STUDYING INVISIBLY: MEDIA NATURALNESS AND LEARNING

Ina Blau and Avner Caspi
Department of Education and Psychology, Open University of Israel

Abstract: This study examines differences between two learning environments: audio-written conferencing and traditional face-to-face instruction. We investigated whether medium richness (Media Richness Theory; Daft & Lengel, 1984), medium naturalness (Media Naturalness Theory; Kock, 2005), and invisibility influence students' achievement, satisfaction, and behavior. In two research settings, a field study and a laboratory experiment, students were taught face-to-face and/or via an audio-written conferencing system; subject-matter and teacher were constant. We found similar achievement in the two environments. Significant differences, in favor of face-to-face communication, were found regarding learner satisfaction. In addition, invisibility increased certain kinds of students' behavior: participation, risk-taking, immediacy feeling, and flaming. These findings were explained in terms of differences in media naturalness and as an effect of invisibility.

Keywords: media naturalness, media richness, online disinhibition effect, invisibility, visual anonymity, online learning, audio-written synchronous conferencing.

1. INTRODUCTION

Synchronous communication tools, such as textual chat, audio or video conferencing, have been used in distance education since the late 1970s of the 20th century (Bates, 2005). The main advantages of synchronous tools in education are that they closely simulate the transactions between teacher and students in a contiguous and conventional form of education (Garrison, 1989), they may maximize the interactions between students and teachers, as well as among students (Guzley, Avanzino, & Bor, 2001), and potential improve the quality of these interactions (Bates, 2005). However, dozens of studies found no significant difference in students' achievement between instructional media, mainly when comparisons were made between face-to-face and computer-mediated instructions (Arbaugh et al., 2009; Bernard et al., 2004; Russell, 1999). The current study compared learning outcomes resulting from audio-written conferencing and conventional face-to-face instruction. We start by reviewing three theoretical perspectives that compare online and offline communication. Then we present previous findings regarding the differences between audio-written conferencing and face-to-face educational environments, analyzing them through these three theoretical perspectives. Last, we present and test our hypotheses, which were based on both the theoretical background and the findings achieved so far.

1.1 Theoretical explanations for differences between computer-mediated and face-to-face communication

Differences between computer-mediated and face-to-face communication can be explained from different perspectives. We present three theoretical frameworks: Media Richness Theory (Daft & Lengel, 1984; Daft, Lengel, & Treviño, 1987), Media Naturalness Theory (Kock, 2005), and the Online Disinhibition Effect (Suler, 2004). Media Richness Theory and Media Naturalness Theory are frameworks that look for an optimal fit between a medium and a message. The Online Disinhibition effect is affiliated with psychological theories that try to explain Internet users' behavior.

1.1.1 Media Richness Theory

There are a cluster of theories that differentiate media by their inherent features, in order to predict efficient communication. Each theory selects different features, depending on its theoretical assumptions. One influential theory in this cluster is the Media Richness Theory (MRT; Daft & Lengel, 1984; Daft et al., 1987). The theory defined four criteria and ranked different media from "richest" to "leanest" according to their capability (1) to provide immediate feedback, (2) to transmit verbal and non-verbal communication cues, (3) to provide a sense of personalization, and (4) to simulate natural language. The theory assumes that face-to-face communication is the richest medium for transmitting information; this richness can reduce receiver uncertainty (i.e., lack of necessary information) and equivocality (i.e., different interpretations of information). Face-to-face communication is considered the most efficient way to convey complex messages.

Clearly, almost all non-face-to-face communication media involve different degrees of anonymity, especially in the sense of invisibility. *Invisibility* is a type of visual anonymity, the absence of communication cues in the form of facial expressions and body language. Christopherson (2007) noted that it may not be the case that one is truly anonymous in a social context, but the individual perceives him or herself to be anonymous to others. Thus, on the one hand, identifiable cues may help reduce equivocal messages by supplying relevant information regarding the sender (for example, by eliciting past experience with the sender's perspectives or attitudes). On the other hand, even when communicators know each other, they may behave *as if* they were anonymous (see also: Suler, 2004), a behavior that may not contribute to reducing equivocality, thus resulting in an inefficient communication. This later state emerges in conditions of invisibility, where the communicators transact information without seeing each other.

The MRT evoked dozens of studies (for recent review see: Donabedian, 2006); several, however, criticized its unidimensionality (e.g., Carlson & Zmud, 1999; D'Ambra, Rice, & O'Connor, 1998; Shachaf & Hara, 2007). In addition, empirical research regarding the influence of media richness on communication provided mixed results (Caspi & Gorsky, 2005).

Assuming that learning is a process that aims to reduce learners' uncertainty and information equivocality, it is reasonable to conclude that a richer medium is more appropriate for instruction and learning. Using a lean communication medium may have a negative effect on students' learning and satisfaction. Testing the theory in educational settings has shown that media richness may indeed influence learning. Schultz (2003) found that students who learned an online lesson mediated through a lean medium (textual chat) had significantly lower grades than students who learned the same lesson with the same tutor through a rich medium (traditional face-to-face instruction). However, other findings pointed to the fact that a rich medium provides distracters that may have a negative effect on learning. Olson, Olson, and Meader (1997) and Sallnäs (2002) found that students using a rich medium (video conferencing) for instructional communication were often distracted and less task

focused than students who utilized a leaner medium (audio conferencing; see also Hampel & Baber, 2003; Rosell-Aguilar, 2006).

