promoted through challenging and appealing projects that required critical thinking and collaboration among users with a view to proposing their

Figure 2. Virtual learning workplaces and visual artifacts
structures. Course activities were carefully chosen, so that users could be engaged in the course content. As was previously described, the group presentation provided instructions for the introductory investigation of creating different virtual learning environments. Pre-service teachers studied their topic and chose which artifacts and materials were beneficial to learning. On the Sloodle page, the team described three applications, the personal benefits of using each program, and how the programs could be used in different content areas of instruction. Weekly Sloodle postings related to users’ opinions were provided. TP was established by organizing the course into weekly learning sections in face-to-face and online settings that were announced through Sloodle. Other links included user’s feedback, technical help, weekly notes, and communication tools. All participants were asked to create their own page in Sloodle.

Feedback was also provided with all course-related questions or problems and it was usually given via Open Sim via chat text or VoIP tool from the researcher and the main instructor. Each presence is responsible for a specific instructional aim, by involving various types of learning activities and having intended instructional effects (see Table 3).
Table 3: The intended instructional effects of the three presence components

<table>
<thead>
<tr>
<th>Coding scheme of a CoI model</th>
<th>Presence indicators</th>
<th>Instructional phases</th>
<th>Collaborative learning process in constructivist-oriented settings</th>
<th>In-class (face-to-face) and online learning modes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teaching presence</td>
<td>Instructional management</td>
<td>- Assign students’ roles with the learning material in Open Sim.</td>
<td>- Team discussions of exercises and practices by constructing and predicting artifacts’ behaviors to complete their tasks required.</td>
<td>- Open discussions to share or propose solutions to a problematic learning situation.</td>
</tr>
<tr>
<td></td>
<td>Building understanding</td>
<td>- Introduction to the learning activity and his/her facilitation role was announced.</td>
<td>- Team-based problem-solving exercise in each team are provided to complete “fading scaffolding” tasks in which the main instructor tried to be abandoned and let students free to execute and correct as possible as they can their programming structures.</td>
<td>- Project formative assessment by firstly main instructor and secondly by reconstruction of the codes from the team (real-time feedback was provided).</td>
</tr>
<tr>
<td></td>
<td>Direct instruction</td>
<td>- Instructors’ final decision for accomplishing in-world problem-based learning tasks each team collaboratively in real time.</td>
<td>- Final team-based reports/presentations are announced.</td>
<td>- The main instructor should conducted with team members regardless the different modes in which he/she attended (online or face-to-face).</td>
</tr>
<tr>
<td>Social presence</td>
<td>Emotional expression</td>
<td>- Team-based conversations and decisions that should be provided in the learning task.</td>
<td>- Team-based conversations and decisions that should be provided in the learning task.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Open communication</td>
<td>- Introduction to the main collaborative course plan.</td>
<td>- Introduction to the main collaborative course plan.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Group cohesion</td>
<td>- Formalization of each team instructions (students had different socio-cognitive background).</td>
<td>- Formalization of each team instructions (students had different socio-cognitive background).</td>
<td></td>
</tr>
<tr>
<td>Cognitive presence</td>
<td>Triggering events</td>
<td>- Decision processes using students’ computational thinking and their higher order skills as the time (30 minutes to finish each programming structure, i.e. sequence or conditional statements) to be finished exercises that pressed them. They should use different programming structures to complete the task.</td>
<td>- Decision processes using students’ computational thinking and their higher order skills as the time (30 minutes to finish each programming structure, i.e. sequence or conditional statements) to be finished exercises that pressed them. They should use different programming structures to complete the task.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Exploration</td>
<td>- Firstly, they should use sequence of structures and then try to combine artifacts using Sloodle’s tools.</td>
<td>- Firstly, they should use sequence of structures and then try to combine artifacts using Sloodle’s tools.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Integration</td>
<td>- Back to other team members and initial results presentation should be presented to receive instructor’s feedback</td>
<td>- Back to other team members and initial results presentation should be presented to receive instructor’s feedback</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Resolution</td>
<td>- Members’ report presentation to the entire virtual class via Sloodle and Open Sim.</td>
<td>- Members’ report presentation to the entire virtual class via Sloodle and Open Sim.</td>
<td></td>
</tr>
</tbody>
</table>

The instructional design approach includes three instructional components that are delivered from the teaching, social and cognitive presences focused on users’ interactions. These components were used in order to promote communication and to
facilitate users’ participation in the blended synchronous mode. All participants tried to create a low cost virtual learning environment collaboratively for foreign language courses. Also, the final products were shared to other teachers on the basic Moodle web page. Pre-service teachers requested to use all tools of Sloodle.

