The Effects of Empathetic Virtual Characters on Presence in Narrative-Centered Learning Environments

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ABSTRACT

Recent years have seen a growing interest in the role that narrative can play in learning. With the emergence of narrative-centered learning environments that engage students by drawing them into rich interactions with compelling characters, we have begun to see the significant potential offered by immersive story-based learning experiences. In this paper we describe two studies that investigate the impact of empathetic characters on student perceptions of presence. A study was initially conducted with middle school students, and was then replicated with high school students. The results indicate that, for both populations, employing empathetic characters in narrative-centered learning environments significantly increases student perceptions of presence. The studies also reveal that empathetic characters contribute to a heightened sense of student involvement and control in learning situations.

Author Keywords

Learning environments, virtual characters, presence, empathy, narrative, and experimental studies.

ACM Classification Keywords

H5.1. Multimedia Information Systems: Artificial, augmented, and virtual realities; Evaluation/methodology.

INTRODUCTION

Narrative-centered learning environments afford significant opportunities for students to participate in motivating story-based educational experiences. Virtual characters can engage users in a variety of task-oriented educational and entertainment roles [3, 4, 19, 43]. Such characters contribute to a larger narrative context that can potentially establish concrete connections with pedagogical subject matter, a phenomenon that may support the assimilation of new ideas in young learners [40]. Further, fantasy contexts in educational games have been shown to provide motivational benefits for learning [31]. Because of the power of story to draw audiences into compelling plots and rich settings through the promotion of suspension of disbelief and increased story involvement, narrative can contribute to learning in important ways.

Incorporating narrative into interactive learning environments elicits fundamentally different student experiences than those found in traditional educational settings. The experience of being an active participant in a narrative, rather than an external observer, also yields significant perceptual differences [20]. Psychologists describe this phenomenon as *narrative transportation*, where audiences report feelings of being transported into a story and becoming involved with its characters [12, 13]. Recognizing narrative-centered learning environments' capacity to draw students into a learning experience introduces opportunities for examining the potential for transparency in technology-mediated pedagogical interactions.

The virtual reality and human factors communities use the notion of *presence* to describe users' perception of transportation into a virtual environment [11, 16, 28, 36, 42]. This definition also points to presence as a useful construct for describing the types of experiences audiences report when feeling transported into a story. Within the presence community, there has been a large body of work examining the effects of technological and fidelity-related factors on presence, but comparatively little work examining the influence of content. By examining interactive, narrative-centered learning environments, a broad range of opportunities arises for investigating the effects of narrative content on student perceptions of presence. Strong narrative is often heavily character-driven [10], so by examining educational, story-related interactions with virtual characters, we can begin to understand the variables inherent in story, their impact on presence, and their relationship to learning experiences. Shifting focus from interface issues to content has long been advocated within the presence community. By exploring narrative

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content's ability to affect presence, we focus on the meaning of an experience, the "deep structure for the virtual world," the "cinema" rather than the "celluloid" [2].

In this paper we examine the effects of empathetic exchanges with virtual characters on student presence. We report results from empirical studies conducted with middle school and high school students interacting with a testbed narrative-centered learning environment, CRYSTAL ISLAND. The studies demonstrate that the use of empathetic characters can have a significant effect on student perceptions of presence, with implications for the use of virtual characters in educational, narrative, and other types of interfaces that seek transparency in technologically mediated interactions.

BACKGROUND AND RELATED WORK

Empathy

Empathy is a complex socio-psychological construct. Defined as "the cognitive awareness of another person's internal states, that is, his thoughts, feelings, perceptions, and intentions" [15], empathy enables us to vicariously respond to another via "psychological processes that make a person have feelings that are more congruent with another's situation than with his own situation" [14].

Social psychologists describe three constituents of empathy. First, the *antecedent* consists of the empathizer's consideration of herself, the target's intent and affective state, and the situation at hand. Second, a*ssessment* consists of evaluating the antecedent. Third, *empathetic outcomes*, e.g., behaviors expressing concern, are the products of assessment [7], including both affective and non-affective outcomes (e.g., judgment, cognitive awareness). Two types of affective outcomes are possible. In *parallel outcomes*, the empathizer mimics the affective state of the target. For example, the empathizer may become fearful when assessing a target's situation in which the target is afraid. In *reactive outcomes*, empathizers exhibit a higher cognitive awareness of the situation to react with empathetic behaviors that do not necessarily match those of the target's affective state. For example, empathizers may become frustrated when the target does not meet with success in her task, even if the target herself may not be frustrated.

