Exploring Embodied Social Presence of Youth with Autism in 3D Collaborative Virtual Learning Environment: A Case Study

Withhold Authors' Information for Review

Abstract

This case study explores the experience of embodied social presence while learning social competence of 11 youth with Autism Spectrum Disorders (ASD). The learning takes place in a series of 13 Naturalistic Practice (NP) learning activities which are part of a 3D Collaborative Virtual Learning Environment (CVLE)-iSocial. iSocial is a translation of a face-to-face clinic based curriculum, Social Competence Intervention-Adolescents (SCI-A), into a 3D CVLE for delivery over the Internet,. This study developed a direct-observation instrument that built upon the Embodied Social Presence (ESP) theory framework to describe youth with ASDs' embodied presence, embodied copresence and embodied social presence. The findings show that youth with ASD achieved embodied presence and embodied copresence in almost all of the NP activities. However, they achieved embodied social presence in only a handful of NP activities. From comparisons between the learning activities that had high or low percentages of achieving ESP, the results indicate associations of design features (narratives, choosing roles, fantasy settings and ease of use of learning tools) with having a higher percentage of youth achieve embodied social presence. Furthermore, the work of this study provides a method for researchers interested in studying ESP and the results can inform future design decisions in the development 3D CVLE and the structure of learning activities within the 3D CVLE.

Keywords

3D Collaborative Virtual Learning Environment; Autism; Design; Collaboration Learning; Social Presence

Introduction

Three-dimensional virtual worlds have potential to support learning (Bailenson, Yee, Merget, & Schroeder, 2006; Barab, Thomas, Dodge, Carteaux, & Tuzun, 2005; Hideyuki, 2004; Lim, Nonis, & Hedberg, 2006; Montoya, Massey, & Lockwood, 2011). Moreover, many universities and schools have begun to use multi-user 3D virtual worlds for distance education purposes as well as for supplementing traditional classroom activities to promote communication and collaboration among students (Dalgarno, Lee, Carlson, Gregory, & Tynan, 2011; De Lucia, Francese, Passero, & Tortora, 2009; Petrakou, 2010). 3D Collaborative Virtual Learning Environments (3D CVLEs) are virtual environments with objects, landscapes and people and allow users to interact, communicate and collaborate via avatars in ways that simulate real world experiences. 3D CVLEs have the potential to engage learners in a local context or from around the globe. The power of utilizing collaborative virtual learning rather than simply single user 3D environments is the potential to address learning needs that require social interaction to build competencies as well as the potential to use the power of social learning to motivate and enrich learning. Researchers have begun to explore, with some promising results, the ability of youth with Autism Spectrum Disorders (ASD) to learn social skills via 3D CVLE (Cheng & Ye, 2010; Mitchell, Parsons, & Leonard, 2007; Parsons, Mitchell, & Leonard, 2005; Schmidt, Laffey, Schmidt, Wang, & Stichter, 2012).

iSocial is a 3D CVLE that supports youth with Autism Spectrum Disorder to learn social competence from physically distributed locations (Laffey, Stichter, & Galyen, 2014; Laffey, Schmidt, Stichter, Schmidt, & Goggins, 2009; Stichter, Laffey, Galyen, & Herzog, 2014). To be more specific, iSocial is a translation into a 3D CVLE for delivery over the Internet from a face to face, clinic based curriculum-Social Competence Intervention-Adolescents (SCI-A), which targets deficits of youth with High Functioning Autism/Asperger Syndrome (HFA/AS) in three social cognition processes: theory of mind, emotion recognition and executive functioning (Stichter et al., 2010). For students with high functioning autism, they are known to "have a desire to be social but do not yet have the knowledge or skills to successfully perform interactions in a complex and social environment" (DuCharme & Gullotta, 2003). The purpose of developing iSocial was to make an evidenced-based curriculum, SCI-A, available to youth in rural and small schools who typically would not have access to such programs.

The effectiveness of virtual learning environments has often been linked to the learners' sense of presence in the environments (Bailenson et al., 2006). 3D CVLE has affordances for helping learners feel more present and immersed in the context compared to more traditional and common forms of virtual learning environments (Allmendinger, 2010; Bailenson et al., 2006). While there is an emerging body of research exploring the social presence of typical learners, there is little research on understanding the experience of presence of individuals with ASD when learning in a 3D CVLE. Like typical learners, to succeed with communication and interaction, as well as collaborative learning in 3D CVLE, youth with ASD must be able to develop a sense of self, others, the object and the context while learning in virtual environments (Parsons et al., 2005; Wallace et al., 2010). Our general observations of the engagement of these youth while participating in iSocial gave us a sense that the students were immersed in the learning experiences, the social presence framework gave us a systematic way to examine and build our understanding of the learning experience in a virtual world.

The current study sought to extend prior work by investigating how youth with ASD with an opportunity to learn and participate in a 3D CVLE develop sense of self, objects, and others in the environment during learning activities in a 3D CVLE. Furthermore, we sought to inform future design of collaborative learning activities in 3D CVLE based on analyzing results of youth with ASD's experience of embodied social presence across Naturalistic Practice Activities (a component of the curriculum where students are given challenges and expected to apply competencies they have developed) in iSocial.

Theory of Embodied Social Presence Framework

Presence and copresence

The concept of presence (Draper, Kaber, & Usher, 1998; Sheridan, 1992), is most often defined succinctly as the sensation of "being there" in the virtual or mediated environment (Heeter, 1992). Goffman (1963) explained that copresence exists when people report that they actively perceive others and feel that others actively perceive them. Further, in its true meaning, "copresence renders persons uniquely accessible, available, and subject to one another" (Goffman, 1963, p. 22). Within human-computer interaction, social presence theory studies how the "sense of being there " and "sense of being there with another" are shaped and affected by interfaces. In 3D CVLE, "there" represents the virtual reality created by the environment and "the others" that users experience are primarily technologically mediated representations of remote humans via text, images, video, and 3D avatars (Biocca et al., 2003).