3. Method

3.1. Setting

The purpose of this study was to investigate possible differences of pre-service foreign language teachers’ learning gain (if any) through the three activities that were implemented in Sloodle that was combined with Open Sim. A one-group pretest–posttest design was adopted by Oncu and Cakir (2011), study for measuring the learning gain as a result of pre-service foreign language teachers’ CPD in three activities. All courses offered as a seminar took place in a Greek school for pre-service foreign language teachers.

3.2. Participants

One hundred thirty-five (n=135) were all pre-service foreign language teachers who were also the participants of this project.

Forty-five (n=45) pre-service foreign language teachers, aged 30–35 (M=34.2, SD=3.8) years old participated in the first activity. Instructors were attended to a non-compulsory academic course entitled as "Introduction to 3D open source/multi-user virtual worlds".

The second activity involved forty-five (n=45) pre-service foreign language teachers, aged 35–40 (M=37.2, SD=2.7). Participants were attending a compulsory course, titled "Introduction to the development of low-cost virtual learning environments".

Forty-five (n=45) were also pre-service teachers, aged 40–45 (M=42.4, SD=3.2)
who finally participated in the third activity.

Table 4 presents participants’ demographic-related information in this dataset more analytically. It is also crucial to be mentioned that participants (pre-service foreign language teachers) had different cognitive background and were separated according to their degrees as follows: a) English pre-service teachers, b) France pre-service teachers c) German pre-service teachers and d) Italian pre-service teachers.

Table 4. Participants’ demographic-related information

<table>
<thead>
<tr>
<th></th>
<th>1st activity using Moodle</th>
<th>2nd activity using Open Sim</th>
<th>3rd activity: Evaluation of the CoI model effectiveness using Sloodle and Open Sim</th>
<th>All activities</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sample size</strong></td>
<td>45</td>
<td>45</td>
<td>45</td>
<td>135</td>
</tr>
<tr>
<td><strong>Age</strong></td>
<td>Mean 38.3</td>
<td>36.3</td>
<td>33.4</td>
<td>35.3</td>
</tr>
<tr>
<td></td>
<td>Range 30-45</td>
<td>32-41</td>
<td>30-44</td>
<td>30-45</td>
</tr>
<tr>
<td><strong>Gender</strong></td>
<td>Male 23</td>
<td>22</td>
<td>23</td>
<td>68</td>
</tr>
<tr>
<td></td>
<td>Female 22</td>
<td>22</td>
<td>23</td>
<td>67</td>
</tr>
<tr>
<td><strong>Technological Literacy</strong></td>
<td>Low 23</td>
<td>22</td>
<td>23</td>
<td>68</td>
</tr>
<tr>
<td></td>
<td>High 22</td>
<td>22</td>
<td>23</td>
<td>67</td>
</tr>
<tr>
<td><strong>Web-generated environments usage frequency</strong></td>
<td>Almost none 4</td>
<td>6</td>
<td>7</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>Monthly 13</td>
<td>13</td>
<td>13</td>
<td>39</td>
</tr>
<tr>
<td></td>
<td>Weekly 20</td>
<td>10</td>
<td>10</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>Everyday 20</td>
<td>10</td>
<td>9</td>
<td>39</td>
</tr>
</tbody>
</table>

3.3. Treatment

A blended (face-to-face and online) course delivery method is commonly identified as a promising approach for teachers’ CPD, providing the opportunity for users and educators to overcome time and space constraints that may be hindered in the conventional class supported (Kaplan & Haenlein, 2010). Participation was compulsory in the three activities and the last one of the three required mini-projects that were finally presented from pre-service teachers. The treatment was the following: Firstly, instructions for the functionality and transactions of the 3D multi-user virtual world were given to all teachers. Subsequently, pre-service teachers should be familiarized with the Sloodle utilities, so that they could practice on its
functions through collaborative tasks, such as creating, editing primitives and artifacts for the development of a 3D virtual learning environment. They should also discuss and comment others’ peers work document their arguments, and insert and edit photos or videos using Sloodle and Open Sim tools for the construction of virtual prototypes in learning environments. An additional assignment was presented to them in the form of a 3D virtual world for practice-based learning tasks, constructed by the authors. Each environment included the objectives of the assignment, its structure, detailed implementation of instructions, the expected learning outcome, the evaluation criteria and representative support material. The instructors worked in a either remote or face-to-face, before, during and after the assignment deadline. Finally, their work was presented briefly.