Devising empathetic virtual humans, agents, and characters for applications in training, education, and entertainment has been the subject of increasing attention. Recent work on empathy in synthetic characters has explored their affective responsiveness to biofeedback information and the communicative context [32]. It has also yielded agents that interact with one another and with the user in a virtual learning environment to elicit empathetic behaviors from its users [30]. The CARE framework [25, 26, 27] has been used in our laboratory to generate models of empathy for synthetic characters playing the role of a companion. Empathy has been investigated in embodied computer agents perceived to care about the outcomes of user experiences in a blackjack game [4] and support user health behavior change [3]. In this work, we are particularly interested in the role empathetic characters, as narrative content, play in transporting users into the CRYSTAL ISLAND learning experience.

Presence

Presence contributes to the goal of transparency in technology-mediated interactions [29]. Although there has been substantial debate on formal definitions, there is a general consensus that *presence* describes a user's sense of "being there" when interacting with a mediated environment [17, 18, 36]. Presence has been alternatively defined as "the perceptual illusion of nonmediation" [23], as well as "the subjective experience of being in one place or environment, even when one is physically situated in another" [42]. It is distinguished from related concepts such as immersion and involvement. *Immersion* generally refers to the extent and nature of technology-provided sensory stimuli; it is often associated with the pervasiveness and fidelity of visual, audial, olfactory, and tactile inputs [36]. *Involvement* refers to the degree of attention and meaning devoted to some set of stimuli [42].

Several groups of factors have been proposed as contributors to presence, including the extent and fidelity of sensory information; the mapping between actions and effects; content factors including characters, objects, and events; and user characteristics including perceptual and cognitive abilities [16]. Lee and Nass recently observed that social factors, such as the relationships between synthesized voice personality, user personality, and presented content can also have significant effects on users' perceptions of social presence [22]. Partially in response to these factor analyses, several separate conceptualizations of presence have been proposed. These are traditionally divided into two types: *physical presence*, the sense of being physically located in a mediated space, and *social presence*, the sense of co-location and social interaction with a virtual or remote partner [23]. In this work, we do not distinguish between physical and social presence. We are interested in how the content of the experience, varied through the empathetic behavior of various characters, influences overall perceptions of presence in a narrative learning interaction. This relates to Lee and Nass' work in investigating social phenomena's relationship with presence using relatively low levels of immersion [22]. However, our current investigation does not focus on student perceptions of individual characters; rather, we seek to investigate easily manipulable content factors that affect student perceptions of presence within the narrative.

Presence is of particular concern because it can play a variety of important roles for supporting education in narrative-centered learning environments [34]. Pedagogical approaches that foster experiential learning, where students actively engage and learn from their experiences [21], can

benefit from enhanced levels of presence; students focus their cognitive resources on the experience rather than the interface or other peripheral features. Waterworth and Waterworth emphasize the use of presence and absence in virtual learning environments, thereby interweaving perceptual and conceptual learning, respectively [39]. This distinction provides insight into the types of cognitive states desirable for concrete and abstract learning tasks. Presence also relates to positive affective states for learning, such as flow [6]. Although the relationship between presence and flow has not been clearly defined, the states share a number of common characteristics, including highly focused attention and lost sense of time. These connections suggest that presence serves an important role in understanding the characteristics of effective narrative-centered learning experiences. In this work we seek to investigate content-based features hypothesized to contribute to presence, thereby enabling a deeper understanding of interactions with narrative-centered learning environments.

Virtual Humans

Virtual humans provide significant opportunities for interacting with computational systems in novel ways. Embodied virtual characters can utilize multimodal mechanisms for communicating information and interacting with a user, e.g., movement, gesture, dialogue participation, and emotionally informed behavior [37]. Beyond expanding the realm of interaction possibilities, virtual humans can impact user perceptions about a mediated interaction. It has been shown that virtual human appearance and behavior can impact measures of social presence in immersive environments [1, 38], as well as influence user behavior and perceptions of personal contact during the experience [11]. Further, within educational contexts, Kim and Baylor have found that the use, gender and appearance of virtual humans can affect student attitudes about math and hard science disciplines [18].