Embodiment and Social Context

Johnson and Lakoff (2002) highlighted the role of the body in mediating all stimuli and, by extension, cognition and thus emphasizes the importance of embodiment in framing perceptions and understanding (Johnson, Lakoff, & others, 2002). In 3D virtual learning environments avatars act as virtual bodies. As technology advances and makes possible more expressive interfaces the avatars will increasingly approach the affordances of 'real' bodies and produce realistic face-to-face communication (Dalgarno & Lee, 2010; Donath, Karahalios, & Viegas, 1999). Like physical bodies, avatars are not mere objects manipulated by their human owner; instead, they are also subjects in a socio–cultural world of meaning (Bailenson et al., 2006; Gerhard, Moore, & Hobbs, 2004; Wolfendale, 2007). Besides the uniqueness of embodied interactions of 3D virtual worlds, researchers who focus on 3D collaborative virtual learning have introduced the notion of "place" to emphasize that the virtual space has a social impact (Bulu, 2012; Mennecke et al., 2011). Places are "settings in which people interact". (Munro, Höök & Benyon, 1999) "While virtual spaces take the users' sense from configuration of brick, mortar, wood and glass, places take their sense from configurations of social actions. Places provide what we call appropriate behavioral framing" (Dourish, 1999). 3D CVLE also act as social context where individuals and communities participate in collaborative activity, interact with the context, internalize and use tools and symbols embedded in the digital culture, and regard and transform social rules and divisions of labor (Mennecke et al., 2011).

Embodied Social Presence

Mennecke et al. proposed a theory of "Embodied Social Presence" for 3D CVLE based on grounded research. According to Mennecke et al, "ESP is premised on the notion that certain communication acts and interactions take place in the context of embodied states that create a sense of presence that is derivative of

human cognitions associated with physical, real world Body to Body interactions" (Mennecke et al., 2011, p. 425).

Mennecke et al. did a qualitative analysis of factors associated with ESP theory to identify the process(es) by which the experiences of ESP are derived and examined the results of this phenomenon on social engagement, collaboration, and interactions. Fifty-seven students enrolled for a graduate level e-commerce course were to participated in business activities, socialization, and collaboration, which involved using the virtual environment of Second Life to hold team meetings, engage in social and task-related activities, and participate in class lectures and discourse. Student reflections were collected and analyzed in the tradition of linguistic anthropology (Sapir, 1949; Whorf, 1956; Volosinov, 1973), which asserts that the physical and social environment of a community can be understood through an examination of the vocabulary used by members of that community. Content analysis was used to analyze the text, as it has been described as a multi purpose technique for studying communication artifacts (Berelson, 1952; Holsti, 1969; Krippendorff, 1980; Weber, 1990) and has been used to discover the psychological, attitudinal, and behavioral states of individuals and groups. The researchers analyzed the collected data by conducting focus analysis, followed by theme development and then operationalized ESP development. Three categories (ESP achieved, neutral, not achieved) were identified based on the distinction between the narrative mode of first-person, and third-person. ESP was achieved by 68% of the students. In addition, a step process model, focused on the conditions needed to achieve ESP, was developed.

According to Mennecke, to achieve ESP, one must first achieve sufficiency of levels of embodied presence and copresence. In 3D CVLE, the learner is presented with stimuli representing the virtual learning environment, the objects in that environment, and their own avatar's representation. If the learner engages with these stimuli he or she will experience, to one degree or another, embodied presence.

Interaction in a 3D collaborative virtual learning environment is a joint activity that requires a sense of presence between two or more learners. Once a learner develops a sense of presence in a virtual environment, the opportunity exists for that learner to share that space with others. When leaners share a virtual space they have the opportunity to experience embodied copresence.

Although embodied copresence includes the presence of another learner in 3D CVLE, it does not capture the deeper interaction that occurs when the leaners' avatars are engaged in substantive activity-based, body-centered interactions. It is at this rich level of interaction that deeper meanings can be encoded and conveyed through actions. For embodied social presence to occur, learners in 3D CVLE must participate in goal-directed, shared activity mediated through embodied representations in a context. Therefore, although virtual bodies cannot replace real-world bodies, a virtual body can be used as a tool for conveying concepts, meaning, and symbolism in a way that mirrors how learners use their physical bodies in real world collaborative learning activities. See figure 1, for a schematic representation of the embodied social presence development framework.

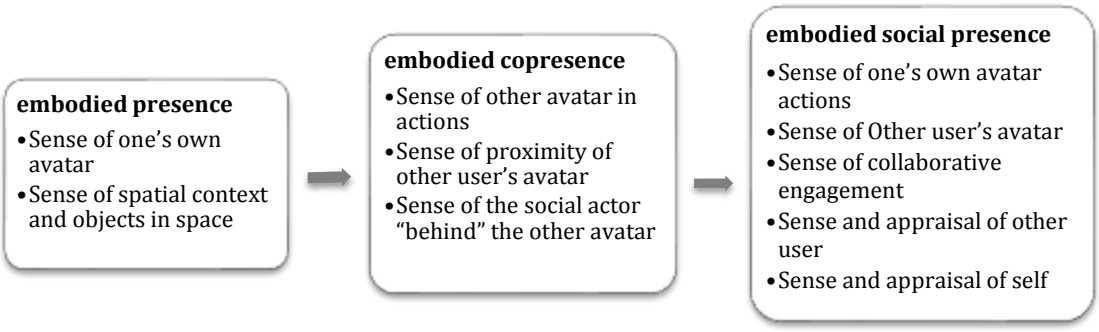


Figure 1. Embodied Social Presence development framework

Finally, Mennecke et al.'s study pointed out that ESP is associated with high levels of cognitive engagement, a focus on shared activities and spaces, on the actions exhibited by the virtual and real bodies

of self and others, and on perceptions and interpretations of intent and content from verbal and nonverbal communication. Thus, their study recommended that a future measurement scale for ESP should focus on these constructs and phenomena.

Youth with Autism's experience of presence in 3D CVLE

While there is an emerging body of research exploring the social presence of typical learners, there is little research on understanding the experience of presence of individuals with ASD when learning in a 3D CVLE. With regard to the promising potential of 3D CVLE technology for engaging youth with ASD, they are known to have perceptual, cognitive and sensory tendencies that may cast some doubt on the potential effectiveness of 3D virtual worlds for facilitating learning (Wallace et al., 2010). Specifically, eye movement studies have shown that youth with ASD tend to focus on (different or inappropriate) details of visual displays compared to typically developing youth (Riby & Hancock, 2009). Also, some youth with ASD are known to experience sensory difficulties or overload in response to particular stimuli (Rogers, Hepburn, & Wehner, 2003). In addition, youth with ASD have little aptitude for pretense, which might constrain opportunities for role-play (Lewis, Boucher, Lupton, & Watson, 2000). These factors could undermine the value of 3D CVLEs for youth with ASD relative to their typical peers, or, at the very least, may hinder their chances of perceiving sufficient levels of presence in the 3D CVLE to benefit from the learning opportunities (Wallace et al., 2010).

