

Enhancing Interactivity in an Online Learning Environment

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Abstract. This study focuses on the use of animation to alert students to incoming messages and system updates in an online environment. It describes an experiment which compares an animation- and a text-based interface in terms of how the students perceived the alerting system. Relationships between the number of interactions, performance, and perceived social presence are examined. The results indicate that the animation-based interface group interact more than the text-based interface group and perceptions of social presence might be stronger for those students who post more messages. In addition, the results suggest that those students who perceived a stronger social presence also performed better. These findings have implications for designing online course environments where the design of the interface should be considered as a variable that enhances social presence.

Keywords: interactivity, social presence, animation, online environment

1 Introduction

The wide use of computer networks to deliver education on the one hand and the emergence of people-centred online education on the other hand has dramatically increased the demand for systems that support social interaction [1,2]. Much of the effort to enhance the participation and interaction of people has taken tools focus (e.g., chat tools, bulletin boards, instant messaging) rather than interface design focus that is crucial for the success of any computer application [3]. In particular, the user interfaces of many online learning systems suffer from their web page origins. The design of interfaces for online learning applications offers many more challenges than the design of web pages, because information that is not relevant for web pages has to be integrated [4]. The interface must provide information about others to efficiently support social interactions – it must enhance social presence [5]. Social presence in this study is defined as the extent to which virtual entities, which represent others, are perceived as real in an online learning environment.

This paper explores the design of interfaces to present system feedback which might enhance social presence in online learning applications. More specifically, this

paper discusses the design, implementation and evaluation of an alerting system based on animation and another based on text in order to promote interactivity.

Interactivity is a dimension associated with social presence and includes the communication style and learning activities in which the users engage [6]. One of the most important components that affects interactivity is response time. When an expected response is not received a feeling of low interactivity is generated, thus diminishing the perceived social presence. Therefore, animations alerting students to incoming messages and system updates might contribute to the perception of responses, thereby increasing interactivity and perceived social presence.

This experiment investigates the use of animation to alert participants to incoming messages and system updates. Incoming messages encompass new instant mailing, web mail or forum messages while system updates are related to modifications to the agenda, tasks page or lecture content.

A number of studies have shown that the human visual system is extremely sensitive to the motion of objects [7-11]. It is hypothesised that animation might attract participants' attention without disturbing them. If too much information is presented, it might become difficult for the students to concentrate on the essential aspects of their study [12]. However, animation might be introduced to support interactivity without generating information overload or having a disruptive effect.

2 Animation

2.1 Perception of animation

Animation might be used to attract the attention of the students because the perception of motion is crucial from an evolutionary point of view. The eye has evolved to function essentially as a motion-detecting system [13]. For example, a camouflaged animal might not be noticed until it moves [14].

Animation uses the principle that the mind fills in the gaps between frames when a rapid series of still images are presented. The illusion of continuous motion is called apparent motion [10]. Ramachandran and Anstis [10] suggest that the visual system applies strategies that limit the number of matches the brain needs to consider to detect which parts of a successive image reflect a single object in motion. Among the features that the visual system might attempt to extract from images Ramachandran and Anstis [10] found that brightness and texture serve as cues for detecting correspondence. Correspondence means that the visual system must determine which parts of successive images reflect a single object in motion. In this case, introducing animation of an object by altering its brightness might not generate information overload because the visual systems tends to match areas of similar brightness before it detects more detailed outlines. Thus, animation based on changing brightness could be used to direct students' attention to a specific point of the interface without generating information overload.

2.2 The effects of animation

The literature on audio-visual communication contains many references to the effects on learning that occur when animation is used to represent information. Animation may enhance descriptive and procedural text [13-16]. Large, Beheshti, Breuleux, & Renaud [14-16] indicated that the presence of animation can help students to understand a text which outlines a series of steps that must be undertaken to achieve a goal. In addition, they suggest that animation is likely to be most effective when combined with text whose content is related to motion. Animation may concentrate attention on those aspects of a text which deal with motion. A similar recommendation is made by Rieber [17, 18]. The experimental evidence brought together by Rieber led him to recommend that animation should be used when visualisation, motion or trajectory are needed for successful completion of an instructional task. Although the use of animation as an alerting system differs in nature to animation as illustration of text, the idea of motion is implicit. In this case the actual state of the system is altered by an incoming message or update.