Investigation of the effects of virtual humans on user interactions has recently yielded several surprising results. Dow *et al*. investigated the relationship between engagement and presence in desktop and augmented reality (AR) versions of the interactive drama, Façade [8]. In the study, participants interacted with believable virtual humans in a highly dramatic narrative scenario. The authors found that the higher levels of presence reported in the AR version of Façade did not necessarily correspond to higher reports of engagement for participants. Further, Zanbaka *et al*. conducted a study finding that the presence of both projected and immersively presented (via head mounted display) virtual characters negatively affected complex task performance, indicating a social inhibitory effect similar to that evoked by real human observers [43]. This result emphasizes the need to consider human social interaction theories in the design of interfaces that use virtual humans.

There is a large and growing body of work on pedagogical virtual humans and interface agents within immersive, educational environments. A variety of virtual characters have been implemented for a range of educational domains, e.g., Steve, a pedagogical virtual human for supporting procedural skills training [33]; Ritchie, a virtual anatomy assistant that interacts with users in an augmented reality setting [41]; and Sam, a pedagogical virtual human that participates with children in collaborative learning settings to support literacy learning [35]. In related work, Johnsen *et al*. utilized virtual characters in the Virtual Objective Structured Clinical Examination scenario [19]. It was found that student interactions with the virtual humans significantly correlated with similar interactions involving humans.

The work presented in this paper focuses on the effects of simple empathetic exchanges on student presence in narrative learning environments. Empathetic characters have previously been investigated in a range of tasks, such as supporting social learning in bullying situations [30] and providing empathetic responses to students during simulated interviews [32]. We seek to use similar empathetic exchanges to elicit significant effects on student presence, varying a component of narrative content rather than utilizing expensive, high immersion technologies or complex, high fidelity virtual human behavior. As discussed, possible connections between presence and flow, and between flow and learning [5] make the exploration of content variables' influence on presence informative for the design of narrative learning environments and the use of virtual humans in educational interfaces.

EXPERIMENTAL STUDY

Following the line of research of employing empathetic characters in education, training, and entertainment we investigate the impact of empathetic characters on users' sense of presence in a narrative-centered learning environment, CRYSTAL ISLAND. We utilize a controlled study design (control vs. empathy condition) to assess the effects of interacting with empathetic characters on recorded experiences of presence.

Participants

A total of 90 students (38 females, 52 males, mean age = 14.78, SD = 1.47) from two populations participated in the studies designed to evaluate the effect of empathetic virtual humans on presence. The subjects in the first study consisted of 55 eighth-grade middle school students (32 females and 23 males). The students ranged in age from 13 to 15 (M = 13.73, SD = 0.59). Approximately 60% of the middle student participants were Caucasian (n = 33), 25% were African-American (n = 14), 5% were Hispanic or Latino (n = 3), 5% were of mixed race (n = 3), and 4% were Asian (n = 2). The students participated as part of their science class.

The study was replicated with a second population consisting of 35 high school students (6 females and 29 males). The high school students ranged in age from 14 to 17 (M = 16.43, SD = 0.74). Approximately, 74% were Caucasian (n = 26), 11% were African-American (n = 4), 9% were Asian (n = 3), and 6% were Hispanic or Latino (n = 2). There were no participant dropouts in either study.

Materials

In our laboratory we are developing a narrative-centered inquiry-based learning environment (Figure 1). The prototype learning environment, CRYSTAL ISLAND, is being created in the domains of microbiology and genetics for middle school students. CRYSTAL ISLAND features a science mystery set on a recently discovered volcanic island where a research station has been established to study the unique flora and fauna. In the learning environment for the genetics domain, the user plays the protagonist attempting to discover the genetic makeup of the chickens whose eggs are carrying an unidentified infectious disease at the research station. The story opens by introducing the protagonist to the island and the members of the research team for which her father serves as the lead scientist. As members of the research team fall ill (Figure 2), it is her task to discover the cause of the specific source of the outbreak. She is free to explore the world and interact with other characters while forming questions, generating hypotheses, collecting data, and testing her hypotheses. Throughout the mystery, she can walk around the island and visit the infirmary, the lab, the dining hall, and the living quarters of each member of the team. She can pick up and manipulate objects, and she can talk with characters to gather clues about the source of the disease. In the course of her adventure she must gather enough evidence to correctly choose which breeds of chickens need to be banned from the island.

To illustrate the behavior of the CRYSTAL ISLAND learning environment, consider the following situation. Suppose a student has been interacting within the storyworld and learning about infectious diseases, genetic crosses and related topics. In the course of having members of her research team become ill, she has learned that an infectious disease is an illness that can be transmitted from one organism to another. As she concludes her introduction to infectious diseases, she learns from the camp nurse that the mystery illness seems to be coming from eggs laid by certain chickens and that the source or sources of the disease must be identified. The student is introduced to several characters. Some characters are able to help identify which eggs come from which chickens while other characters, with a scientific background, are able to provide helpful genetics information. The student discovers through a series of tests that the bad eggs seem to be coming from chickens with white-feathers. The student then learns that this is a codominant trait and determines that any chicken containing the allele for white-feathers must be banned from the island immediately to stop the spread of the disease. The student reports her findings back to the camp nurse.