Parsons, Mitchell and Leonard (2005) found that teenagers with ASDs functioned effectively in a desktop-presented 3D virtual environment of a cafe. In this study participants successfully lined up at the counter, placed an order and paid for their food. The investigators concluded that the participants perceived a subtle understanding of the difference between representations of people in VEs and films of real people. Nevertheless, the subjects demonstrated a sufficient level of imagination to impute human behaviors to virtual people. For example, they avoided bumping into other people's avatars when navigating their own avatars. They also showed awareness of not walking through the space when there were two virtual people standing in proximity and oriented toward each other because these two people were "having a conversation".

Building upon Mennecke et al.'s work, the current study aims to determine and represent the ESP level of youth with ASD by identifying and classifying their behaviors in the iSocial environment. As Creswell pointed out, the acuteness and richness of results and interpretations are greatly dependent on the measurements (Creswell, 2012). In the following section, the author will review measurements that have been used to examine and represent the general concept of "presence" in 3D collaborative virtual worlds.

Measuring youth with ASD embodied social presence in 3D CVLE

The most commonly used measurements have participants' self-complete surveys, rating scales, or questionnaires after they have experienced the learning tasks in 3D CVLE. The major examples are Witmer and Singers' (1998) presence questionnaire (PQ) (Schrader & Bastiaens, 2012; Witmer & Singer, 1998), Slater et al.'s place presence, copresence scale(Bulu, 2012; Durlach & Slater, 2000;) and Vrellis et al.'s temple presence inventory (TPI) questionnaire (Vrellis, Papachristos, Natsis, & Mikropoulos, 2012). The results from these questionnaires and scales are scores on pre-defined items. A second form of measurement is when researchers conduct interviews or give written open-ended questions with students after their experience in VLEs (Mennecke et al., 2011; Schifter, Ketelhut, & Nelson, 2012). These two forms of measurements, questionnaire and interview measurements, provide a certain structure for reporting the perceptions of presence which has advantages of self reporting but may miss some parts of the experience of presence. Some of the key limitations are that the questions in the questionnaires and interviews occur after the experience and represent memories of an experience as well as attempts by the participants to respond to what the interviewer wants to hear. As such, these measurements are susceptible to providing inaccurate or misleading reports of participant perceptions.

Some studies interested in understanding the experience of participants in 3D CVLE have started to use methods such as, direct observation of learners' behavior or content analysis of text transcript of learners' interaction to examine the evidence of learners' experience of social presence in the environment. First of all, the results from these direct observation measurements can be more rich and descriptive compared to post-experience questionnaires and interviews. Quotes from the students and narrative of events provide

accurate descriptions of students' experience of levels of presence. Second, the results from direct observation provide more direct associations for how technology features and activity designs support or constrain the development of presence. For example, McKerlich et al.'s study described students' use of affective gestures that promote social presence, as well as technology issues that prevented some students from hearing audio in the environment which likely influenced low social presence (McKerlich & Anderson, 2007).

Mennecke et al.'s ESP theory described the evolution of embodied social presence during the experiences of social interaction for a social actor. ESP is associated with the actions exhibited by the virtual and real bodies of self and others, and on perceptions and interpretations of intent and content from verbal and nonverbal communication. The researchers also pointed out that in the future, a measurement scale for ESP "will focus on these constructs and phenomena; that is, the other social actor's virtual body and self, shared actions and communications, and the social actors' own body and self" (Mennecke et al., 2011, p. 438).

Based on the nature of ESP theory, examination of ESP ideally involves identifying the learner's behaviors and classifying observed particular behaviors as exhibitions of certain ESP levels. The current study describes the levels of ESP for youth with ASD using coding and analysis of their verbal and nonverbal behaviors. The observation of verbal and nonverbal behavior for youth with ASD during Naturalistic Practice activities is guided by the ESP framework. Detailed description of the ESP observation measurement is in the data analysis section of this paper.

Research focus

a) Explore and describe youth with ASD experience of embodied presence, embodied copresence and embodied social presence across the variety of Naturalistic Practice activities in iSocial.

b) Implications for future design of 3D Virtual learning activities for youth with ASD learning social competence.