Although the findings of Large, Beheshti, Breuleux, & Renaud and Rieber support the use of animated graphics to present information better than static display, Morrison, Tversky and Betrancourt [19] argue that the findings are due to greater information in the animations than in the static display. This means that if the animation and static display had the same amount of information, the results could be less encouraging. Morrison, Tversky and Betrancourt [19] suggest two principles specifying conditions for successful animated graphics. The Principle of Apprehension which establishes that animation must be readily perceived, and the Principle of Expression which establishes that conceptual knowledge to be conveyed must be apparent from animation.

These two principles specify conditions that the animation must fulfil in order to be successful. One condition is that the animation must be readily perceived. In order to achieve this, the animation was produced in a simple manner by altering button sizes and/or brightness. The other condition states that conceptual knowledge should be apparent from the animation. The conceptual knowledge associated with the animation in this experiment was that a new message had arrived or the system had been updated. To make this idea apparent, the animation was conceived to represent the change in the system. To test if the animation was simple and communicated the change in the system a pilot study was carried out [20]. The results of the pilot study suggested that:

1. The animation did not cause disruption;
2. The contrast of the circular sections should be enhanced, and;
3. The tutor's messages should have the highest priorities.

3 The aim of this experiment

A series of experiments were designed to study the relationship between the interface design and social interaction among students in an online learning environment [21-24]. This experiment reports the findings of the fifth in the series.

The aim of this experiment is to compare two different interfaces to an online course, one based on text, referred to as the text-based interface and the other based on animation, referred to as the animation-based interface. Measurements are made of perceived social presence, and the number of interactions.

The following hypotheses were tested:

1. Alerting the participants to incoming messages and system updates using an animation-based interface results in a greater number of interactions among students compared to the number of interactions with a text-based interface.
2. Alerting the participants to incoming messages and system updates using an animation-based interface results in a stronger social presence compared to the social presence perceived by the students with a text-based interface.
3. The degree of social presence perceived by participants is positively related to the quantity of their interactions. This means that a greater number of interactions correlates with a stronger degree of social presence.
4. The performance of participants is positively related to the degree of social presence. This means that a stronger degree of social presence correlates with a better performance.

4 Experimental plan

4.1 Interface design

The interfaces used in this experiment were developed in a previous experiment [21] and were modified in this experiment to present an alerting system. In the text-based interface the alerting system is represented using text (see Fig 1). The text is located below the grey bar in the same column as the bulletin board.

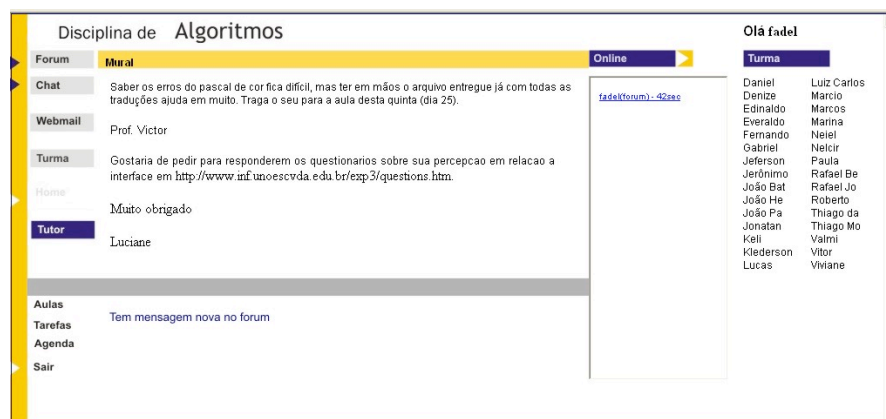


Fig 1. Home page for the text-based interface showing the text 'Tem mensagem nova no Forum' (There is a new forum message) alerting the students to new forum message

The animation-based interface uses animated buttons to alert students to incoming messages and system updates. A priority is associated with each button. This means that only one animated button will be shown each time the user reaches the home page (see Fig 2).