Figure 1. The research camp on CRYSTAL ISLAND.

Figure 2. Jin, the camp nurse, with a sickened Bryce, lead researcher on CRYSTAL ISLAND.

Pre-experiment Materials

Pre-experiment questionnaires collected data on participant demographics (including age, gender, and race), game and computer usage, empathy, goal orientation, and immersion tendencies. The researchers designed a game and computer usage questionnaire to measure how frequently participants play games (e.g., "How many hours per week do you spend playing video games?"), their perceived level of game playing skill on a Likert scale (1 – not at all to 5 – very skilled), what type of games they play (e.g., role-playing, strategy, sports, etc.), and how many hours per week they use a computer. The interpersonal reactivity index [7] is a validated instrument including 28 items that measure the participants' empathetic nature by asking them to rate the degree to which each statement describes them. These items are assessed on a 5-point Likert scale (0 – does not describe me well to 4 – describes me very well). The IRI is divided into four subscale measurements quantifying the following qualities of empathy: fantasy, perspective taking, empathetic concern, and personal distress [7]. Participant

IRI scores were collected to evaluate the interaction between participant empathetic nature and presence. The achievement goals questionnaire[1] [9] is a validated instrument which measures four achievement goal constructs (mastery-approach, performance-approach, mastery-avoidance, and performance-avoidance goals). Participants indicate the extent to which each statement is true of them on a 7-point Likert scale (1 – not at all true of me to 7 – very true of me). The results of the achievement goals questionnaire were used to determine if there is an effect of student goal orientation on presence. Witmer and Singer developed and validated the Immersive Tendencies Questionnaire (ITQ) to measure individual predispositions towards presence experiences [42]. The ITQ consists of three subscales: activity involvement tendency, activity focus tendency, and video game playing tendency. Participants indicate their level of tendency for each item on a 7-point Likert scale. Witmer and Singer found individual tendencies, as recorded by the ITQ, to be predictive of presence [42].

Prior to and during participant interactions with CRYSTAL ISLAND students had access to several materials. These materials consisted of a backstory and task description, character handout, map of the island, and a control sheet. The backstory and task description detail the relationship of the students' character to CRYSTAL ISLAND (a visiting child, named Alyx, of the lead researcher, Bryce) who plays the role of "medical detective" seeking to discover the cause and source of illness causing members of the research team to fall ill. The character handout has a picture, name, and role of each character included in the CRYSTAL ISLAND narrative. The map depicts each of the buildings of the research camp, various foliage, and the waterfall. Finally, the control sheet presents each of the keyboard and mouse controls with short descriptions used to maneuver the student's character through the learning environment.

Post-experiment Materials

Post-experiment questionnaires collected data on participant presence experience and perceptions of the various virtual humans inhabiting CRYSTAL ISLAND. Participants' presence experience was captured using the Presence Questionnaire (PQ) developed and validated by Witmer and Singer [42]. The PQ contains several subscales including involvement/control, naturalism of experience and quality of the interface scales. The PQ accounts for four categories of contributing factors of presence: control, sensory, distraction, and realism. The results of the PQ serve as the primary dependent variable investigated in this paper. In addition to the PQ participants also received a questionnaire to assess their perceptions of the virtual humans inhabiting CRYSTAL ISLAND. Questions assessed the quality of the characters along several dimensions including friendliness, empathy, and trust.

Apparatus

Middle school participants completed CRYSTAL ISLAND interactions on Pentium M 1.73 GHz IBM notebooks with 512 MB of RAM and an ATI Mobility Radeon 9000 Graphics card. The high school student participants completed CRYSTAL ISLAND interactions on Pentium IV 3.0 GHz Dell PCs with 2 GB of RAM and an NVidia Quadro FX 1300/1400 Graphics card. All participants controlled their character (Alyx) through the various goals and character interactions utilizing an extended version of standard Half-Life 2 controls requiring both keyboard and mouse manipulations.