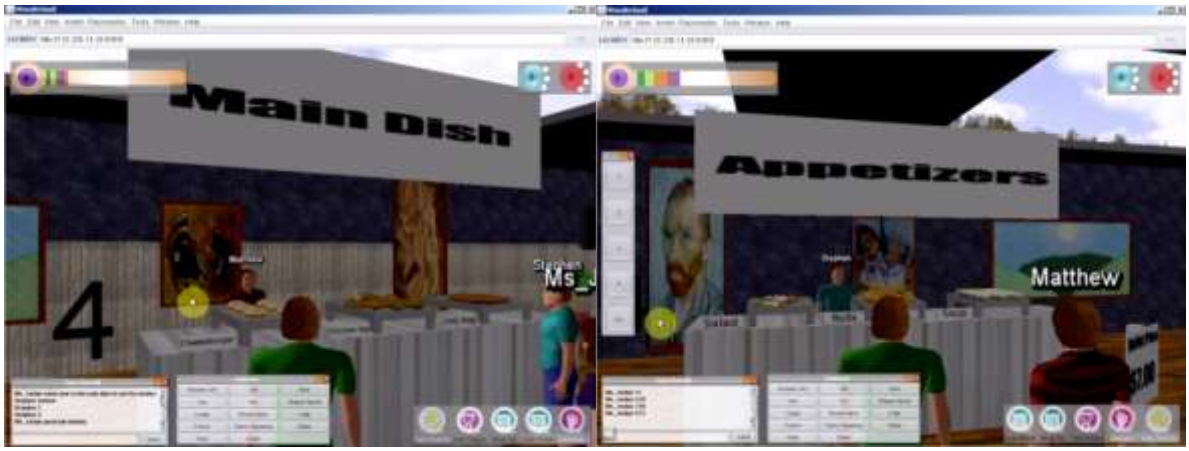
Method

Participants

Participants are eleven youth aged from 11 to 14 who were diagnosed with Asperger's syndrome by Autism Diagnostic Interview Revised (ADI-R) (Rutter, Le Couteur, & Lord, 2003) and/or the Autism Diagnostic Observation Schedule (ADOS) (Lord, Rutter, DiLavore, & Risi, 2002). Additionally, an IQ of 75 or above and capable of speech are required for participation. These 11 participants are all male. Participants were from three different junior high or middle schools in the mid-west area of the United States. As part of the development process for iSocial participants in the same school district were formed into a cohort and took the course together via internet connections. Cohort 1 has 3 students and Cohorts 2 and 3 have 4 students. These 3 cohorts were taught by the same teacher, an online guide (OG) in the 3D CVLE, who is highly trained in teaching social competencies for youth with ASD. The three cohorts went through the same iSocial curriculum.

iSocial Natualistic Practice activities

In iSocial lessons, each user has one's own avatar. Students can interact with peers and the Online Guide (OG) using both verbal and nonverbal communications via avatars. Game-like learning activities in iSocial provide opportunities for students to manipulate objects and select options in the environment. Goal-oriented learning tasks stimulate discussions and negotiations among students. Figure 2 provides some snapshots from when the students are participating in lessons in iSocial. In the screenshots the students are participating in an activity where they are working together and learning to share ideas as they design and build a restaurant together.



a) Students were discussing option #4 for main dishes.

b) Students were deciding what appetizers they want for their buffet.

Figure 2. Screenshots of students participating in NP activities in iSoicial

Naturalistic Practice (NP) activities in iSocial is a curricular component of the later lessons in a unit in which students are encouraged to speak freely and discuss with the group about the challenging activity they are being asked to undertake in iSocial. The NP activities were chosen as the data source for this study because they are the stage in the curriculum when students have the greatest opportunities to interact with their peers in natural ways for accomplishing authentic social tasks. iSocial represents about 22 to 24 hours of online curriculum divided over five units, and there are 30-62 total minutes of NP activities in each unit. NP activities last from 10 to 33 minutes.

Data collection

The screens of every student and the online guide are recorded for the entire set of lessons using a video recording software-ScreenFlow. Then the videos of the students and OG in the same cohort and the same lesson were synced and merged into an all-view video using a video editing software-ScreenFlow. Each all-view video allows the researchers to see every participant's view and the OG's view simultaneously during the lesson.

Table 1. Data description for each student in each NP activity.

NP #	Name of NP activity	Estimated Duration	Cohort 1			Cohort 2				Cohort 3			
			S01	S02	S03	S04	S05	S06	S07	S08	S09	S10	S11
1	Facial expression Scenarios	20 min	x	x	x	x	x	x	x	**Excluded**			
2	Share Out	10 min	x	x	x	x	x	x	x	**Excluded**			
3	Lost at sea: take items	25 min	x	x	x	**Excluded**				x	x	x	x
4	Lost at sea: go to island	25 min	x	x	x	x	x	x	x	x	x	x	x
5	Sell it!	10 min	x	x	x	x	x	x	x	x	**A**	x	x
6	Restaurant buffet I	33 min	**Excluded**			x	x	x	x	x	x	x	x
7	Restaurant buffet II	10 min	x	x	x	**Excluded**				x	x	x	x
8	Emotion status activity	12 min	x	x	x	x	x	x	x	x	x	x	x
9	Emotional role play	25 min	x	x	x	x	**A**	x	x	x	x	x	x
10	Role play planning and taping	25 min	x	x	x	x	x	x	x	x	x	x	x
11	Watch and rate role plays	12 min	x	x	x	x	x	x	x	x	x	x	x
12	Plan Quest activity	10 min	x	x	x	x	x	x	x	x	**A**	x	x
13	Quest activity	30 min	x	x	x	x	x	**A**	x	x	x	x	x

Notes: "x" means the student was attending and experience no major technical issue for that activity. "A" means the student was absent for that activity.

Due to some technical errors that happened during the NP activities, such as client crash, screen frozen and audio issues that kept a student or students from participating in NP activities, the all-view videos that have two or more students having these severe technical errors have been excluded from analysis. Also, during a lesson, if two or more students were absent for that lesson, the all-view video was also excluded. The reason to do so is that each cohort in our study has only three to four students, if two or more students could not participate in the NP activity, then the form of collaboration and social interaction for the NP activity is likely different than the typical form which is the subject of this study. As a result, 5 videos from the total number of 39 videos (13 NP video per cohort) were excluded. See table 1 for detailed information for data

Data analysis

To examine students' embodied sense of presence, copresence and social presence during the NP activities, the ESP framework is used to guide observation and coding of students' behavior in the iSocial 3D CVLE.

The authors examined whether the participant showed evidence of (1) embodied presence which includes "sense of avatar representation of self" and "sense of virtual objects/context"; and (2) embodied copresence which includes "sense of avatar representation of other people" and "sense of avatar proximity". Moreover,

to the extent that these first 2 levels of presence can be shown, the author examined embodied social presence which includes "sense of collaborative engagement", "sense and appraisal of others", and "sense of one's own actions as manifest in avatar-based social interaction".

Within each level of ESP, students' experience of presence is examined by answering specific questions. For example, to examine the evidence of a student's sense of his own avatar in an NP activity, the author needs to answer the question "did the student regard his avatar as the representation of himself in the environment?" To do so, the author observed this student's behavior in this NP activity and determined whether there was evidence that the student identified his avatar as a representation of himself. Data which confirm a positive answer include whether the student always refers to his avatar as my avatar or I; or a negative answer, which includes whether the student refers to his own avatar as "this avatar" or "this character", etc. see table 2 for the set of examining questions and sample supporting evidence.

Table 2. Embodied presence, co-presence and social presence observation guide.