Pre-service foreign language teachers were divided into groups. Each group was consisted of four or five members. They were allowed to freely form their groups without any restrictions. Each task was graded by the main researcher emanated from the CoI model questionnaire for measuring the effectiveness of learning gain.

3.4. Instrumentation

The main questionnaire was completed by the pre-service foreign language teachers at the beginning and at the end of each learning activity. It consisted of two parts. One to be collected the demographic information and a second one to be measured the knowledge acquisition of pre-service teachers using CoI instrument. The former was completed before the activity via Sloodle and Open Sim. Personal information of participants was collected regarding Internet, 3D multi-user virtual worlds’ general usage and their first impression and adoption using Sloodle. The second part of the main questionnaire consisted of basic aspects and implications of evaluation of the CoI model effectiveness.
The validated questionnaire that proposed by Swan et al. (2008) was used in this study. Some sub-questions should have the appropriate construct and adopted according to this study’s needs. For example, Swan et al. (2008) questionnaire to be measured: a) CP has the sub-question: “I have developed solutions to course problems that can be applied in practice”. In order to establish a more reliable to this study demands question, it was adopted as follows: “I had the opportunity to think critically and develop solutions in problem-based programming situations that can be applied in practice” b) SP has the sub-question: “Online discussions help me to develop a sense of collaboration” and it was adopted as follows: “Online discussions via Open Sim combined with Sloodle helped me to develop a sense of collaboration with my team in different instructional format (in-class and online)” and lastly c) TP has the sub-question “The instructor helped to keep course participants engaged and participated in productive dialogue” and it was needed to be adopted as follows: “The instructor helped to keep all team members engaged and participated in productive dialogue in Open Sim and Sloodle provide adequate feedback in real time and in the same virtual place”.

The questions of this study were adopted by the CoI instrument and consisted of 34 Likert-scale (from 1=strongly disagree to 5=strongly agree) items: 13 items for teaching presence (TP), 9 items for social presence (SP), and 12 items for cognitive presence (SP) (Swan et al., 2008). This instrument has been tested to establish a reliable measurement for three presences (Arbaugh et al., 2008) and was validated, by using a multi-institutional data set (Swan et al., 2008). This questionnaire is the most important tool to measure the students’ presence indicators and their interaction in a virtual community of inquiry. This questionnaire decided to be the main instrument of this study because: a) it provides a construct validity to all questions, b) its
construction was based on previous studies (Akyol et al., 2010; Garrison et al., 2000) and lastly c) it was used previously for measuring users’ interactions who participated in blended instructional formats (Pellas & Kazanidis, 2014b).

Statistical analyses of the data were performed by SPSS (ver. 22). The respective presence indicators were interested this present study, as bivariate and partial correlation analyses due to (a) the violation of normality assumption and (b) the possible multi-collinearity problems which refuted from high correlations between the presences. Also, to check the reliability of each factorial structure for the three thematic areas, the Cronbach’s alpha ($\alpha$) index was used and calculated prices of presence indicators that considered in satisfactory levels with $\alpha>.07$, $a_{SP}=0.81$, $a_{CP}=0.78$ and $a_{TP}=0.74$, having satisfying levels, according to Singh (2007) recommendations.

3.5. Description of the activities

The design of each activity was proposed, according to CoI model presence indicators that proposed by Garrison et al (2000) study (see Table 3). Pre-service teachers’ learning was expected to be achieved four processes: a) information seeking and retrieval, b) arguments and refinement to support their opinions in the context of the assignment, c) collaboration with other participants and d) their engagement with the 3D multi-user virtual world. Furthermore, in the third activity participants had to evaluate each 3D virtual learning environment, which was an additional learning objective for them. In all activities, the topic was selected because it was a notable part of the course’s overall outline.