The virtual world of CRYSTAL ISLAND, the semi-autonomous characters that inhabit it, and the user interface were implemented with Valve Software's Source™ engine, the 3D game platform for Half-Life 2. The Source engine also provides much of the low-level (reactive) character behavior control. The character behaviors and artifacts in the storyworld are the subject of continued work. Students direct their character through CRYSTAL ISLAND by using the keyboard controls (WASD) and mouse movements. These are the default controls for Half-Life 2 and many other popular PC games.

Procedure

Participants entered the experiment room with completed informed consent documentation. Participants were randomly assigned to either the empathy or the control condition and were seated in front of a laptop computer. They were given an overview of the experiment agenda. Next, participants completed the pre-experiment questionnaires including the demographics, game and computer usage survey, IRI [7], goal orientation[1] [9], and ITQ [42]. Twenty minutes were allotted for completion of pre-experiment questionnaires.

Upon completion of pre-experiment questionnaires, participants were instructed to review CRYSTAL ISLAND instruction materials. These materials consisted of the backstory and task description, the character handout, the map of the island, and the control sheet. Participants were then further directed on the controls via a presentation explaining each control in detail. Five minutes were allotted for this instruction.

Participants, in both conditions, had 35 minutes to solve the mystery. Solving the mystery consisted of completing 15 goals including learning about various diseases, compiling the symptoms of the sickened researchers, testing a variety of possible sources, and reporting the solution (cause and source) back to the camp nurse.

[1] Only the eighth-grade middle school population (n = 55) received Elliot and McGregor's achievement goal questionnaire [9].

Immediately after solving the science mystery of CRYSTAL ISLAND, or 35 minutes of interaction, participants completed the post-experiment questionnaires. First to be completed was the PQ [42] followed by the researcher designed questionnaire assessing perceptions of individual CRYSTAL ISLAND characters. Fifteen minutes were allotted for completion of post-experiment questionnaires. In total, experiment sessions lasted 75 minutes.

Design

Students were randomly assigned to either the control condition or the empathy condition to measure the effect of empathetic characters on the dependent measure of presence. The empathy condition exposed participants to three empathetic characters: Jin, the camp nurse; Elise, the lab technician; and Audrey, a research assistant. In the empathy condition each of these characters inquired about students' emotion and provided text-based empathetic responses prior to delivering pedagogical content. For example, a student might approach Jin, the camp nurse, who begins a conversation by asking the student how they feel. Jin then empathetically responds to students' selected affective state prior to describing the characteristics of the disease wreaking havoc on CRYSTAL ISLAND. In the control condition, students encountered precisely the same characters delivering the same text-based pedagogical content, but the characters did not empathize with students. For example, instead of Jin inquiring about student affect and empathizing with them, Jin would directly proceed to providing the pedagogical content regarding the characteristics of the disease spreading across CRYSTAL ISLAND. Table 1 depicts the results of random assignment.

Condition (n = 90)							
Control (n =47)				**Empathy** (n = 43)			
MS (n = 29)		**HS** (n = 18)		**MS** (n = 26)		**HS** (n = 17)	
F	**M**	**F**	**M**	**F**	**M**	**F**	**M**
17	12	2	16	15	11	4	13

Table 1. Breakdown of condition assignments by group and gender. Note: MS = Middle School students, HS = High School students, F = Female, M = Male.

RESULTS

Presence Results

In the first study (middle school participants), there was a significant effect of empathetic character exposure on presence, $F(1, 54) = 4.13$, $p = 0.047$. Participants reported a greater sense of presence (totaled PQ) in the empathy condition ($M = 147.04$, $SD = 23.13$) than in the control condition ($M = 132.03$, $SD = 30.62$). Figure 3 shows a box plot of the presence reports of the control and empathy condition for participants from the middle school population.

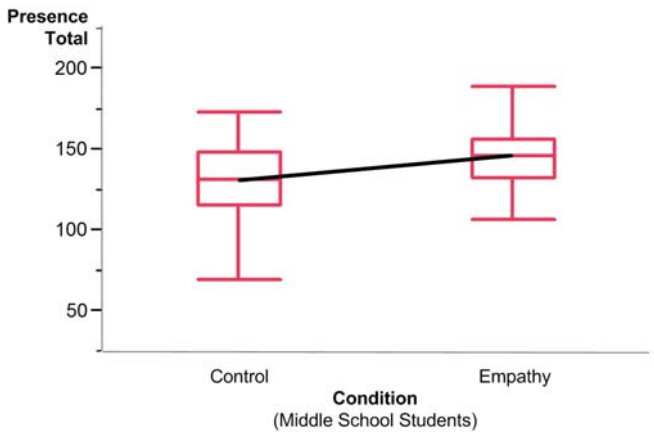

Figure 3. Box plot with connected means of presence results (total PQ) from the first study for control and empathy conditions with middle school participants.