Level of ESP	*Sense within each level*	*Examining questions*	*Evidence*
Embodied presence	Sense of one's own avatar	Did the student regard his/her avatar as the representation of himself/herself in the environment?	Positive if always refer one's own avatar as "my avatar" or "I"
			Negative if refer to one's own avatar as this avatar or this character
	Sense of virtual object and space	Did the student aware of the spatial context and objects in the context?	Positive if one interact with objects and indicate knowing the context of the environment
			Negative if no interaction between a student and the environment
Embodied copresence	Sense of other avatars	Did the student exhibit awareness of the existence of other avatars around?	Positive if one interact with others via verbal or non-verbal communication
			Negative if one showed no interaction with others
	Sense of proximity of other avatars	Did the student have spatial proximity when using his/her own avatar in the environment?	Positive if one keep his/her avatar an appropriate distance from others
			Negative if one shows no awareness of avatar proximity
Embodied social presence	Sense of one's own avatar	Did the student regard his/her avatar as the representation of himself/herself in the environment?	Positive if refer one's own avatar as my avatar or I
			Negative if refer to one's own avatar as this avatar or this character
	Sense of other user's avatar	Did the student have awareness of the existence of other avatar around them?	Positive if one interact with others via verbal or non-verbal communication
			Negative if one showed no interaction with others
	Sense of collaborative engagement	Did the student's avatar engage in a goal oriented collaborative/joint activities with the other social actors' avatar?	Positive if the student collaborate with others using verbal and non-verbal communication; interact with object in the environment during a goal-oriented joint activity
			Negative if the student did not collaborate with the others or interact the object in the environment during a goal-oriented joint activity

Level of ESP	*Sense within each level*	*Examining questions*	*Evidence*
	Sense and appraisal of others	Did the student show appraisal or reflection on the idea that "real person" is behind other avatar?	Positive if the student comment on or evaluate the opinions of others during collaboration
			Negative if the student show no response to others' opinions and questions
	Sense of one's own actions as manifest in avatar-based social interaction	Did the student show appraisal or reflection on the idea or opinions of himself when embodied in one's own avatar?	Positive if refer one's own avatar actions as my avatar did… or I did… or I agree, or I think… during collaboration
			Negative if refer to one's own avatar actions as this avatar did… or this character did… or did not refer to oneself at all during collaboration

Inter-rater agreement

According to Kazdin (2011), central to the collection of direct observation data is evaluation of agreement among observers. Inter-rater agreement, also referred to as reliability, refers to the extent to which observers agree in their identifying and classifying of behavior. The raters first engaged in a calibrating phase. In the calibrating phase, 3 raters (the main rater, rater A and rater B) worked collaboratively to get familiar with the ESP coding scheme and practice with the ESP coding sheet on sample data. The 10 minutes sample data were selected from iSocial lessons activities that are not NP activities. After both rater A and rater B reached 85% inter rater agreement (IRA% is calculated as (#agree)/(#agree + #disagree) × 100) (Krippendorff, 2004) with the main rater, the independent coding phase started. Discussions were held periodically during the independent coding phase, normally once a week or once every other week, to discuss any disagreements or questions that appeared during the coding. Coding examples were added to the coding scheme along with the coding to enrich the raters' understanding about the coding scheme, and therefore avoid raters' drift (Kratochwill & Levin, 1992). The coding process lasted for 8 weeks.

Thirty-four NP activities were coded in total by three coders (doctoral students). 20% of each rater's work was coded by another rater. The overall agreement was 97%.

Results

Embodied Presence, copresence and social presence

In 9 out of 13 NP activities, 100% of the students achieved embodied presence. On average, 97% of the time students achieved embodied presence across the 13 NP activities. Students frequently showed sense of one's own avatar by referring to the avatar representation of self in the virtual environment as "my avatar" or "I". All of the students achieved sense of object and space in all of the 13 NP activities by showing interactions with at least one of the following: the virtual object, learning tools, other avatars or/and the virtual environment.

Secondly, The results for embodied copresence showed that in 11 out of 13 NP activities, 100% of all the students achieved embodied copresence. On average, 98% of the time students achieved embodied copresence across the 13 NP activities. The findings showed that 100% of students achieved sense of other avatar in all 13 NP activities because all of the students have either verbal or non-verbal interactions with other avatars during NP activities. As for sense of proximity of other avatars, most students kept good proximity with other avatars in the virtual environment during NP activities. There are a few cases where some youth with ASD failed to show awareness of avatar proximity in the 3D CVLE.

Thirdly, the results for achieving embodied social presence show that on average, only 61% of the time students achieved embodied social presence across the 13 NP activities. There are 3 out of 13 NP activities

in which 100% of students achieved embodied social presence. However, in some NP activities, like NP #1, and #2, none of the students achieved embodied social presence. To achieve sense of collaborative engagement the student must show evidence of participating in the collaborative discussion in NP activities. Findings showed that on average, 83% of students in all NP activities achieved sense of collaborative engagement. Results showed that students achieved sense and appraisal of others by making evaluations or suggestions/comments on others' opinion during the collaborative learning activity. For example, saying "good job", "I agree" to other members in the group. On average, 76% of students in all NP activities achieved sense of one's own action and appraisal of others. Sense of one's own action as manifest in avatar based interaction is achieved when students express their own opinion as a contribution to the collaborative discussion process in an embodied state, which is through the action of their own avatars in the 3D CVLE. Results showed that on average, only 67% of students in all NP activities demonstrated sense of one's own action as manifest in avatar based interaction.

The findings also showed an interesting pattern: a set of NP activities that generally have high percentage of students achieving ESP like NP #3, #4, #7, #10 and a set of NP activities that generally have low percentage of students achieving ESP like NP #1, #2, #8, #11 See table 3. The author identified four design features of the NP activities in the 3D CVLE: narratives, choosing roles, fantasy settings, and ease of usability of learning tools, which may contribute to the difference between students' demonstration of ESP in these NP activities.

Table 3. Overview of average percentage of students achieve EP, ECP and ESP.

NP activities	*Number of students*	*achieved EP*	*achieved ECP*	*achieved ESP*
NP 1	N=7	100%	100%	0%
NP 2	N=7	86%	100%	0%
NP 3	N=7	100%	100%	100%
NP 4	N=11	100%	100%	91%
NP 5	N=10	100%	100%	60%
NP 6	N=8	100%	88%	75%
NP 7	N=6	100%	100%	100%
NP 8	N=10	90%	100%	10%
NP 9	N=10	100%	90%	80%
NP 10	N=11	100%	100%	100%
NP 11	N=11	100%	100%	18%
NP 12	N=10	90%	100%	80%
NP 13	N=10	90%	100%	80%

3D CVLE Activity design and embodied social presence

Based on the results of 11 youth's experience of EP, ECP and ESP, table 4 classifies 13 NP activities into two categories: NP activities that have high and low percentages of students achieving embodied social presence.