The objective of this project was the exploration of perspectives of virtual class-supported prototyping in Open Sim via Sloodle. This process was focused on simplified content creation and collaborative reflection in educational aspects for pre-
service foreign language teachers’ CPD. In this research, took part pre-service foreign language teachers whose common course was titled “Computer Science and ICT services for language learning courses”. Another common characteristic was their willing of studying/implementing constructivist-oriented instructional design frameworks and candidate learning platforms as a means to improve their professionalism and technological literacy. Specifically, the course of this study was titled “Designing collaborative virtual learning spaces and 3D visual prototyping in Virtual Worlds” and focused on the possible use of “Collaboration & Design in Learning” (CDL) processes and results via 3D virtual places and visual artifacts that could be useful to a larger group of users in various teaching and learning processes.

Following TP instructional phases in the first activity (see Table 3), the learning objective was to understand and explore basic concepts of 3D multi-user virtual worlds and Sloodle. Moodle page included four segment topics on which pre-service foreign language teachers relied to accomplish their activity: a) technological background of using Sloodle and Open Sim, b) general information, c) reasons of using Open Sim combined with Sloodle as candidate platforms, and d) potentials for/against their usage.

Following SP instructional phases that provided in the second activity (see Table 3), the learning objective was to understand basic aspects and implications of Sloodle and Open Sim transactions. Several topics on which pre-service foreign language teachers relied to accomplish their activities as community members were presented: a) Moodle’s founders, history and reasons of combing with Sloodle with Open Sim, b) search and development techniques using Sloodle tools, c) the technological infrastructure of Open Sim and d) use Open Sim combined with
Sloodle’s tools as a candidate platform for pre-service foreign language teachers’ CPD.

Following CP instructional phases that provided in the third activity (see Table 3), the pre-service foreign language teachers needed to study and present the most widely adopted usability evaluation techniques to include basic definitions of how effective can become instructional design frameworks in a 3D virtual learning environment, based on users’ interactions. In addition, they had to delineate the required process to carry out an evaluation of CoI model instructional effectiveness. Finally, they had to document their comments about their virtual learning prototypes (i.e. virtual learning environments). All of them needed to explain and rationalize their virtual learning environment as prototypes, when they studied with others in blended instructional formats and finally they evaluated the effectiveness of the learning process.

The first activity required critical thinking or decision making skills. All pre-service teachers had to debate exploring different sides of the Open Sim transactions. The second activity contributed to knowledge acquisition through constructivist-oriented learning processes. The third activity belonged to the third class of contextual applications, in which all of teachers had to apply the rules to begin the assessment process of the CoI model instructional effectiveness.

In all activities, pre-service foreign language teachers need to create their own virtual learning environment, in which they could develop the theme of their assignment. An exemplary web page was constructed in Moodle by the main instructor. The aim was to provide to all pre-service teachers support, by organizing their environment, the material, and by structuring their arguments. All participants need to cover the topics of the exemplary Moodle page, which were organized into
subsections (Figure 1). For each topic or other sub-topics, an indicative outline and specific arguments were given to all teams for developing and supporting materials in their virtual learning environments. Given that the open nature of combination between Sloodle and Open Sim could lead to inappropriate use of content from other sources, it was stressed that usage of others’ work should be followed specific rules. The rest evaluation criteria that adopted in the CoI instrument were relevant to the creation of foreign language virtual learning environments, argument originality and reasoning, compliance with the provided structure and guidelines, material appropriateness using Sloodle and Open Sim transactions.

Before getting involved to this project, all participants should learn how to use all built-in, visual and communication tools of Open Sim. Moodle transactions were already known to all participants. After this, pre-service teachers who participated to all activities were divided as teams of four or five members with four different roles: a) "Material Gatherer", was responsible to observe and organize digital-oriented materials, b) "Coordinator", was responsible to examine the material in exchange of ensuring consistency with the objectives of the entire virtual learning environment, c) "Analyzer" was responsible to compose the basic arguments and learning materials, according to the this project objectives and to configure them on the virtual learning environment produced by the “Material Gatherer” and the “Coordinator”, d) the "Director" was responsible to check the contents of the work in terms of its appropriateness, consistency, completion, structure and compliance with the objectives of the scenario. However, a limitation for each team was to have at least one pre-service teacher with a different degree (i.e. each team should have one English pre-service teacher, one France pre-service teacher, one German pre-service and one Italian pre-service teacher). Pre-service teachers’ identities and roles were
published on the main Moodle page. They were instructed to carry out the appropriate tasks related to their assigned roles. Of course, they could sometimes help others to complete their roles to be succeed their tasks as soon as possible. The questionnaire was shared to all teachers regardless to their primary roles. Figure 3 presents an example of two different virtual learning environments created in Open Sim.