1.1.2 Media Naturalness Theory

A more recent approach to computer-mediated communication, Media Naturalness Theory (MNT; Kock, 2005), used "naturalness" (instead of "richness") as a criterion for differentiating media. Similarly to MRT, face-to-face communication was ranked highest according to five criteria: co-location, synchronicity, and the ability to convey facial expressions, body language and speech. According to MNT, a decrease in the degree of media naturalness may lead to (1) an increase in cognitive effort, which is defined as "the amount of mental activity… involved in communication interaction" (Kock, 2005, p.122), (2) an increase in communication ambiguity, and (3) a decrease in physiological arousal (Kock, 2005; Kock, 2009). Thus, the MNT suggests a compensational mechanism in which performance outcomes may be similar despite differences in naturalness of the media used. For example, learning via textual chat (an unnatural medium in terms of MNT) demands more cognitive effort to decrease communication ambiguity, which may result in outcomes similar to learning face-to-face (the most natural medium according to MNT). However, since using an unnatural medium may decrease physiological arousal, learners may be less satisfied and less exited than learners who study using a natural medium.

Anonymous communication, either just visual or more extensive, is not a natural way of human interaction. From an evolutionary point of view, anonymous communication evolved only after face-to-face communication had existed. Thus, it seems plausible that the three predictions of NMH are valid for invisible communication.

Kock (2005) interpreted some of the mixed results obtained in MRT studies in terms of media naturalness. Nevertheless, he argued that other factors (like social influence or organizational climate; see: Fulk, Schmitz, & Steinfeld, 1990; Fulk, Steinfield, Schmitz, & Power, 1987) may override media naturalness when selecting a medium for communication.

Some evidences found in educational settings may support Media Naturalness Theory. The prediction of the MNT regarding an increase in cognitive effort using unnatural medium may be referred to as *extraneous load* in terms of Cognitive Load Theory (CLT; Sweller, 1998; van Merriënboer & Sweller, 2005). Extraneous load is caused by the format of an instruction (as opposed to *intrinsic load* which is associated with the learning task itself). According to CLT, higher extraneous load interferes with learning. Chen, Wu, and Yang (2006) found that satisfaction from cooperative learning tasks in audio conferencing (the more natural communication medium in their study) was significantly higher relative to textual chat (the more unnatural communication medium). However, there was no difference between media in terms of learning outcomes. In the same vein, tutors in Rapanotti, Blake, and Griffiths' (2002) study reported feelings of discomfort when teaching through audio conference. This discomfort was caused by the absence of visual cues and body language that characterized face-to-face classes. All these findings may be interpreted as a result of increased cognitive efforts and decrease in physiological arousal in less natural media. Recently, Kock, Verville, and Garza (2007) found that while at the middle of a semester students learning face-to-face achieved significant higher grades than students who learned online, at the end of the semester this difference disappeared. They did not find support for the compensational mechanism, and explained the no difference effect using Carlson and Zmud's (1999) Channel Expansion approach, which is not rooted in an evolutionary perspective (Kock, 2009).

While MRT assumes that a good fit between a message and a medium will result in better performance and higher satisfaction, MNT assumes that performance and satisfaction depend on inherent characteristics of the medium, and are not dependant on the message's attributes. As noted above, the two theories disagree on the criteria that differentiate media, and have different predictions regarding the impact of media on learning. Table 1 presents examples of predictions from both theories for different media and different messages. Example for a

simple message in educational context may be "Notify students about a change in deadline for handing in an assignment"; example for a complex message may be "Clarify a complex theoretical issue for a given course unit" (Caspi & Gorsky, 2005).

Table 1. Examples of Different Predictions of MRT and MNT.

Medium	Message	MRT	MNT
Face-to-face	Simple	High outcome	High outcome
		High satisfaction	High satisfaction
	Complex	High outcome	High outcome
		High satisfaction	High satisfaction
Audio conferencing	Simple	High outcome	High outcome
		High satisfaction	Low satisfaction
	Complex	Low outcome	High outcome
		Low satisfaction	Low satisfaction
Chat	Simple	High outcome	High outcome
		High satisfaction	Very low satisfaction
	Complex	Very low outcome	High outcome
		Very low satisfaction	Very low satisfaction

1.1.3 Online Disinhibition Effect

Some communication media afford invisibility, which – as noted above – is a type of visual anonymity. Visual anonymity may disinhibit communicators' behavior, even if the identity of all participants is known (Suler, 2004). Suler described the Online Disinhibition Effect as behavior in cyberspace that is not ordinarily done in the face-to-face world. In cyberspace people may loosen up, feel less restrained, and express themselves more openly. Suler divided the disinhibition effect into positive and negative behaviors. Positive behavior may include exposing personal information, revealing secret emotions, fears, or wishes, as well as behaving kindly and generously. Negative behavior may include using rude language, harsh criticisms, anger, hatred, even threats, as well as exploring pornography, committing crimes or using violence. Suler maintained that the distinction between "positive" and "negative" disinhibition might be complex or ambiguous in some cases. One important effect of the online disinhibition is risk-taking. Being invisible, people may feel more secure and allow themselves to engage in risky behaviors. For example, problematic behavior may be amplified by the special conditions of Internet surfing, like visual anonymity and illegal content availability (e.g., Quayle & Taylor, 2003)

From a learner's point of view, the learning environment may include risks of two kinds: intellectual or social. A student may choose to learn difficult subject matter that might lead to a failure. This is an *intellectual* risk. Tutor or students may criticize the learner for asking questions, or answering incorrectly; thus, participation may involve *social* risk taking. Clifford (1991) reviewed dozens of studies that examined academic risk taking. She found that students preferred moderate risks, and believed that risk taking benefits their learning. However, her review focused mainly on intellectual risk taking (i.e., solving a difficult task, learning difficult subject matter), rather than social risk taking (i.e., active participation in class). When students were asked about the reasons they avoid participation in face-to-face classes and in asynchronous conferencing, they mentioned mainly "social" risk (e.g., avoiding social criticism; Caspi, Chajut, Saporta, & Schupak, 2006). Such reasons were more disseminated in face-to-face classes than in asynchronous conferencing that afforded invisibility.