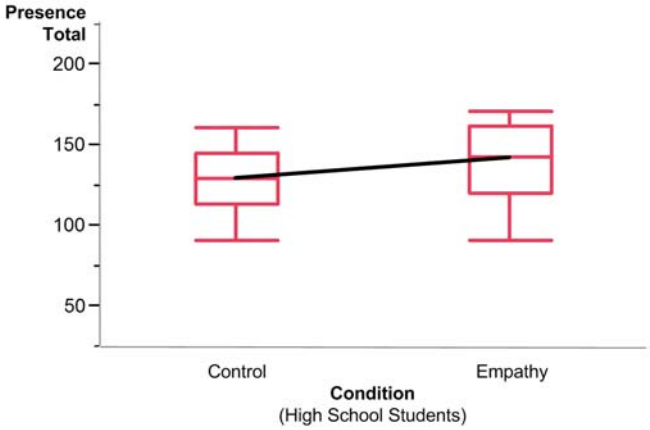

Figure 4. Box plot with connected means of presence results (total PQ) from the replicated study for control and empathy conditions with high school participants.

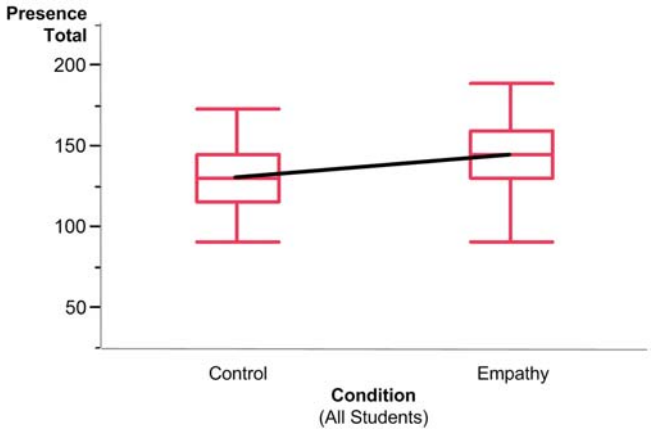

Figure 5. Box plot with connected means of presence results (total PQ) from the replicated study for control and empathy conditions with high school participants.

In the replicated study (high school participants), there was a weak significant effect of empathetic character exposure on presence for the high school population $F(1, 34) = 3.11$, $p = 0.087$. High school participants reported a greater sense of presence (totaled PQ) in the empathy condition (M = 140.29, SD = 23.14) than in the control condition (M = 127.89, SD = 18.31). Figure 4 shows a box plot of the presence reports of the control and empathy conditions for participants from the high school population.

Within each condition there was no significant difference among reported presence between populations. There was no significant difference found in the empathy condition, $t(42) = 0.93$, $p = 0.36$, between middle school and high school participants. In addition, there was no significant difference in the mean presence reports found in the control condition between populations, $t(46) = 0.58$, $p = 0.56$. With these results in mind we consider both populations, middle school students (n = 55) and high school students (n = 35), as a whole.

Examining the population as a whole we find a strong significant effect of empathetic character exposure on presence, $F(1, 89) = 7.02$, $p < 0.01$. As a single population, participants reported a greater sense of presence (total PQ) in the empathy condition (M = 144.37, SD = 23.09) than in the control condition (M = 130.44, SD = 26.43). Figure 5 shows a box plot of the presence reports of the control and empathy conditions for participants from the combined populations.

Similar results were found for the involvement/control subscale of the PQ. In the first study there was a significant effect of empathetic character exposure on reported involvement/control in the middle school population $F(1, 54) = 4.32$, $p = 0.042$. Middle school participants in the empathy condition reported more involvement and greater control (M = 56.42, SD = 9.89) than middle school participants in the control condition (M = 50.06, SD = 12.46). Likewise, in the replicated study, there was a significant effect of empathetic character exposure on reported involvement/control in the high school population $F(1, 34) = 3.97$, $p = 0.054$. High school participants in the empathy condition reported more involvement and greater control (M = 57.35, SD = 8.84) than high school participants in the control condition (M = 51.0, SD = 9.95).