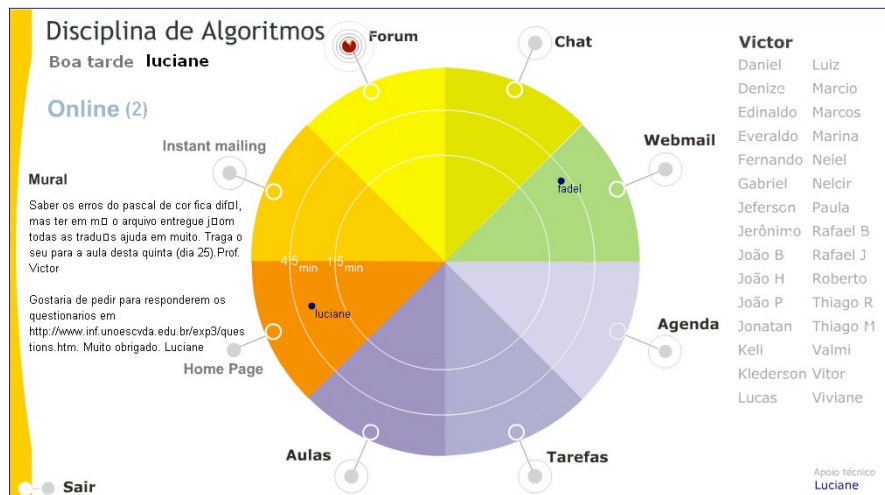


Fig 2. Home page for the animation-based interface showing an animated forum button alerting the students to new forum posting

The animated button

Fig. 3 shows a storyboard for the animated buttons. Modifying the size of a copy of the button's external circle and the colour of the button's internal circle creates the animation. The copy of the circle was used so the original form of the button was not modified. The copy of the grey external circle's radius is increased from its original size until it touches the circular sector. There is also an increase in the size of the contour and brightness of this circle. The increasing size of the external circle might look like the concentric waves caused by a stone thrown into the water.

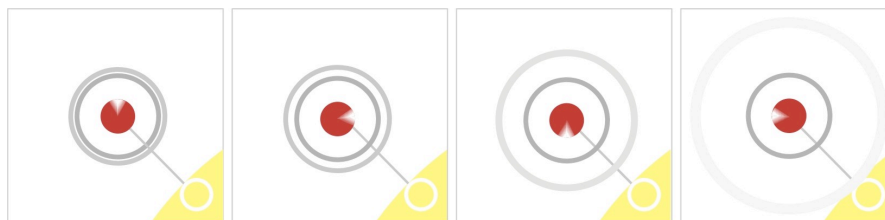


Fig. 3. Storyboard of animated button 4 frames showing the increasing size of the grey circle and the increasing brightness

The colour of the internal circle is dark red and a bright triangular shape rotates 360°. The internal circle is red for incoming instant mailing, web mail and forum messages and blue for system updates buttons, i.e., changes in the agenda, tasks and lecture contents. The red colour used in the internal circle might be associated with something important, while the rotation of the triangular shape might remind the participants of a radar form which searches for something new.

4.2 Participants

The course 'Algorithm' is a mandatory course offered to 1st year Computer Science students at the Universidade do Oeste de Santa Catarina (UNOESC) in Videira, Brazil. Thirty students were recruited for the experiment. The sample consisted of six women and twenty-four men. Participants were assigned to use one of the two interfaces such that equal numbers of participants used the text-based interface (15 students) and the animation-based interface (15 students). The criteria used to assign the students to groups were age, gender and the report from the tutor about each student's previous performance in another course. The aim in assigning students to groups was to ensure that, as far as possible, both groups were equivalent in terms of these factors (age, gender and level of performance).

4.3 Data collection procedures

Data was collected using a questionnaire, participants' grades and system logs. The questionnaire collected perceptions of social presence from the students. The system logs included data from the Web server access log (name of the user, date and time), pages visited and messages exchanged (content, sender, receiver). Using these logs it is possible to record the number of interactions (messages sent and received), the content of messages, and number of page hits for each individual page. Students' performance in this experiment was measured by their final grades which are the total points the student received during the course. The tutor was responsible for marking and assessments.

4.4 Questionnaire content

The items of the questionnaire used to assess the perception of social presence in this experiment was developed iteratively, based on previously published research, piloting the questionnaire and analysing data from previous experiments [21,22]. The aim was to design a questionnaire concise which assessed the students' perception of the presence of the others supported by the interface in an online learning environment.

The questionnaire consisted of 7 items and aimed to find out the degree of social presence sensed by the students, investigating their perceptions about feelings of being part of a group and group belonging. Indicators of their feeling of being part of a group were obtained from the first four items. Indicators of group belonging were

obtained from the last three items. The seven items used to assess each participant's perceptions of social presence were a set of statements with which students were asked to agree or disagree. The responses used a five-point Likert-scale where 1=strongly disagree, 2=disagree, 3=neither disagree nor agree, 4=agree, 5=strongly agree. A scale of five points was chosen because it encompasses a clear set of options. The wording of statements varied so that agreement might indicate either a strong or a weak sense of social presence. This was done to try to ensure that each question was read, rather than the same response ticked for each item. This questionnaire was answered at the end of the course.