Visual anonymity, and even its weaker form – invisibility, may serve as a "shield" for students who are afraid of making mistakes in a face-to-face learning situation (Caspi, et al, 2006; Kötter & Shield, 2000; Oren, Mioduser, & Nachmias, 2002; Rosell-Aguilar, 2005). Freeman, Blayney, and Ginns (2006) found that students who interact invisibly expressed more willingness to participate in class. Lobel, Neubauer, and Swedburg (2002) reported that students who interact invisibly perceived less risk and more opportunity for self disclosure. Consequently, they engaged in a larger 'windowed' opening to the self, which led them to be more involved in the learning.

There are other consequences of invisible interaction, which might be a result of disinhibited behavior. Eklund-Braconi (2005) argued that synchronous communication created a closer relationship (immediacy) between teachers and students and among students than did face-to-face instructional communication (see also Coghlan, 2000; Tosunoglu Rapanotti, & Griffiths, 2002). Lea, Rogers, and Postmes (2002) found that interactions among invisible learning group members encouraged them to develop strong identifications with their group, which in turn increased the quality of a group's product.

The "shield" of visual anonymity may allow more equal learner participation, perhaps as another "positive" effect of online disinhibition. Rains and Scott (2007) argued that anonymity in computer-mediated communication diminishes status differences between group members, which encourages more equal participation from all members and allows communicators to focus on the content rather than on the identity of the contributor. Warschauer (1996) studied this "equalization effect" (Dubrovsky, Kiesler, & Sethna, 1991; Siegel, Dubrovsky, Kiesler, & McGuire, 1986) in group communication and found more balanced participation between communicators in textual chat relative to face-to-face discussions. Similarly, Blau and Barak (2009) found more equal participation in textual chat than in face-to-face communication. However, in another study (Böhlke, 2003), more equal participation in chat was found only in small groups. Christopherson (2007) opined that absolute anonymity is not a necessary condition for the equalization effect to occur. Thus, invisibility may be sufficient to generate equalization.

Positive outcomes of visual anonymity may be accompanied by some negative ones. Sia, Tan, and Wei (2002) found that visual anonymity caused some individuals to generate more novel arguments, but also to engage in more confrontational behavior. Reinig, Briggs, and Nunmarker (1997) found that students in online discussion generated almost five more comments than face-to-face students, but also transacted more flaming and buffoonery expressions. Nevertheless, percentages of flaming and buffoonery messages were negligible (about 2%). Chester and Gwynne (1998) found a strong sense of community among students who interact invisibly, but also some (minimal) instances of insult and flaming. Freeman and Bamford (2004) reported that some anonymous learners use anonymity to become chronic complainers, and did not help other learners. Additionally, students provided more negative feedback (i.e., dissatisfaction) when anonymity was an option. It is noted that in Freeman and Bamford's study, although students had the option to communicate anonymously, the majority of students did not use this option. In another study, where anonymous participation was an option and manipulated (Kilner & Hoadley, 2005), half the participants chose to participate anonymously. Again, more comments were posted under anonymous conditions; anonymity was positively correlated with quality of messages, and only few messages (6%) were classified as flaming.

To summarize, online disinhibition may influence learning in two opposite ways. On the one hand, it may raise the level of participation, may create equalization among participants, may result in a strong sense of community, may allow students to take more risks, and may even elevate the quality of the discussion. On the other hand, although not so common, some negative behaviors such as flaming or unjustified criticism may appear.

As noted above, different media provide different degrees of anonymity. Written communication tools afford both visual and auditory forms of anonymity. These tools also secure other aspects of the communicator's identity, such as name or gender. Audio tools keep

visual anonymity but may reveal other aspects of the communicator's identity. A communicator's voice may expose gender or race. In that sense, audio tools afford invisible communication, not the fully anonymity afforded by unidentifiable textual communication. If the Online Disinhibition Effect depends on the degree of anonymity, then we may predict that the above listed impacts of the effect on learning may be larger when anonymity is greater.

One criterion of Media Richness Theory indirectly relates to invisibility – the capability of a medium to transmit non-verbal cues. Media Naturalness Theory has three criteria (out of five) that their combination may define invisibility: co-location, conveying facial expression, and conveying body language (these two may be combined with "transmission of non-verbal cues"). By definition then, media naturalness approach assigns a higher degree to invisibility in its analysis of communication media.

One may argue that comparing face to face communication with audio-written communication has a potential confound. A more appropriate procedure would compare audio-written communication with video-written communication. In a pilot study, we tried the video-written communication option and found that it was impossible to keep eye contact between communicators. Eye contact has significant value in human communication (Senju & Johnson, 2008), but visibility does not readily mean the existence of eye contact (Barak, 2007). In order to be seen as keeping eye-contact with the other communicators, one must look directly at the camera. However in the current technological solutions for desktop video communication, the angle at which participants view the screen is different from the angle at which the camera is located. Thus, if the communicator looks directly at the camera, she cannot see the other participants, and when the communicator looks at the screen, it appears that she is not looking at the other participants. The two options are not close to natural conditions of communication.

1.2 Learning via audio-written conferencing relative to face-to-face class

The current study compares learning outcomes in two environments: The so-called traditional class, in which instruction is done face-to-face, with an audio conferencing system that embodies textual chat (for a matter of convenience we use the term audio-written conferencing or AWC). Ruan (1996) did not find significant academic achievement differences between distance students that were taught via audio-written conferencing and students taught face-to-face. Some studies (Pan & Sullivan, 2005; Rapanotti et al., 2002; Tosunoglu et al., 2002) suggested that audio-written conferencing is an effective tool for synchronous discussion that promoted learning. This tool also affords the formation of out-of-class peer support groups that continue the learning (Hampel & Hauck, 2004). Hampel (2006) suggested that the use of audio-written conferencing in language courses has the potential to increase students' participation and interaction.

Few studies compare audio-written conferencing and face-to-face learning. Several of those that do have methodological weaknesses (e.g., instructional modes were self-selected, different instructors used different tools, etc.). The current study aimed at testing differences in the two environments, in terms of achievements, satisfaction, and students' behavior. We analyzed the two learning environments through the three theoretical perspectives presented above: Media Richness Theory, Media Naturalness Theory, and the Online Disinhibition Effect.