Figure 3: Two virtual learning environments for foreign language courses

During all learning activities the researcher and the main instructor were the facilitators. The instructor had a role to assist not only their first attempt to execute the different code structures, but also to evaluate optically and predict artifacts’ behavior in order to correct the execution of teachers’ actions.

4. Results

First, reliability analysis was conducted and for each activity a learning assessment based on Swan et al. (2011) questionnaire was utilized. Reliability referred to the extent to which the CoI instrument could bring the same results under consistent conditions (Nunnally & Bernstein, 1994). It is most commonly measured using Cronbach’s alpha ($\alpha$), which was a measure of internal consistency. The main CoI questionnaire that was used in both the first and third activities had good internal consistency; $\alpha=0.77$ and $\alpha=0.86$ respectively. This questionnaire was also used in the
second activity; however it did not provide sufficient reliability ($a = 0.67$) to meet the typical minimum standard of 0.70.

Following Nelson et al. (2009), the below normalized learning gain was used and defined as:

$$G = \frac{\text{post} - \text{pre}}{\text{max} - \text{pre}}$$

This equation had the advantage of “normalizing the observed gain (the numerator) against the amount of possible learning that could be achieved (the denominator)” (Nelson et al., 2009, p. 1797). This led to fair comparison of learning gains for teachers with different pretest scores.

Table 5 presents descriptive statistics of the collected dependent variables. Users had similar initial scores, according to CoI instrument and higher scores after taking part in the learning activity using Open Sim and Sloodle achieved (Figure 3).

Table 5. Dependent variables that are assessed in Open Sim combined with Sloodle activity

<table>
<thead>
<tr>
<th>Activity</th>
<th>Pre-test score [0–100]</th>
<th>Post-test score [0–100]</th>
<th>Normalized learning gain [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Activity 1: Using Sloodle</td>
<td>34.7 ± 3.3</td>
<td>43.3 ± 5.1</td>
<td>25.4% ± 11.6%</td>
</tr>
<tr>
<td>Activity 2: Using Open Sim</td>
<td>39.2 ± 1.8</td>
<td>68.7 ± 1.3</td>
<td>29.5% ± 4.0%</td>
</tr>
<tr>
<td>Activity 3: Evaluation of the CoI model effectiveness using Sloodle and Open Sim</td>
<td>48.2 ± 2.7</td>
<td>44.1 ± 7.4</td>
<td>24.2% ± 10.4%</td>
</tr>
<tr>
<td>All activities</td>
<td>42.3 ± 1.8</td>
<td>66.1 ± 3.1</td>
<td>24.7% ± 3.7%</td>
</tr>
</tbody>
</table>

*Mean ± 95% C.I.

An initial analysis was conducted in order to investigate which effects had the activities teachers’ pre-test score, post-test score and learning gain. The assumption of normality was violated for the three dependent variables in at least one level of the
independent variable (Shapiro-Wilk tests, p < 0.01). Levene’s test indicated that the assumption of homogeneity of variance was also violated for both the post-score (F(2,42) = 5.246, p < 0.01) and learning gain (F(2,42) = 4.452, p < 0.01) respectively. Thus, Kruskal-Wallis one-way ANOVA, a non-parametric test was applied. Results showed no significant effect of activity on teachers’ pre-test score (H(2)=5.232, p= 0.064), post-test score (H(2) = 4.120, p = 0.247) and the learning gain (H(2) = 1.002, p = 0.55).

These findings provided the support to conduct analysis on the aggregated cross-activity dataset. Results showed no significant effects on both variables and thus they were excluded from subsequent analysis. In this dataset, a heterogeneity regarding teachers’ gender noted. In all subsequent statistical analyses, effect sizes were calculated according to Field (2009).

4.1. Learning effectiveness of activities in Open Sim combined with Sloodle

A Wilcoxon signed rank test investigated differences between pre-service foreign language teachers’ pre-test and post-test score using the CoI instrument. A non-parametric test was selected to point out the different distribution in dependent variable (test score) between the two related conditions deviated significantly (D(46) = 0.855, p < 0.05) from a normal distribution. Results indicated that pre-service teachers achieved expressively higher (z = 10.698, p < 0.001, r = 0.527) test scores after their participation in Open Sim combined with Sloodle activity. This large effect size (Cohen, 1992) demonstrated the learning benefits of properly designed learning activities in the context of foreign language teachers’ CPD.