4.5 Procedure

The course was structured around reading and weekly discussions. In addition, practical tasks were required which were designed to get students to use their acquired knowledge. The tasks were related to the week's topic. The tasks could be an essay or developing an algorithm based on the theory. The students were supposed to work alone but they could ask for help from the other students or from the tutor using email, forum or chat.

The course was organised into fifteen weeks. During the first four weeks the course was delivered using face-to-face meetings at the University. The next five weeks the course was delivered in the form of distance learning using the site. After that, the students had one face-to-face meeting at the University followed by four weeks of online meetings. The last lecture was a face-to-face meeting.

One week before the first online meeting the students were trained to use the interfaces. The tutor explained to each group separately what they were supposed to do, how they should study, how they would be assessed and how to use the environment. In addition, the groups were aware of the same functionalities of the different interfaces. Finally, the experiment was explained and they were asked to sign a consent form as part of the University of Reading's Research Ethics Committee procedure.

When the course was delivered online, the lecture's topic was presented to the students using the online learning environment. The students had a week to read the material and to prepare the tasks. On Thursdays they met in a chat session to discuss the topic. The completed tasks were sent to the tutor using web mail. The chat sessions were scheduled for Thursday evenings and lasted for two to three hours depending on how many questions the students had.

The chat sessions used a chat room on a different server from the environment because the system chat did not support the whole group at the same time. Both groups used this chat room outside the online learning environment. The chat room used is located at <http://batepapo.bol.com.br/Outrostemas/Computacao1>. This chat room had no restricted access and therefore unfortunately allowed people other than the students to participate in the chat session. The messages exchanged among these non-students and the students were discarded.

5 Results

The results are organised in four sections. The first two sections describe the results from the groups separately. These results are considered in relation to hypotheses 1 and 2. These hypotheses concern the relationship between the use of text and the use of animation to alert participants to incoming messages and system updates, and the number of interactions and social presence. The last two sections describe the results from both groups combined and these results are used to evaluate hypotheses 3 and 4. These hypotheses deal with the relationship between social presence, number of interactions and performance.

5.2 Number of postings

The text-based interface group sent a total of 158 messages during the course. These postings were produced via chat (106), forum (17), web mail (21) and instant mailing (14). The total number of postings of individual students in this group ranged from 0 to 43 with a mean of 12.1.

The animation-based interface group sent a total of 502 messages during the course. These postings were produced via chat (208), forum (10), web mail (44) and instant mailing (240). The total number of postings by individual students for the course ranged from 0 to 75 with a mean of 38.6.

The number of postings in chat, web mail and instant mailing is higher for the animation-based interface group. A t test to examine the differences between the total means found $t = 3.63$ (26df, $p < 0.05$) and it is therefore concluded that the mean number of postings from the animation-based interface is significantly more than from the text-based interface group.

The animation-based interface group sent many more messages using the instant mailing feature than the text-based interface group. There were a total of 240 messages posted using the instant mailing feature for the animation-based interface group against 14 for the text-based interface group ($t = 4.36$, 26df, $p < 0.001$).

The number of messages posted via web mail was 44 for the animation-based interface group and only 21 for the text-based interface group. Almost all the messages (total of 18) posted by the text-based interface group were replies to original messages originated by the animation-based interface group using the instant mailing.

5.3 Text- and animation-based interfaces and social presence

The groups did not differ significantly in relation to the perceived social presence and it is therefore concluded that there is no difference in the perceived social presence between groups.

5.4 Number of postings and degree of social presence

Table 2 shows the number of postings and the degree of social presence. There were a total of 660 postings during the course. This total includes all the messages exchanged between students and between student and tutor but does not include the postings from the tutor. These postings were produced via chat (314), forum (27), web mail (65) and instant mailing (254). There is a low correlation between the number of postings and the degree of social presence across the two groups, with a correlation coefficient (r) of 0.2, which is not statistically significant ($t=1.09$, 24df, $p>0.05$). However, Fig 3 illustrates a positive significant relationship between the number of instant mail postings and the perceived social presence for the animation-based interface group ($t=2.24$, 11df, $p<0.05$).