In terms of Media Richness Theory, face-to-face is a rich communication medium, while audio-written conferencing is a lean one. Although the conveyance of speech may enrich the medium, immediate feedback (not necessarily verbal one), transmission of non-verbal cues, and sense of personalization are lower. According to the Media Naturalness Theory, the two communication modes differ less. They have a similar level of synchronicity and they convey

speech to a similar degree. Figure 1 depicts the differences. Audio-written conferencing affords visual anonymity whereas in a face-to-face environment people are identified.

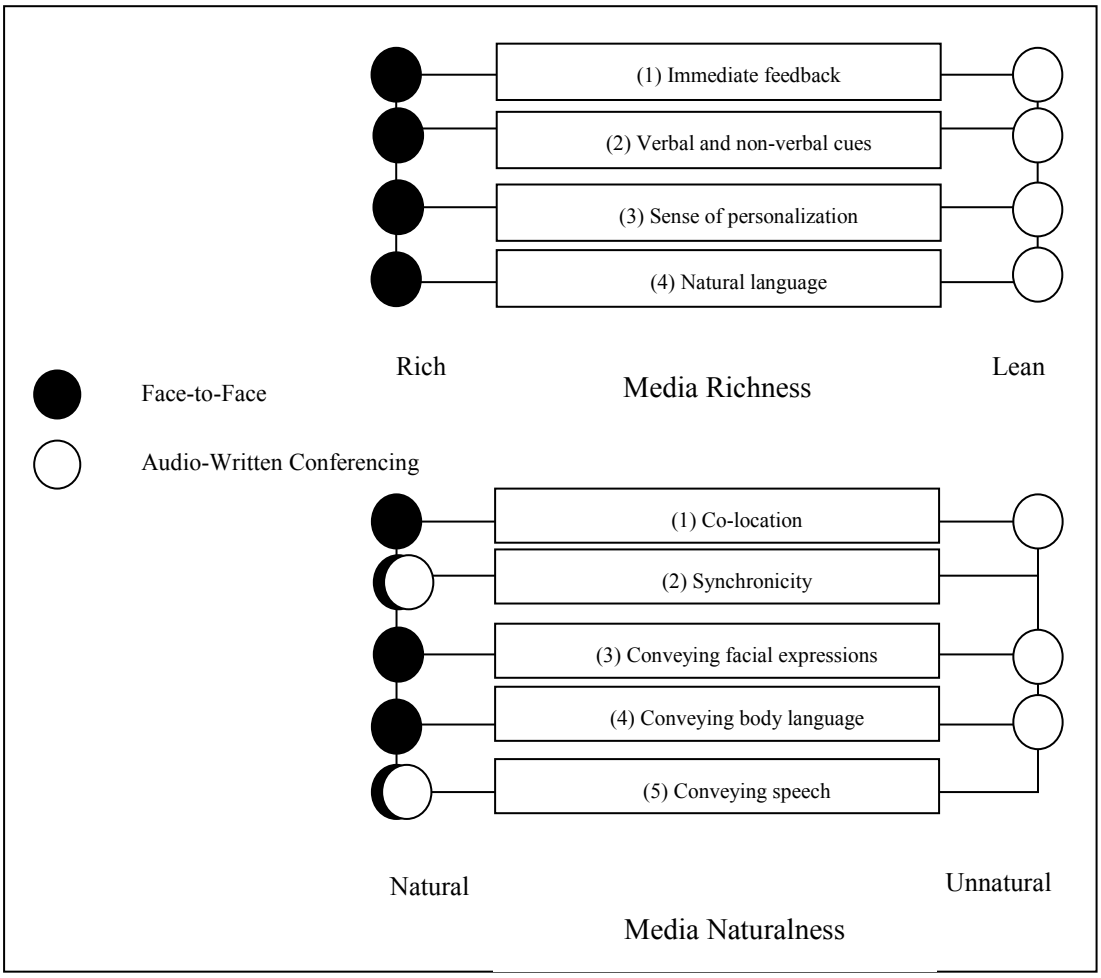

Figure 1. Analyzing Face-to-Face vs. Audio-Written Conferencing Learning Setting in terms of Media Richness (top) and Media Naturalness (bottom)

Our dependent variables are "achievement", "satisfaction", and "students' behavior". Achievement is the difference between pre-learning and post-learning tests. We also measure perceived learning in terms of five possible conceptions of learning (Marton, Dall'Alba, & Beaty, 1993; Marton & Säljö, 1976a, b). Satisfaction was measured by students self-reports vis-à-vis emotions that were evoked during learning (such as enjoyment or interest). Students' behavior was measured by counting risk-taking events (operationalized as answering teacher's questions and offering opinions), counting "public" participation (talking in the class or in the audio-written conference), and counting expressions of immediacy and flaming.

The predictions of the three theoretical perspectives are presented in Table 2. Clearly, the three theoretical perspectives have different predictions regarding achievement. MRT predicts better performance in face-to-face settings, since this medium affords exchanging more information that might be more relevant and accurate. MNT predicts that the disadvantages unnatural medium has may be compensated by investing extra cognitive efforts. Thus, achievement may be equal in both settings, unless insufficient cognitive efforts were devoted. The Online Disinhibition Effect predicts better performance under visual-anonymous communication, unless levels of negative disinhibited behavior are high.

Regarding satisfaction, both MRT and MNT predict higher levels of satisfaction in face-to-face environments, whereas Online Disinhibition Effect does not have a specific prediction, depending on the actual behavior took place. Students that communicate invisibly may feel higher levels of immediacy, take more risks, and have higher and more equal participation. At the same time, according to the Online Disinhibition Effect, they may also feel more satisfied than in face-to-face communication. However, if negative events happen, they may feel less satisfied. There are no direct predictions of MRT and MNT vis-à-vis students' behavior.