Although the teaching goals of these 13 NP activities in this study are similar (facilitate youth with ASD's collaborative learning of social skills and foster rich, on-topic discussions and compromises) these NP activities are not identical. The design features of these activities and environment supporting these activities are varied because different types of learning objectives call for different learning tasks and students need variety to sustain interest and engagement. The point of this analysis is to identify which design features of the activity/environment differentiate between high and low percentages of students achieving ESP. The researchers identified four design features that could differentiate these two sets of NP activities based on the findings of this study.

Table 4. NP activities that have low or high percentage of students achieve sense of ESP.

Percentage of students achieved ESP	Naturalistic Practice activities in iSocial
Low	NP 1, 2, 8, 11
High	NP 3, 4, 7, 10

Narrative

Narrative entails a setting through which characters engage in a plot or series of actions (Murray, 2001). The benefit of integrating narrative into a learning environment is that it provides opportunities for reflection, evaluation, illustration, exemplification, and inquiry (Conle, 2003).

Table 1. Compare low-ESP and high-ESP activities for narratives.

Low-ESP		*High-ESP*	
NP #1	**Facial expression**-taking pictures Students and the Online Guide were in a virtual room. They were asked to take pictures of their facial expressions showing one of the seven basic emotions that match the situations described in the scenarios using the built in camera of the computer. After they took the pictures, the pictures would show up on the mediaboard in the virtual room.	NP #3	**"Lost at sea"-**choosing items The students and the Online Guide were on a ship voyage. The ship is slowing sinking. Fortunately, there is a deserted island nearby. Students can choose some useful items on the ship to take with them to the island before the ship sinks.
NP #2	**Facial expression-**discussing the pictures In a virtual room, students' avatars were standing in front of the Mediaboard and discussing the pictures they took in NP #1 and using TSM (Triangle Scanning Method) to explain how the picture of themselves shows the emotion they want to express.	NP#4	**"Lost at sea"-**choosing campsite The students and the Online Guide were on a ship voyage. The ship is slowing sinking. Fortunately, there is a deserted island nearby. Students can go to the deserted island to survive. There are four campsites they can choose on the island: the grassy area, the cave, the volcano, and the rocky area.
NP #8	**Emotion and feelings**-discussing the emotions In a virtual room, students' avatars were standing in front of the StickyNote and discussing the emotional status of people described in the given scenarios written on the Sticky Note.	NP#7	**"Building your own restaurant"-**choosing main dishes Students and the Online Guide were in an empty lot beside a city street to build their very own restaurant. They chose the theme, exterior & interior of the restaurant, dress code, table and chair styles, etc. The students were choosing the main dishes for their restaurant.
NP #11	**Rate video recordings** In a virtual room, students' avatar stand in front of a Media player to watch the video recordings of the role play that was recorded in NP #10. Then students fill out the video rating sheet.	NP#10	**"Role play act-out"**-choose emotions and act out in front of camera Students pretend to show emotions of different scenarios and act in front of a camera. They took different roles to act out a play. Different roles have different emotions (happy, sad, scare, etc.)

Comparing these two sets of NP activities, the low-ESP activities were activities that do not have narratives; on the other hand, the high-ESP activities all have intriguing narratives. The high-ESP activities provided situated learning scenarios and discussion topics in these learning activities which match the narrative scenarios. See a detailed description in table 5.

Choosing roles/role play

In low-ESP activities, students were not provided with any opportunity to choose a role or to role-play. While in all the high-ESP activities, students were provided with opportunities to choose roles or role play. See a detailed description in table 6.

Table 2. Compare low-ESP and high-ESP activities for narratives.

Low-ESP		*High-ESP*	
NP #1	There is no opportunity for student to choose a role. Students were taking pictures in the virtual environment.	NP #3	Students discuss as a group and then each chooses one of the following roles: time manager, location manager, item manager and chore manager. For this activity, item manager will lead the discussion. In addition, all students had roles of crew members of a ship which was lost at sea.
NP #2	There is no opportunity for student to choose a role. Students were discussing the pictures they took.	NP#4	For this activity, the location manager role and chore manager role will lead the discussion. In addition, all students had roles of crew members of a ship which was lost at sea.
NP #8	There is no opportunity for student to choose a role. The students were discussing the emotions of the characters in the given scenarios.	NP#7	Students assume one of the following roles: price manager, drink and beverages manager, dessert manager and main dishes manager. In addition all students had roles as owners of the restaurant.
NP #11	There is no opportunity for student to choose a role. The students were rating the video recordings.	NP#10	Students assume roles of their own role play. For example, one student plays the role of a person who was misunderstood for a thief and another student assumes the role of a person who lost his ipod.

Fantasy settings

The environmental settings between the low-ESP activities and high-ESP activities were also quite different. The virtual environments of the High-ESP activities have the appearance of virtual objects with design elements of a fantasy. However, low-ESP activities usually had environments which were more functional and less fantasy. See a detailed description in table 7.

Table 3. Compare low-ESP and high-ESP activities for fantasy settings.

Low-ESP		*High-ESP*	
NP #1	A virtual room with big Mediaboards	NP #3	A virtual ship cabin with all the virtual items and tables. Items like money, water, raft, fishing pole, etc.
NP #2	A virtual room with big Mediaboards	NP#4	A virtual ship deck with four portals to the locations of a island. In addition there is a virtual cave on the island.
NP #8	A virtual room with three Sticky notes	NP#7	A virtual restaurant with virtual tables and chairs, food booth, dishes, etc.
NP #11	A virtual room with a big Mediaboards and a Media player	NP#10	A virtual room with big Mediaboards and a recording area with a virtual professional-looking camera.

Ease of use of learning tools

In most of the high-ESP activities, the learning tools are straightforward and easy to use. While in the low-ESP activities, the learning tools are generally more difficult and time-consuming to use. For example,

typing on a Mediaboard in the 3D virtual environment is really hard and time consuming for most students. Sometimes in the low-ESP activities, the Online Guide even needed to instruct students multiple times on how to use the tools because they were too complicated for the student to operate, e.g. taking pictures using the Mediaboard.