Table 2. Number of postings and degree of social presence

Text-based interface group			Animation-based interface group		
Student	Number of postings	Social presence	Student	Number of postings	Social presence
1.	0	2.7	1.	64	4.0
2.	1	3.4	2.	23	2.6
3.	2	3.3	3.	51	3.3
4.	1	3.7	4.	15	4.0
5.	20	3.3	5.	30	3.7
6.	9	3.1	6.	39	3.3
7.	6	3.7	7.	26	2.9
8.	29	3.7	8.	24	2.9
9.	43	4.3	9.	49	2.5
10.	0	2.4	10.	69	3.9
11.	5	2.9	11.	17	2.9
12.	2	3.0	12.	20	3.3
13.	40	3.3	13.	75	4.3
Total	158	-	Total	502	-
Mean	12.1	3.3	Mean	38.3	3.4
SD	15.6	0.5	SD	20.8	0.6

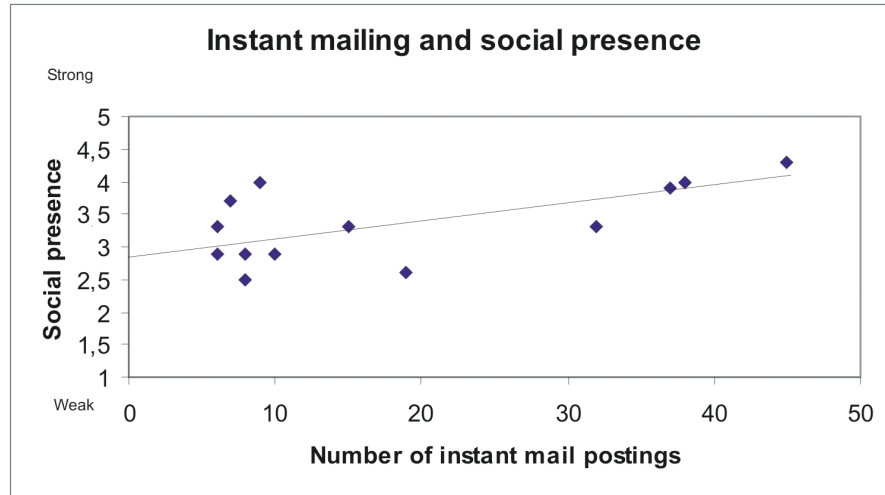


Fig 3. Scatter diagram illustrating correlation between the number of instant mail postings and the perceived social presence for the animation-based interface group

5.5 Degree of social presence and performance

Students' performance in this study was measured by their final grades which are the total points the student received during the course. Point scores for each graded item (participation, tasks and exam) were converted to a grade point (GP) scale. The participation score (PS) was the sum of grade points from the number of messages related to the subject posted at forum, instant mailing, web mail and the number of chat sessions the students participated in.

The overall grade for the course is calculated based on a weighted average, as follows: $\text{Final grade} = 0.3 * (\text{participation GP}) + 0.2 * (\text{tasks GP}) + 0.5 * (\text{Final Exam GP})$.

Those participants who did not answer the questionnaire on perceived social presence were not considered in the correlation between performance and social presence. Fig 4 shows a significant relationship between the degree of social presence and the student's performance with a correlation coefficient (r) of 0.48 ($t=2.7$, 24df, $p<0.05$). This means that those students who perceived a stronger social presence also performed better.

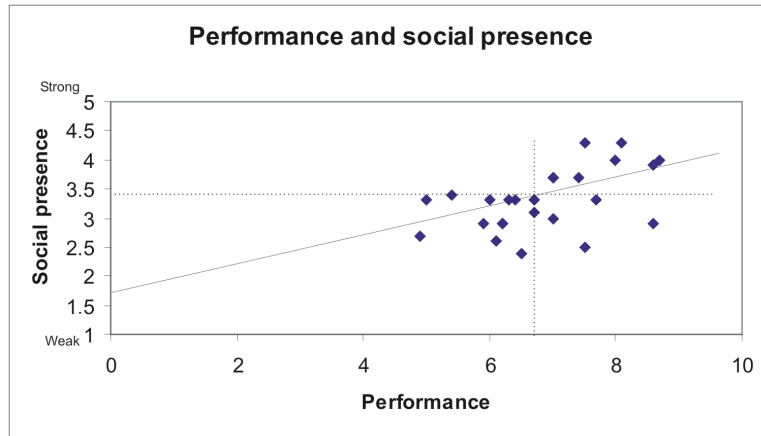


Fig 4. Scatter diagram illustrating correlation between the degree of social presence and student's performance represented by their final grades

A more detailed analysis of the relationship between performance and social presence shows that there is a correlation between the task grade points and perceived social presence with a correlation coefficient (r) of 0.53 ($t=3.04$, 24df, $p<0.05$) and between the exam grade points and perceived social presence with a correlation coefficient (r) of 0.48 ($t=2.7$, 24df, $p<0.05$).