Table 2. Predictions of the Three Perspectives. FtF = face-to-face, AWC = audio-written communication

	MRT	**MNT**	**Online Disihibition**
Achievement	FtF > AWC	FtF ≥ AWC	FtF ≤ AWC
Perceived learning	FtF > AWC	FtF > AWC	FtF < > AWC
Satisfaction	FtF > AWC	FtF > AWC	FtF < > AWC
Students' behavior:			
risk-taking			FtF < AWC
participation			FtF < AWC
equalization			FtF < AWC
immediacy			FtF < AWC
flaming			FtF < AWC

These predictions were tested in two studies. In the field study, all students alternated between lessons taught face-to-face and lessons taught via audio-written conferencing. In this study, we focused on students' behavior. In the laboratory study, participants were randomly assigned to audio-written conferencing or to a face-to-face lesson. This study measured achievement, learning satisfaction, and students' behavior. In both studies, students were taught by the same teacher in both conditions.

2. STUDY 1: FIELD STUDY

The field study utilized a pedagogical opportunity whereby a teacher could not meet her students face-to-face every week. The solution was audio-written conferencing that took place every even week. Under these conditions, the option to test students every week was unreasonable and might even be unethical. We thus, focused on students' behavior: attendance, participation, equalization, risk-taking, immediacy and flaming.

2.1 Method

2.1.1 Participants

Twenty-eight high school students (25% female) from a rural school in northern Israel were studying for a matriculation exam. Participation was mandatory. Two independent groups were formed: 11 eleventh grade students and 17 twelfth graders. Learning through audio-written conferencing was a new experience for all students.

2.1.2 Instruments

Audio conferencing was done using Skype™, an Internet application that allowed rich synchronous communication. All students knew each other; they were identified by name or nickname. Skype allows video communication, but only in a one-by-one mode. Thus, only two communication channels were available: auditory and textual.

Students' behavior. Participation, risk-taking, immediacy and flaming were checked using quantitative content analysis of the lessons' records. Participation was measured by the frequency of each student's (and of the teacher's) speaking and writing. For oral participation, we regarded a single unit of participation as continuous speaking until another participant started to speak. For written communication, every message was regarded as a single unit of participation. Risk-taking was measured by the frequency of answering the teacher's questions and offering opinions regarding the subject matter. Immediacy was measured by frequency of warmth and confidence expressions, use of humor, and self-disclosure. Flaming was measured by the frequency of potentially offensive expressions. A second rater, familiar with the subject matter but not with the students, analyzed 25% of the records, and a high level of agreement between raters was found (above 90% agreement for each category of analysis, Cohen's $\kappa = .88$).

2.1.3 Procedure

Students alternated between face-to-face lessons taught in school and audio-written conferencing lessons taught at a distance. Students participated in the audio-written conferencing lessons from their home, and were free to select the mode of communication. The teacher spoke using the audio mode, but also replied to student input (questions, answers, comments) via the textual chat mode. All lessons were recorded, 12 lessons (6 face-to-face and 6 audio-written conferencing) were randomly selected for the analysis.

2.2 Results

Despite that attendance was mandatory and equal importance was assigned to face-to-face lessons and to audio-written conferencing, students attended significantly more the face-to-face lessons than audio-written conferencing lessons, $t^1(9) = 3.30$, $p < .001$, $d' = 2.0$ (STE: 0.7). Average attendance is presented in Table 3.

Table 3. Average (and standard deviation) of Students Attendance (number of students attended a lesson)

Lesson mode:	11th grade	12th grade	Total
FtF (6 lessons)	9.00 (1.65)	13.33 (1.25)	11.60 (2.55)
AWC (6 lessons)	5.33 (0.47)	7.33 (2.36)	6.53 (2.09)

Participation was measured in two ways. In terms of average participation per lesson (number of students who participated in a lesson divided by number of attendees), there was no significant difference between the two modes of instruction. In terms of the relative contribution to the lesson (the average proportion of an individual student's oral or written contributions in a single lesson relative to all participants in that lesson including the teacher), we found that students contributed significantly more in audio-written conferencing lessons,

[1] We used a *t*-test that assumed heteroscedasticity. Note that the unit of analysis is the lesson observation, not the student.

$t(8) = 4.07$, $p < .001$, $d' = 0.6$ (STE: 0.6). The teacher did not intentionally encourage participation more in one mode of instruction or in the other – there was no significant difference between the two modes of instruction in number of questions referred to students. Table 4 presents the average participation. The contribution of the teacher also did not significantly differ between the two modes of instruction. We found no evidence for equalization effect.

Table 4. Average (and standard deviation) of Students Participation

	Lesson mode:	**11th grade**	**12th grade**	**Total**
Average	FtF (6 lessons)	8.43 (11.27)	7.74 (10.23)	8.03 (10.68)
Participation	AWC (6 lessons)	9.32 (8.66)	12.52 (7.39)	11.14 (8.12)
Relative	FtF (6 lessons)	6.39 (7.15)	5.02 (5.93)	5.57 (6.48)
Contribution	AWC (6 lessons)	10.17 (7.34)	9.86 (5.51)	9.99 (6.61)

Within the Skype mode, we further tested for differences between audio and chat in terms of students' participation. Students talked 111 times; they wrote 218 messages. As Figure 2 shows, a significant difference between classes was found, χ^2 (1) = 88.19, $p < .001$: Eleventh graders used the audio channel more than the text channel, whereas twelfth graders did the opposite.