In addition, through analysis on a study basis the same pattern was adopted. Wilcoxon signed rank tests showed after Bonferroni correction that pre-service foreign language teachers achieved significantly higher scores, according to the CoI
instrument after teachers’ participation in the first activity ($z = 3.443, p < 0.001, r = 0.366$), in the second activity ($z = 8.792, p < 0.001, r = 0.452$), and in the third activity ($z = 3.772, p < 0.001, r = 0.344$).

4.2. Learning gain for pre-service foreign language teachers with low and high pre-test performance

Table 6 presents dependent variables that were assessed by pre-service teachers through their pre-test scores, based on their initial performance. The dataset was recorded for pre-service teachers’ initial performance, as it was assessed by their pre-test scores. To this end, the following results are presented: pre-service teachers with pre-test score below or equal to the median were assigned in the low pre-test performance condition ($n=70$), whereas the others were assigned a task in the high pre-test performance condition ($n=65$). Post-test scores were similar to users with low (76.1/100) and high (69.6/100) initial performance. However, all participants that had with low initial performance achieved higher learning gain (42.4/100) compared to those who had high initial performance (11.2/100).

Table 6. Dependent variables grouped by pre-service foreign language teachers’ initial performance

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Pre-test score [0–100]</th>
<th>Post-test score [0–100]</th>
<th>Normalized learning Gain [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low initial performance</td>
<td>70</td>
<td>30.9 ± 1.3</td>
<td>76.1 ± 2.5</td>
<td>42.4% ± 2.5%</td>
</tr>
<tr>
<td>High initial performance</td>
<td>65</td>
<td>48.3 ± 1.8</td>
<td>69.6 ± 3.1</td>
<td>11.2% ± 5.6%</td>
</tr>
</tbody>
</table>

*Mean ± 95% C.I.

A two-tailed Man-Whitney U test was used to investigate the effect of pre-service foreign language teachers’ initial performance on their normalized learning gain. A non-parametric test was selected because both the assumptions of normality (Shapiro-Wilk tests, $p < 0.001$) and homogeneity of variance (Levene’s test, $F(1,38) = 5.771, p$
< 0.01) were violated. Pre-service foreign language teachers with low initial performance achieved a significantly higher ($z = 3.357, p < 0.001, r = 0.422$) learning gain compared to those with high initial performance. Considering the entire dataset, a significant negative correlation ($r_s = -0.427, p < 0.001$) was found between pre-service foreign language teachers’ pre-test score and the normalized learning gain.

These findings shown that learning activities using Sloodle and Open Sim might be more beneficial to pre-service teachers with lower initial performance. However, additional studies are required to both verify this finding and amplify as well specific reasons for this outline of learning gain.

### 4.3. Effect of pre-service foreign language teachers’ school stream on learning gain

Pre-service foreign language teachers’ performance according to the stream that they chose in the secondary education’s curriculum is presented in Table 7. The pre-test mean score of instructors who followed the theoretical stream was slightly lower (29.7/100) compared to instructors of the technological or the scientific stream (31.2/100). Pre-service foreign language teachers who had a theoretical background in secondary education achieved lower post-test scores (62.6/100) compared to those that had a technological or scientific background (62.9/100).

**Table 7.** Dependent variables grouped by pre-service foreign language teachers’ education curriculum

<table>
<thead>
<tr>
<th>Education Curriculum</th>
<th>N</th>
<th>Pre-test score [0–100]</th>
<th>Post-test score [0–100]</th>
<th>Normalized Learning Gain [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low level of technological literacy</td>
<td>68</td>
<td>29.7 ± 2.6</td>
<td>62.6 ± 4.4</td>
<td>27.2% ± 4.7%</td>
</tr>
<tr>
<td>High level of technological literacy</td>
<td>67</td>
<td>31.2 ± 3.7</td>
<td>62.9 ± 3.2</td>
<td>30.9% ± 6.2%</td>
</tr>
</tbody>
</table>

Mean ± 95% C.I.
A two-tailed Man-Whitney U test investigated the effect of pre-service foreign language teachers’ school stream on their normalized learning gain. A non-parametric test was selected since the assumption of normality was violated for the group of instructors who attended the theoretical school stream (D(54)=0.781, p<0.001).