We again find strong significance when we consider the population as a whole, i.e., the middle school students and the high school students together. Within conditions there is no significance between groups. There is no significant difference between the populations in reported involvement/control within the empathy condition, $t(42) = 0.32$, $p = 0.75$. There is also no significant difference between the populations in reported involvement/control within the control condition, $t(46) = 0.28$, $p = 0.78$. Considering both populations as a whole we find a significant effect of exposure to empathetic characters on reported involvement/control $F(1,89) = 8.21$, $p = 0.005$. Tables 2 and 3 summarize the presence results by groups.

	Total (0-200)	**INV** (0-200)	**NAT** (0-200)	**IFQ** (0-200)
MS-C[1]	M = 132.03 SD = 30.62	M = 50.06 SD = 12.46	M = 11.89 SD = 4.27	M = 11.72 SD = 3.75
MS-E[2]	M = 147.03 SD = 23.13	M = 56.42 SD = 9.89	M = 13.26 SD = 3.50	M = 12.46 SD = 2.92
HS-C[3]	M = 127.88 SD = 18.30	M = 51.0 SD = 9.95	M = 12.61 SD = 3.23	M = 9.88 SD = 2.16
HS-E[4]	M = 140.29 SD = 23.13	M = 57.35 SD = 8.84	M = 13.88 SD = 3.29	M = 10.0 SD = 1.65
CC-C[5]	M = 130.44 SD = 26.43	M = 50.42 SD = 11.46	M = 12.17 SD = 3.89	M = 11.02 SD = 3.33
CC-E[6]	M = 144.37 SD = 23.09	M = 56.79 SD = 9.39	M = 13.51 SD = 3.39	M = 11.48 SD = 2.76

Table 2. Presence results by group (MS – middle school, HS – high school, CC – combined) –C refers to the control condition and –E refers to the empathy condition. INV = involvement/control, NAT = natural, IFQ = interface quality. Ranges for each subscale are in parentheses.

Pop. sizes: $n^1 = 29$, $n^2 = 26$, $n^3 = 18$, $n^4 = 17$, $n^5 = 47$, $n^6 = 43$.

	RES (0-200)	**HAP** (0-200)	**AUD** (0-200)
MS-C[1]	M = 8.75 SD = 3.23	M = 7.89 SD = 2.90	M = 14.06 SD = 4.68
MS-E[2]	M = 10.19 SD = 2.22	M = 9.07 SD = 2.92	M = 16.57 SD = 2.98
HS-C[3]	M = 9.11 SD = 2.74	M = 8.5 SD = 3.16	M = 14.16 SD = 3.86
HS-E[4]	M = 10.35 SD = 3.10	M = 9.17 SD = 3.35	M = 14.88 SD = 4.59
CC-C[5]	M = 8.89 SD = 3.03	M = 8.12 SD = 2.98	M = 14.10 SD = 4.35
CC-E[6]	M = 10.25 SD = 2.57	M = 9.11 SD = 3.06	M = 15.90 SD = 3.74

Table 3. Presence results by group continued (MS – middle school, HS – high school, CC – combined) –C refers to the control condition and –E refers to the empathy condition. RES = resolution, HAP = Haptic, AUD = auditory. Ranges for each subscale are in parentheses.

Pop. sizes: $n^1 = 29$, $n^2 = 26$, $n^3 = 18$, $n^4 = 17$, $n^5 = 47$, $n^6 = 43$.

Other Variable Results

In addition to the effects of participants' interaction with empathetic characters on perceptions of presence, there were several other interesting and significant results. In the

first study, with the middle school population, goal orientation was found to affect students' reported presence. In particular there was a significant effect of mastery approach on presence within the empathy condition, $F(1, 25) = 5.34$, $p = 0.029$, and performance avoidance on presence within the empathy condition, $F(1, 25) = 6.22$, $p = 0.019$. Mastery oriented students reported greater levels of presence than performance-oriented students.

Middle school participants IRI score also had a significant effect on reports of presence, $F(1, 25) = 6.38$, $p = 0.018$, and involvement, $F(1, 25) = 5.90$, $p = 0.022$, within the empathy condition only. Students with greater IRI scores, thus more empathetically inclined, reported greater presence than low-IRI students in the empathy condition. In the replicated study, a weak significant effect was also found in the high school population, $F(1, 16) = 4.03$, $p = 0.063$, within the empathy condition. In the combined population the effect of participant empathetic nature on presence was significant, $F(1, 42) = 11.82$, $p = 0.0014$.

It is noteworthy that the effect of gender on presence was insignificant, $F(1,89) = 0.06$, $p = 0.82$. CRYSTAL ISLAND is built on the popular PC game Half-Life 2, and despite the first-person shooter look-and-feel (minus weapons and frags), there were no differences across gender.