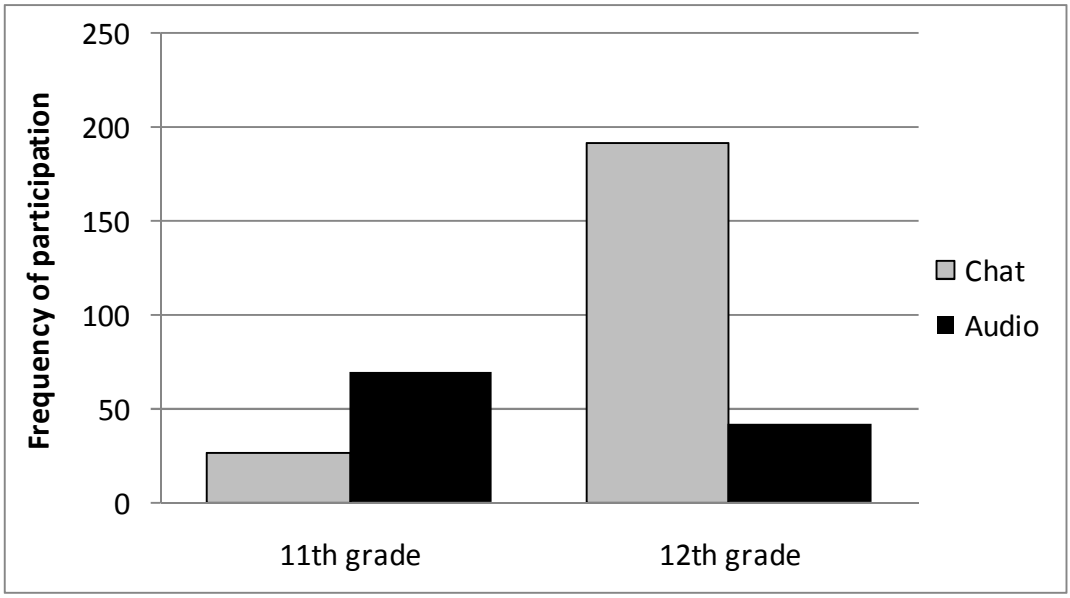

Figure 2. Frequencies of Participation

Risk taking, measured as answering teacher's questions and offering opinions regarding the subject, was similar in the two modes of instruction. Comparison of risk-taking in audio versus chat revealed that students took more risks in chat (72 events) relative to audio (37 events). A significant difference between classes was found, χ^2 (1) = 50.03, $p < .001$; this is of course resembles the interaction pattern reported regarding participation in the two channels (see Figure 3).

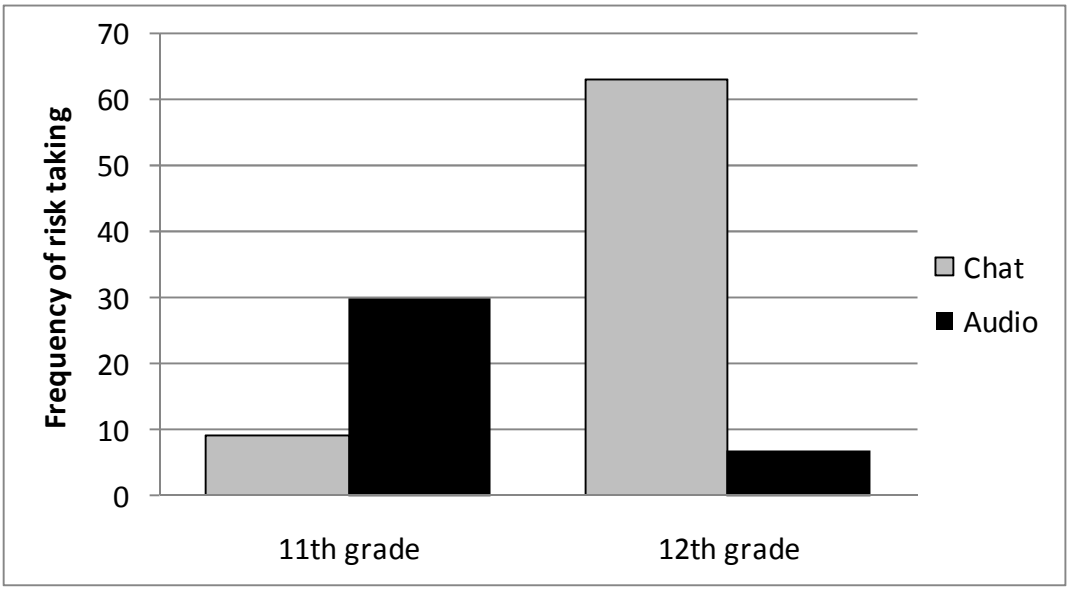

Figure 3. Frequencies of Risk-Taking

We found 92 expressions of immediacy in audio-written conferencing as opposed to 56 in the face-to-face class. However, the two classes differed significantly, χ^2 (1) = 16.68, $p < .001$: Amount of immediacy expressions was similar in both eleventh and twelfth grade face-to-face classes, but in audio-written conferencing we found more than four times the number of expressions of immediacy in the twelfth grade class relative to eleventh grade (see Figure 4).