It was expected that those students who perceived a stronger social presence also performed better because the students were supposed to work together to solve tasks. To solve the tasks the students might have used the instant mailing feature to discuss a topic or to organise 'who does what'. In this case, interacting more might have contributed to a higher grade and a better performance. This assumption is based on the number of messages and further analysis on content of the messages should be carried out to establish causation.

6 Discussion

The purpose of this experiment was to compare a text-based interface with an animation-based interface to alert participants to incoming messages in an online course.

The results do suggest that alerting the participants to incoming messages and system updates using an animation-based interface results in a greater number of interactions among students compared to the number of interactions with a text-based interface. This suggestion is based on the fact that the animation-based interface group send more messages than the text-based interface group which might be related to animation directing students' attention to a specific point in the interface. The students responded to the animation by selecting the animated button and consequently posting messages. This sequence of actions might have been facilitated because the animated buttons appeared only in the home page from where other pages

should be selected. In this case there were no other elements competing with their attention, such as, the content of the lecture. It seems that the animated button not only directed students' attention but also provoked a response. This could be related to the fact that the only way of stopping the animation is responding to it by selecting the animated button. Considering that participants in the pilot study selected the animated button when they had no other activity planned, such as reading the content of the next lecture, it is assumed that this call for participation triggered by the animation did not cause a disruptive effect. Indeed, the animation-based interface group seemed not be disturbed by the animation since they performed better than the text-based interface group.

The results of this study do not support the hypothesis that alerting the participants to incoming messages and system updates using an animation-based interface promotes a strong social presence compared to the social presence perceived by the students with a text-based interface. The perceived social presence was similar for both groups and might be related to the fact that the participants shared some face-to-face courses.

Although there is no correlation between the degree of social presence perceived by participants and the overall number of postings there is a correlation between the degree of social presence perceived by animation-based interface group and the quantity of their instant mail messages. This result might be related to the fact that the instant mailing feature is a service for exchanging messages between two online students. Thus, an instant mail message usually asks for an immediate reply. The message exchanging increases the interactivity and consequently the perception of the receiver/sender as a real participant.

The results showed that the performance of participants is positively related to the degree of social presence. This means that a stronger degree of social presence correlates with a better performance. Social presence appears to have a positive effect on performance because the students who perceived a stronger social presence might have the opportunity to cooperate with their peers to complete their tasks. If they perceived the presence of the others they might have felt more inclined to share experiences which would increase their task points and consequently exam grade points. These findings support prior research that established a correlation between perceived social presence and written assignments [25]. However, autonomous students who perform better in online learning environments also prefer immediate communication like for example instant mailing. Immediate communication is associated with a stronger social presence [26]. This means that good students might choose ways of communicating that enhance the perceived social presence.

7 Conclusion and future work

This study had shown that animation alerting the students to incoming messages results in a greater number of web mail and instant mail messages. The results also indicated that a greater number of instant mail messages had a positive effect on the perceived social presence. In addition, the students who perceived a stronger social presence performed better in tasks and written exams.

Future work should investigate social presence when the students do not have other courses with a face-to-face approach. In this case, the sense of presence would be informed only by the online experience and not influenced by their 'real life' relationships. In addition, the findings reported in this paper indicate that the students behave differently using different interfaces. Previous research has indicated that social presence is perceived differently by each user. Potentially research could include the creation of design solutions that are responsive to dynamic changes in information and the user's intention, i.e. adaptive interfaces.

The results of this experiment indicate that the design of interfaces should be carefully considered in the development of online learning environments. Students' behaviour may be driven by the interface design. These findings have implications for designing online course environment where the design of the interface plays a crucial role in enhancing social presence.