DISCUSSION AND DESIGN IMPLICATIONS

The studies found that participants' sense of presence was increased by enabling characters to interact empathetically. Empathetic characters had a significant effect on measurements of overall presence (total PQ), involvement and control, naturalism of the experience, and resolution. The results suggest that designers of narrative-centered learning environments who seek to increase their students' sense of presence should consider introducing empathetic characters. The studies also have the following implications, each of which is discussed below:

- Individual differences in student empathy should be considered in designing characters and their interactions with students.
- The design of characters and interactions should also account for differences in students' achievement goal orientation (mastery vs. performance).
- Learning experiences that seek to involve students in content and motivate them with a sense of control should consider the deployment of empathetic characters.
- Empathetic characters constitute only one of the many narrative content factors to consider in designing effective narrative-centered learning environments. Future studies should investigate varying other aspects of the narrative learning experience as well.

The studies found that participants' empathetic nature, as gauged by Davis' IRI [7], affected the participants' perceptions of presence. The narrative transportation of students, who are empathetic, and perhaps socially intelligent, is supported by interactions with empathetic characters.

Also found in these studies was an effect of student goal orientation on perceptions of presence among the middle school participants. The gaming environment, on which CRYSTAL ISLAND is built, may have had an effect on performance-oriented students, encouraging them to solve the mystery quickly. Meanwhile, it seems that mastery oriented students, who tend to measure success by absorbing content and learning, reported a greater perception of presence. It is possible that mastery oriented students were more likely to take their time during character interactions, perhaps leading to recognition of the characters' empathetic nature.

The strong effect of empathetic characters on involvement and control may have important implications for learning. There are known motivational benefits of user control on the effectiveness of learning [24]. Having characters that respond to student affect may give the student a greater sense of control over the environment by regulating how they feel. Thus, empathetic characters may be able to scaffold student experiences to support regulation of emotions that benefit learning. One such emotion shown to correlate positively with learning is flow [5]. Not surprisingly, there is a relationship between the constructs of flow and presence, expressed in the overlap of oft-mentioned qualities of each, such as focused attention and the sense of losing time after the experience. Thus, deeper understanding of the relationship between presence and flow, as well as the content variations that affect presence in narrative-centered learning, may lead to effects that promote flow, and ultimately effective learning experiences.

The results of the studies should motivate further investigation into the effects various content factors can have on presence in virtual environments. Beyond empathetic exchanges, there are a variety of narrative-related factors that require further exploration, including student perceptions of narrative drama, participants' assigned or chosen role within the story, virtual characters' personality, narrative structure, and plot coherence. Such investigations will be critical to the design of future training and educational environments, particularly after establishing a better understanding of the processes supporting presence and learning.

LIMITATIONS

The results of the studies are affected by the three virtual characters that interacted empathetically with participants in the empathy condition. It is possible that the gender, narrative role, and pedagogical role of the empathetic characters may not generalize to other characters and across

domains. Another shortcoming was that presence was solely assessed after interaction via a questionnaire. Although post-hoc surveys are the currently the most accepted means for gauging presence, it would nevertheless be useful to include additional methods for presence assessment in the future. Finally, to determine how broadly the results hold, the effect of empathetic characters on additional populations should also be studied.

CONCLUSION AND FUTURE WORK

Given the central role of empathy in human interaction, it was hypothesized that empathetic characters could increase student perception of presence in narrative-centered learning environments. In a study with middle school students comparing non-empathetic and empathetic characters, it was found that empathetic characters in narrative-centered learning environments had a significant effect on measurements of students' overall presence (total PQ), involvement and control, naturalism of the experience, and resolution. When the study was replicated with high school students, the same effects were found. In short, it appears that empathetic interactions with characters in narrative-centered learning environments can contribute to a greater sense of presence.

These results indicate that the factors bearing on presence are more complex than previously established. This necessitates an examination of the content presented in a virtual environment, as well as the social and emotional interactions that take place during that experience. This added dimension of complexity opens up a wide range of opportunities for future research on presence, narrative-centered learning experiences, and interfaces that seek levels of interaction transparency.

The results suggest several directions for future work. First, the myriad content factors that bear on presence should be more carefully investigated. Second, the effect of adaptive empathy in virtual characters that base their assessments on real-time information, rather than on pre-scripted responses as used in the study reported here, should be explored. Finally, the impact of presence on learning should be investigated through rigorous studies that account for both assessed perceptions of presence and their relation to learning effectiveness.

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