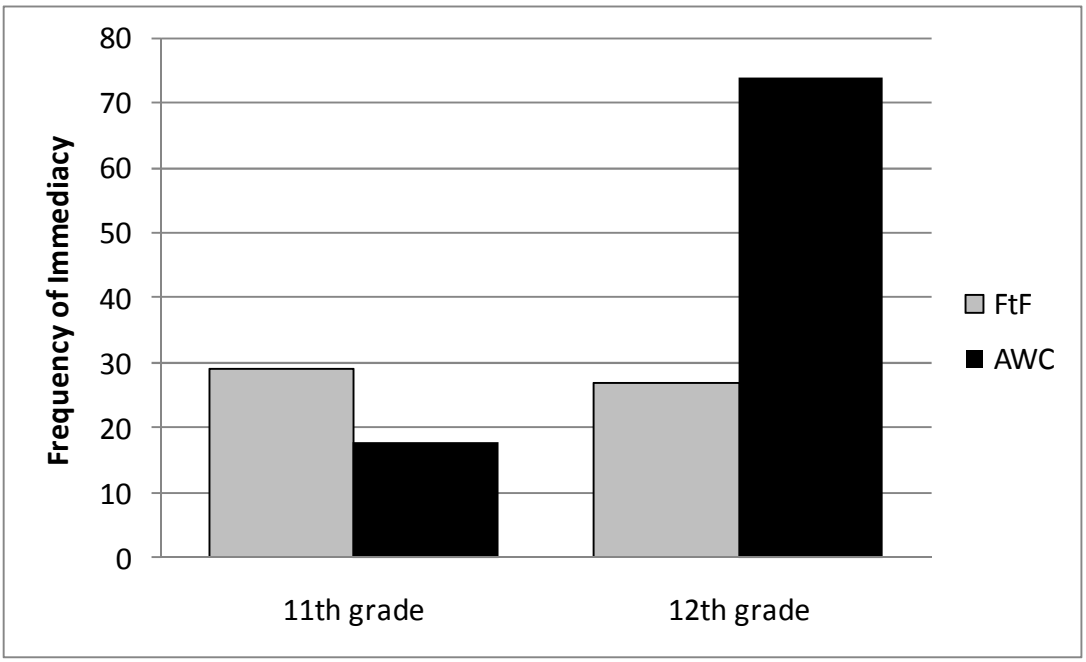

Figure 4. Frequencies of Immediacy

Flaming expressions were rare. We found 16 flaming in audio-written conferencing (8 in eleventh grade and 8 in twelfth grade) as opposed to seven in face-to-face classes (5 in eleventh grade and 2 in twelfth grade).

2.3 Discussion

The field study gave initial support for the Online Disihibition Effect predictions. We found that students participated relatively more in invisible communication; they took more risks in chat than in audio, expressed more immediacy, and at the same time more flaming appeared. We found no evidence for the equalization effect.

These results were moderated by classes. The results found among twelfth grade students were exactly as predicted while among eleventh grade students they were not. A possible explanation is that twelfth grade students know each other for a longer period of time, thereby making communication easier. Another possible explanation is skill or proficiency in the subject-matter. Vetter and Chanier (2006) and Chanier, Vetter, Betbeder, and Reffay (2006) found significant difference between beginners and advanced students: Advanced students communicated through audio conferencing while beginners used textual chat nearly twice. Our data is exactly the opposite: Twelfth grade students use the chat more than the audio channel and eleventh grade students vice versa. If proficiency matters, then our data suggest that students use a less natural (or less rich) medium more only after subject matter proficiency is accomplished. Another possible explanation is gender distribution. In the eleventh grade, male students were a majority in the class, while in the twelfth grade, gender was evenly distributed. It is possible that males prefer spoken communication and females prefer written communication (for a similar suggestion see Caspi, Chajut, & Saporta, 2008).

The field study has some limitations. First, we did not measure achievements and satisfaction. Second, students' attendance differed between the two modes of instructions: fewer students attended the audio-written conferencing lessons, but those who showed up participated more. This finding in its own may tell us something about the attractiveness of audio-written communication as a way of studying. While this communication mode is prevalent among teenagers (e.g., Blais, Craig, Pepler, & Connolly, 2008; Bryant, Sanders-Jackson, & Smallwood, 2006), they attend these lessons much less than lessons delivered in the traditional teaching mode. We do not know if this attendance pattern is due to the communication features of this technology or due to other factors (such as learning from home instead of in class). To overcome the noted limitations, we designed a laboratory experiment.

3. STUDY 2: LABORATORY EXPERIMENT

3.1 Method

3.1.1 Participants

Forty-two undergraduates (71% women) from the Department of Psychology and Education at the Open University of Israel received an academic credit for participation in the experiment. Participants' ages ranged from 14 to 42, mean age was 28 years, and the median was 26. The participants' ages did not differ between the two experimental conditions (F2F – Mean: 28.5, SD: 6.8; AWC – Mean: 26.9, SD: 4). None of the participants had prior acquaintance.

3.1.2 Instruments

Communication media were identical to the field study: face to face and audio-written conferencing via Skype.

Post-lesson questionnaire. To measure perceived learning we administered a questionnaire that related to the five conception of learning (Marton, Dall'Alba, & Beaty, 1993; Marton & Säljö, 1976a, b). Students were asked to self-evaluate their learning along the five conceptions of learning (increasing one's knowledge, memorizing, gaining applied knowledge, understanding, and changing a point of view), using a six-point Likert scale (ranging from "not at all" to "very much").

To measure satisfaction, students used a six-point Likert scale (ranging from "not at all" to "very much") for reporting their emotional states. Six questions related to students' emotional states during learning: losing attention, getting bored, lessening difficulties, enjoying students' interaction, enjoying teacher-students interaction, and feeling that the content is difficult. In addition, students also evaluated their own achievement ("how many answers do you think were correct in the post-test quiz?"), and a general question regarding their own learning ("to what degree do you believe that you learned from the lesson?", answers ranged from "not at all" to "very much" on a six-point Likert scale).

Students' behavior. Participation and risk-taking were measured using quantitative content analysis of the lessons' records. Participation was measured by the frequency of verbal actions (speaking and writing) enacted by each student and the teacher; risk-taking was measured by testing the frequency of answering teacher's questions and offering opinions regarding the subject.

3.1.3 Procedure

Participants were randomly allocated to face-to-face or audio-written conferencing conditions. Every triad of students received a 20 minute music history lesson, taught by the same teacher. This subject matter was unfamiliar to all participants. For a matter of convenience, we set the group size to three students. This size allows testing the behavioral dependent variable (participation, risk-taking, and equalization).

Before the lesson started, the students answered a 10-item quiz (pre-test). The same quiz was administered upon completion of the lesson. Additionally, they filled the post-lesson questionnaire. All lessons were recorded for analysis.

3.2 Results

Table 5 presents pre- and post-test results. There were no significant differences between the two modes of instruction, either in pretest, posttest or the difference between them, but effect size (Cohen's *d*) was medium for the posttest and the difference between the post and pre-tests.