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References

1. Anderson, T., Getting the mix right again: An updated and theoretical rationale for Interaction. *International Review of Research in Open and Distance Learning*, 2003. 4(2).
2. McInnerney, J.M. and T.S. Roberts, Online learning: Social interaction and the creation of a sense of community. *Educational Technology & Society*, 2004. 7(3): p. 73-81.
3. Jung, Y. and A. Lee. Design of social interaction environment for electronic marketplaces. in *DIS'00 - Designing Interactive Systems: Processes, Practices, Methods, Techniques*. 2000. New York: ACM Press.
4. Kreijns, K., P.A. Kirschner, and W. Jochems, The sociability of computer-supported collaborative learning environments. *Educational Technology & Society*, 2002. 5(1): p. 1-19.
5. Lee, A., et al. Fostering social interaction in online spaces. in *INTERACT 2001*. 2001. Amsterdam: IOS Press
6. Tu, C.-H. and M. McIsaac, The relationship of social presence and interaction in online classes. *The American Journal of Distance Education*, 2002. 16(3): p. 131-150.
7. Cutting, J.E., *Perception with an eye for motion*. 1986, Cambridge, Massachusetts: The MIT Press.
8. Imura, T., et al., Perception of motion trajectory from the moving cast shadow in human infants. *Vision Research*, 2006. 46: p. 652-657.
9. Limoges, S., C. Ware, and W. Knight. Displaying correlations using position, motion, point size or point colour. in *Graphics Interface*. 1989.
10. Ramachandran, V.S. and S.M. Anstis, The perception of apparent motion. *Scientific American*, 1986. 254(6): p. 80-87.
11. Johansson, G., Visual motion perception. *Scientific American*, 1975. 232: p. 76-89.
12. Sohlenkamp, M., Supporting group awareness in multi-user environments through perceptualization, in *Dept. of Computer Science*. 1998, Paderborn: Sankt Augustin, Germany. p. 151.
13. Large, M.-E., A. Aldcroft, and T. Vilis, Perceptual continuity and the emergence of perceptual persistence in the ventral visual pathway. *Journal of Neurophysiology*, 2005. 93: p. 3453-3462.

14. Large, A., et al., Multimedia and comprehension: a cognitive study. *Journal of the American Society for Information Science*, 1994. 45(7): p. 515-528.
15. Large, A., et al., Multimedia and comprehension: the relationship among text, animation, and captions. *Journal of the American Society for Information Science*, 1995. 46(5): p. 340-347.
16. Large, A., et al., Effect of animation in enhancing descriptive and procedural texts in a multimedia learning environment. *Journal of the American Society for Information Science*, 1996. 47(6): p. 437-448.
17. Rieber, L., Animation in Computer-Based Instruction. *Educational Technology Research and Development*, 1990. 38(1): p. 77-86.
18. Rieber, L., Using computer animated graphics in science instruction with children. *Journal of Educational Psychology*, 1990. 82: p. 135-140.
19. Morrison, J.B., B. Tversky, and M. Betrancourt, Animation: Does It Facilitate Learning? *International Journal of Human Computer Studies*, 2002. 57(4): p. 247-262.
20. Fadel, L.M. and V.F. Jr. Enhancing interactivity using animation to alert students to incoming messages. in *ICBL2007*. 2007. Florianopolis, SC.
21. Fadel, L. and M.C. Dyson. Comparing a text- and visual-based interface presenting social information in an online environment. in *IEEE Symposium on Visual Languages and Human-Centric Computing*. 2006. Brighton, UK.
22. Fadel, L., L. Licheski, and L. Paz. A comparison of the complexity in the perception of social information in text and visual-based interfaces. in *ICOS 2006:interfacing society, technology and organisations: The International Conference on Organisational Semiotics*. 2006. Campinas, Brazil.
23. Fadel, L.M. and M. Dyson. The effect of interface design on the enhancement of social presence in online courses. in *ICL2006*. 2006. Villach, Austria: Kassef University Press.
24. Fadel, L.M. and M.C. Dyson. A Comparison of the perception of social information in text and visual-based interfaces. in *12th International Conference on Technology Supported Learning & Training - Online Educa Berlin*. 2006. Berlin, Germany.
25. Picciano, A.G., Beyond student perceptions: issues of interaction, presence, and performance in an online course. *JALN*, 2002. 6(1): p. 21-40.
26. Tu, C.-H., The impacts of text-based CMC on online social presence. *Journal of Interactive Online Learning*, 2002. 1(2): p. 1-24.