Table 4. Compare low-ESP and high-ESP activities for learning tools usability.

Low-ESP		*High-ESP*	
NP #1	Mediaboard. Taking pictures of self requires students to: ● click on the top border of the mediaboard. ● click on the camera icon that appears on the board. ● Click on "take picture" ● Click on "accept" ● Click on the right upper corner "release control" ● Arrange the picture by dragging it to the desired position	NP #3	Inventory list. Putting items in the inventory list requires students to: ● Click on the item ● Click on "take it"
NP #2	Mediaboard. Same as above	NP#4	Teleport. Use of teleport require students to: ● Navigate avatar to go through the portal.
NP #8	Sticky note. Use of sticky note requires students to: ● Click on the sticky note ● Use keyboard to type on the sticky note. ● Click off sticky note	NP#7	Option number. Use of option number require students to: ● Get on the pop up pod ● Click on the numbers of the Option number listing
NP #11	Rating sheet. Use of rating sheet require students to ● Click on the Rating sheet icon in the dock ● Click on the selected answers on the sheet ● Click and type for short answer questions ● Click finish	NP#10	Mediaboard. Same as NP #1 and #2.

In summary, the findings show that presence and copresence were readily achieved across the NP activities. This result indicates that the students were able to act and interact in the virtual social context. The findings also show that while all students could achieve ESP it was experienced only 61% of the time across students and NP activities. This result led to an examination of variation across the features of the NP activities to identify possible associations between design features and the experience of ESP. Four design features were found to differentially impact the achievement of ESP.

Discussion

This study examined 11 youth with ASD's experience of embodied presence, embodied copresence and embodied social presence across 13 Naturalistic Practice activities in iSocial. According to Mennecke's (2011) component steps involved in ESP, these results indicate that in most cases across the 13 NP activities, the 11 youth with ASD were able to "recognize one's own digital self" and develop "a perception of his embodied representation as an avatar". In addition, all students showed engagement in the virtual space and its social context.

The findings of all 11 students being able to engage in the virtual environment and interact with stimuli across NP activities are consistent with Wallace (2010) and Parson et, al. (2005)'s findings that youth with ASD could effectively perceive the social context of 3D CVLE. Furthermore, the findings showed direct behaviors that indicate youth with ASD's recognition of their digital self and the perception of one's own avatar as representation of self.

The findings show that the 11 youth perceived avatar representation of others across NP activities. In the NP activities, students were facilitated to participate in goal-oriented collaborative learning activities using their virtual bodies and interact with others in the shared social space. The spatial and embodied context afforded by iSocial NP activities is the key for the development of students' sense of others and sense of avatar proximity. The fact that students are able to interact with other avatars and show awareness of real people behind the avatars in iSocial is a further validation of Parson et, al. (2005)'s findings that "youth with ASD perceived a subtle understanding of the difference between representations of people in VEs and films of real people. Nevertheless, they demonstrated a sufficient level of imagination to impute human behaviors to virtual people." Engaging in interactions with other avatars is necessary for students to engage in meaningful collaborations and effective social learning.

Achieving embodied presence and embodied copresence in the 3D CVLE for youth with ASD means that collaborative engagement in the shared task activity could follow when their cognitive attention becomes focused on interactions with the other students, his or her avatar, and the avatar's embodied actions. The findings of this study also show that 11 youth experienced embodied social presence in some activities in iSocial. The results indicate that, in some NP activities, the students were able to jointly strive to accomplish a purpose that is unattainable individually, to achieve a consensus, and a mutual commitment to a shared meaning that drives their activity within a virtual context. However, the results also showed variations of students' experience of embodied social presence across NP activities.

After comparing NP activities in which students tend to have high percentages of achieving ESP with those in which students tend to have low percentages of achieving ESP, four design features of the NP activities were identified: 1) narratives, 2) choosing roles, 3) fantasy settings, and 4) ease of use of learning tools. The results suggest that these features contribute to a higher sense of ESP in the 3D CVLE. While the data do not represent a causal relationship of design features of 3D CVLE and learners' achievement of embodied social presence, the identified associations between the two have implications for future design of 3D CVLEs and further research.

Narratives

The results suggest that high-percentage ESP NP activities all have narratives whereas low-percentage ESP NP activities do not. Dickey (2006) reviewed the devices and techniques for narratives in computer games and how they may inform instructional design. Dickey found that elements of narratives such as challenge, fantasy and curiosity support development of embodied game experience and foster engagement during game play. Mennecke (2011) identified the social context of interactions in 3D CVLE as a crucial key factor that could affect learners' experience of ESP. The narratives in NP activities define the social context for the interactions among the youth. The narratives in the high-percentage ESP NP activities place the students in situated learning scenarios. For example, in NP 3 the narrative for the activity is "The students and the Online Guide are on a ship in voyage. The ship is slowly sinking. Fortunately, there is a deserted island nearby. Students can choose some useful items on the ship to take with them to the island before the ship sinks." The learning goal in this activity is to help students use good listener and speaker roles, and to collaborate with others when making group decisions. This goal-oriented narrative integrated both adventure and problem solving. It fosters students' experience of immersion and engagement. It helps

students to navigate in the environment and comprehend objects in the environment (Laurillard, 1998). It also facilitates social collaboration among students. For example, in the NP #3 when Brendon said: "Want to take 12 packs of water?" Cody answered: "No, we are surrounded by water." Then Cody suggested the island map, Brendon said: "I think I agree with that." The use of narrative can be seen as helping all students in Cohort 1 achieve embodied social presence in NP #3.