Results showed no significant difference (z= 0.731, p=0.465) in the learning gain that achieved by those teachers who attended the theoretical curriculum and those who attended the technological or scientific curriculum.

These findings showed that learning activities using Sloodle and Open Sim were beneficial to all pre-service teachers, regardless their secondary education stream of studies. However, one should be tentative with this finding given that approximately 75% of the pre-service in this study’s sample came from a theoretical school stream.

4.4. Effect of pre-service teachers’ role in the activity on their performance

Table 8 presents instructors’ performance according to their assigned role in the learning activity using CoI presence indicators: Material Gatherer (n=35), Coordinator (n=33), Analyzer (n=33), and Director (n=34).

Table 8. Dependent variables grouped by pre-service foreign language teachers’ roles in learning activities.

<table>
<thead>
<tr>
<th>Role</th>
<th>N</th>
<th>Pre-test score [0–100]</th>
<th>Post-test score [0–100]</th>
<th>Normalized learning Gain [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Material Gatherer</td>
<td>35</td>
<td>37.7 ± 5.6</td>
<td>57.7 ± 3.4</td>
<td>35.9% ± 4.7%</td>
</tr>
<tr>
<td>Coordinator</td>
<td>33</td>
<td>37.4 ± 6.9</td>
<td>56.3 ± 4.3</td>
<td>24.2% ± 8.7%</td>
</tr>
<tr>
<td>Analyzer</td>
<td>33</td>
<td>35.8 ± 5.1</td>
<td>53.5 ± 5.5</td>
<td>24.7% ± 6.5%</td>
</tr>
<tr>
<td>Director</td>
<td>34</td>
<td>36.3 ± 3.8</td>
<td>55.5 ± 3.4</td>
<td>29.1% ± 6.2%</td>
</tr>
</tbody>
</table>

*a Mean ± 95% C.I.*

A Kruskal-Wallis one-way ANOVA test investigated the effect of teachers’ roles on their normalized learning gain. A non-parametric test was selected since the
assumption of normality was violated for the instructors with the role of “Material Gatherer” (D(35) = 0.785, p < 0.001), “Coordinator” (D(33) = 0.891, p < 0.05) and “Director” (D(34) = 0.868, p < 0.05). Results showed no significant effect of teachers’ roles on their learning gain (H(3) = 2.988, p = 0.315). This finding suggests not only that 3D multi-user virtual world-mediated learning activities were beneficial to all teachers, regardless their specific role, but also that the responsibilities of each role were well-distributed.

5. Discussion and Conclusion

In this paper, the results of three activities investigating the effectiveness of 3D multi-user virtual world-mediated learning were presented. One hundred and thirty-five (n=135) pre-service foreign language teachers participated in this study. Evaluation to be measured the learning effectiveness of three activities based on CoI model was carried out using a one-group pretest–posttest design. The results showed significant improvement in learning outcomes, particularly for pre-service teachers with low initial performance. The average pre-service foreign language teachers’ answers in the main questionnaire for measuring CoI model instructional design effectiveness score overlapped from 42.3/100 to 66.1/100. The pre-service teachers with low initial performance (below or equal to the median initial score) indicated an improvement of 35.2 percentage points, whereas pre-service teachers with high initial performance (above-median initial score) showed an improvement of 20.3 percentage points. In addition, in all three activities a comparable and significant learning gain was observed. The persistence of the results strongly indicates that pre-service foreign language teachers learned meaningfully with Open Sim and Sloodle regardless of the activity’s class or knowledge subject.
Moreover, no significant variation between the pre-service teachers’ learning outcome and their secondary education curriculum (i.e., school stream) in the 3D virtual world-mediated activity was observed. Given that all the three activities were both mediated and related to information technology, pre-service teachers who had a technological background were expected to achieve higher learning gain. However, it was found that 3D virtual world-mediated learning activities were beneficial to all teachers, regardless of their previous knowledge and experience.

The existence of a well-designed instructional approach based on the CoI model is recognized as a prerequisite factor for the existence of efficient collaboration among community’s members (pre-service teachers). The role of instructional approach in a socially-oriented 3D virtual learning environment is to describe the instructional workflow for the implementation of collaborative activities under specific theoretical constructivist-oriented underpinnings, consisted to previous findings (Pecka et al., 2014). It remains of course to this day an important issue how an instructional design framework is exploited in 3D virtual environments and how it can assist students primarily on understanding their roles and personal activities and secondarily, a better performance during a collaborative process (Pellas & Kazanidis, 2014a). Furthermore, it was found that learning gain was not related with the teachers’ roles in the activity. This is in line with previous research (Lambert & Fischer, 2013; Shea & Bidjerano, 2009). The study results are also consistent with these of Gamage et al. (2011) who pointed out that benefits in using 3D multi-user virtual worlds for learning by teachers without prior experience could become very positive for their technological literacy. This issue can be suggested as a positive outlook for a wider adoption of this technology in the future.
However, the introduction of roles can help pre-service teachers who worked collaboratively to construct knowledge (Clarke & Bartholomew, 2014) and can also increase cohesion, responsibility and awareness with other group members (Akyol & Garrison, 2008). In contrast, previous studies (Cleveland-Innes et al., 2007; Pecka et al., 2014) have underlined a varying impact of roles on knowledge construction using CoI model.

This paper makes the following contributions related to the effectiveness of technologically-advanced learning activities:

a. Significant and persistent learning gain was found across three activities, according to an instructional design framework proposed by the CoI model and which was used to facilitate pre-service teachers’ CPD.

b. The learning gain was found to be significantly higher for pre-service teachers with low initial achievement compared to pre-service foreign language teachers with high initial achievement.

c. Pre-service foreign language teachers’ roles in the activity did not significantly affect their learning gain.

d. Pre-service foreign language teachers’ stream did not significantly affect their learning gain.

The study findings provide evidence that a 3D multi-user virtual world-based activity with a suitable context and support from Sloodle’s tools freely, can substantially facilitate teachers to achieve higher levels of learning. Given that there is a lack of rigorous studies demonstrating the learning effectiveness of the instructional design model proposed by Garrison et al. (2010), results of the present study are really important for CPD where foreign language teachers want to develop virtual learning platforms. The CoI model proposed as an instructional design model to guide the
design of online activities based on users’ interactions was also used in this study. In these dimensions, this study presents the following educational implications which established as significant for pre-service teachers’ CPD: a) establish a purpose for utilizing an instructional process based on CoI model presence indicators for the creation of 3D virtual learning environments using the 3D open source virtual world of Open Sim combined with Sloodle, b) define and classify the learning goals of the 3D virtual learning environments for foreign language courses, c) design a rich context and problem that support the achievement of the purpose and goals of creating low-cost virtual learning environments, d) prepare pre-service teachers to study using two digital-oriented environments as a unique 3D virtual/web-based platform, e) promote a collaborative process through which active, and social learning can take place in the 3D persistent environment of Open Sim, optically or acoustically in real-time or asynchronously via email and weekly notes via Sloodle dashboard. Given that teachers in group projects might not contribute the same amount of work, it is also argued that each community’s member had a role with specific responsibilities. In addition, according to this framework, learning activities that can be implemented via Open Sim and Sloodle are grouped into three classes: knowledge construction, critical thinking and contextual application.

The CoI model as a theoretical framework to organize a virtual class using Sloodle and Open Sim seemed that: (a) can support the pre-service teachers to broaden their search on connecting innovative technologies for CPD, escaping from the traditional instructional approach of searching and creating web-based platforms. Even interactive web (2.0)-based applications or transactions can support only theoretical learning issues, by uploading users’ opinions or comments; (b) can utilize Sloodle and Open Sim as a virtual learning environment, which can be adapted
according to the technological infrastructure that depends on the interests and needs of pre-service teachers. It is not limited to its use in real class, but also outside of it (online courses); and (c) can promote online collaborative activities for creating learning virtual learning environments by teachers who have the right conditions and opportunities to develop virtual learning platforms for foreign language courses.

However, this study also had its own limitations. The obtained results did not explain how the foreign language teachers have benefited from their engagement in the activities using only Sloodle or Open Sim by presenting qualitative data (main instructor’s observations or answers according to pre-service teachers’ interviews). The current study was deployed in blended sessions held in Open Sim combined with Sloodle in which the main instructor’s feedback was sufficient and daily. Pre-service teachers’ characteristics may differ from other countries, and the results of this study cannot be generalized.

A comparative study to measure the effectiveness of knowledge acquisition between a 3D multi-user virtual world and other web 2.0 technology-mediated transactions for foreign language teachers’ CPD constitutes is the basic future research goal.

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