Choosing roles

Role-playing has long been a technique used in educational activities. Role-playing provides opportunities for collaboration across time and space (Riner & Clodius, 1995). Choosing roles or role play in massively multiple online role-playing games foster players' intrinsic motivation (Dickey, 2007). The results of this study revealed that high-percentage ESP NP activities all have elements of letting students choose roles or role play whereas low-percentage ESP NP activities do not. For example, in NP # 3 students can work as a group with roles for each member: time manager, location manager, item manager and chore manager. When picking out items for survival on the island, the item manager leads the discussion. Then when discussing chore assignment on the island, the chore manager leads the discussion, etc. In addition, all students have the role of crewmembers on a ship that is lost at sea. Role-playing creates opportunities for embodiment and social interaction in 3D CVLE (Cole & Griffiths, 2007). In our findings, when assuming a role the students tended to play the role and collaborate with the other student(s) regarding the task. For example, in NP 4 Zack is the chore manager. Brayden asked, "Anybody would like to take food?" Zack said, "Yeah, I kinda said that." Brayden said, "I guess I kinda like to take water." Stephen said, "I know what I would like to take...Matthew, what chore would you like to take?" Matthew said, "I was hoping to choose water." Zack asked, "Stephen, which job do you want?" Stephen said, "I would like to take lookout." Zack said, "Ok, you got it."

Mennecke's ESP framework is focused on goal-oriented collaborative activity within a social context. Having roles and perhaps also the process of choosing roles provided opportunities for students to achieve embodied social presence. The roles created a social context for interactions and structured as well as necessitated social interactions among roles for the learners in NP #4.

Fantasy settings

Fantasy settings refer to the environment designs of the NP activity. Environmental designs of NP activity are the virtual places and social contexts where students' avatars interact. Munro, et al. defined places as "settings in which people interact" (Munro, Höök & Benyon, 1999). "While virtual spaces take the users' sense from configuration of brick, mortar, wood and glass, places take their sense from configurations of social actions. Places provide what we call appropriate behavioral framing" (Dourish, 1999). The findings of this study suggest that environmental settings of the high percentage ESP NP activities match the narratives of the activities with detail-rich virtual settings. For example, in NP 3 and NP 4 students were on a virtual ship in a virtual sea. On the other hand, low percentage ESP NP activities have environmental settings that provide less adventurous visual stimulation. For example, in NP #1 and #2 students were in a virtual room with a shared virtual board.

As Bulu (2012) and Vrellis, et al. (2012) point out, the representational fidelity of the environment is important to facilitate development of presence. Furthermore, fantasy-embedded environmental settings encourage exploration activity (Prasolova-Førland, 2008) and promote motivation for students to participate in the learning activities (Dickey, 2006). Mennecke's ESP framework recognized spatially defined interaction as key to the perception of embodied social presence (Mennecke et al., 2011). Contributing to previous research, the results of this case study suggest that the element of fantasy and the visual details of environmental design may contribute to the learners' development of embodied social presence in 3D CVLE during activity-based social interactions.

Ease of use of learning tools

In 3D CVLE, ease of action, feedback and interactivity are important features that can affect users' experience of presence (Jelfs & Whitelock, 2000). Mennecke's ESP framework also recognizes interface characteristics and degree of interactivity as factors that influence the experience of embodied social presence (Mennecke et al., 2011). The results of this study show that in most of the high-ESP activities, the learning tools that student are required to use are quick and easy to use. While in the low-ESP activities, the

learning tools that student are required to use are more time-consuming to use and less interactive. For example, in NP #4, students can just navigate their avatar to go through the chosen portal which allows them to enter the island world to do their next activity. Or in NP #7, they can fulfill the choosing dishes job by clicking the option numbers. However, in the low-ESP percentage activity, NP #1, to complete the learning task, students need to first take control of the mediaboard, click the camera icon, take a picture, accept it, and then release control of the mediaboard. Therefore, the ease of use of the learning tools may be a factor in achieving embodied social presence in 3D CVLE.

Conclusion

The results of this case study provide rich descriptions of youth with ASD's embodied presence, embodied copresence and embodied social presence across NP activities in iSocial 3D CVLE. Specifically, this research characterized student learning experiences in a virtual world by the three phases of ESP: embodied presence, embodied copresence and embodied social presence. The findings support the ESP framework developed by Mennecke and colleagues that uses perceptions and cognitive responses of the individual to account for embodied representations of shared activity in virtual contexts.

This study responded to Mennecke's call for further study to develop methods to examine behavior of users participating in collaborative activities in 3D virtual worlds. The direct observation method has proven to be very informative and provides rich descriptions. Furthermore, the results of this study could be regarded as a starting point for developing a more comprehensive method of examining ESP. Future researchers could also utilize the method to collect presence data from multiple angles. For example, combining self-report methods with direct observation methods may prove useful in developing new insights about ESP.

The results of youth with ASD's embodied presence, copresence and social presence enrich current knowledge of how youth with ASD function in a 3D virtual world and how they perceive and interact with others in an embodied state. These findings of levels of ESP in iSocial NP activities reveal associations of certain design features of the 3D CVLE learning activities. The findings suggest that including narratives, allowing youth to choose and play roles, situating the learning tasks in fantasy settings and attending to the ease of use of learning tools contributes to the achievement of ESP for these youth in virtual environments. These results provide design guidelines for improvements and extensions of iSocial NP activities to better support youth with ASD's experience of embodied social presence, therefore, facilitating higher levels of cognitive engagement, arousal and motivation for learning social competence in iSocial. Furthermore, this study provides insight for other practitioners who are interested in implementing 3D CVLE in teaching youth with ASD social skills and other topics in 3D virtual environments. For example, the findings suggest ways of choosing types of activity to be most effective in engaging the learners and ways of choosing features of the virtual environment to facilitate reaching the objectives of the curriculum. A next step for researchers and designers of CVLE would be to replicate the methods of this study for typical learners who do not have to overcome a lack of social competence to engage in CVLE and to see if the associations between design features and levels of ESP hold.

This case study also builds knowledge for understanding how learners react to and perceive other learners in the virtual environments. Even students challenged by a lack of social competence were able to engage with others and participate in social activity in the iSocial implementation of 3D CVLE. While iSocial has a broad range of activities and contexts future research should extend the study of the experience of social presence to other learning domains and with other forms of collaborative learning. To the extent that this future research can utilize or advance the methods of study used in the current work we have a potential for educational technologists to build deeper understandings of how students experience and participate in learning in virtual environments with the their rich potential for supporting collaboration and learning.
These studies to extend the current work would be especially important for researchers and developers that are interested in understanding learners' embodied social interactions in 3D CVLE and how to design effective platforms for collaborative learning in 3D CVLE. Additionally it should be noted that the current study, while extensive in its examination of ESP, studied only a small number of students and future research could involve more students and thus more rigorously examine the strength of associations found between design features and student experiences.

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Withhold for Review

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