Table 5. Pre-test and Post-test Averages

	FtF	**AWC**	***t*-test results**	***d′* (STE)**
Pretest	1.6 (0.8)	1.6 (1.2)	n.s.	0.0 (0.31)
Posttest	8.6 (1.0)	8.2 (1.4)	n.s.	0.3 (0.31)
Difference	7.0 (1.3)	6.6 (1.6)	n.s.	0.3 (0.31)

The two groups of learners did not differ in their self-evaluated achievement, or in their general evaluation of the learning took place. The correlation between actual and self-evaluated achievement was high ($r = .63$, $p < .001$), and no significant difference was found between actual and self-evaluated achievement. There were no significant differences in perceived learning (see Table 6). One exception is memorization. Face-to-face learners felt the lesson helped them memorize the content more readily than the audio-written conferencing learners and the effect size was large. However, we found significant differences in satisfaction; the effect size was large for all the questions, except the small effect for perceived difficulty. Table 7 summarizes the differences.

Table 6. Achievement, Self-Evaluated Learning, and Conceptions of Learning Averages

	FtF	**AWC**	***t*-test results**	***d′* (STE)**
Achievement: self-evaluation	8.5 (1.2)	8.5 (1.4)	n.s.	0.0 (0.31)
Learning: general evaluation	5.2 (0.8)	5.2 (0.7)	n.s.	0.0 (0.31)
Perceived learning:				
Increasing one's knowledge	5.3 (0.8)	5.1 (0.7)	n.s.	0.3 (0.31)
Memorization	5.2 (0.9)	4.6 (1.0)	$t(40) = 2.10$*	0.6 (0.32)
Implementation	3.1 (0.9)	2.7 (0.9)	n.s.	0.4 (0.31)
Understanding	5.1 (1.0)	4.7 (1.1)	n.s.	0.4 (0.31)
Perspective changing	3.3 (0.8)	3.2 (1.5)	n.s.	0.1 (0.31)

* $p < .05$

Table 7. Emotional States Averages

	FtF	**AWC**	***t*-test results**	***d′* (STE)**
Losing attention (R item)	5.29 (0.90)	4.43 (1.40)	$t(40)= 2.36$*	0.7 (0.32)
Getting bored (R item)	5.33 (0.80)	4.29 (1.55)	$t(40)= 2.75$**	0.8 (0.32)
Lessening difficulties	5.05 (1.07)	4.33 (1.28)	$t(40)= 1.96$*	0.6 (0.32)
Enjoying peers interaction	4.67 (1.02)	3.76 (1.26)	$t(40)= 2.56$*	0.8 (0.32)
Enjoying teacher interaction	5.29 (0.72)	4.24 (1.30)	$t(40)= 3.23$***	1.0 (0.33)
Perceived difficulty	4.43 (1.21)	4.86 (1.01)	$t(40)= 1.24$º	0.1 (0.31)

º n.s.; * $p \leq .05$; ** $p < .01$; *** $p < .001$

Teacher's participation in face-to-face lessons (Average: 67.4, SD: 19.5) was statistically lower than in audio-written conferencing lessons (Average: 81.6, SD: 16.9), $t(6) = 2.87$, $p < .05$, $d′ = 0.7$ (STE: 0.55) but students' participation was statistically not (FtF - Average: 25.7, SD: 14.5; AWC - Average: 32.6, SD: 16.8, $t(40) = 1.43$, $p > .1$, $d′ = 0.4$, STE: 0.32). There was no significant difference in teacher's encouragement to participate - the number of questions asked by the teacher was similar in the two modes of instruction (FtF – Average: 45, SD: 4.93; AWC – Average: 46.57, SD: 5, $t(6) = 0.59$, $p > .5$, $d′ = 0.3$, STE: 0.54).

An equalization effect was not found. In 5 out of 7 groups in each media, one student was dominant and provided more than 50% of the verbal responses.

In terms of risk-taking, students in the audio-conferencing groups answered significantly more questions (Average: 20.6, SD: 4.5) than students in the face-to-face groups (Average: 13.5, SD: 3.7), $t(40) = 2.46$, $p < .05$, $d′ = 1.69$ (STE: 0.36).

3.3 Discussion

The null effect found for achievement supported the Media Naturalness Theory. Achievement was similar under the two conditions. MNT may explain that by arguing that the learner invested more cognitive efforts to compensate for the virtuality of the audio-written conferencing. However, perceived difficulty did not statistically differ between the two conditions, a result that corroborated Kock, Verville, and Garza (2007), but questioned the original MNT assumption. Media richness theory predicts better outcomes in the richest medium (face-to-face), and the Online Disinhibition Effect predicts better performance for invisibility condition, unless the level of negative disinhibited behavior is high. Neither prediction was supported. We found no evidence for negative disinhibited behavior in the current experiment.

Participants were significantly more satisfied with face-to-face instruction, a result that also supports the Media Naturalness Theory. Nevertheless, students did not perceive their learning to be worse (or better) in the audio-written conferencing condition. Regarding risk-taking, the results replicated the field study. Taken together, the laboratory study supported the media naturalness predictions to a greater degree, but some evidence for the effect of online disinhibition was also found.

Face-to-face learners felt that the lesson helped them memorize the content more readily than the audio-written conferencing learners. A possible explanation for this difference is that face-to-face teaching has less distracters or that the audio-written communication has some seductive details (e.g., highly interesting and entertaining information that is only tangentially related to the topic but is irrelevant to the teacher's intended theme; Garner, Brown, Sanders, & Menke, 1992; Harp & Mayer, 1998; Mayer, 2005). However, the post-tests did not statistically differ. In addition, the theoretical analysis of Robert and Dennis (2005) suggests exactly the opposite: a rich medium may have more distracters than a lean one. Together, this explanation is ruled out.

An equalization effect was not found. In most of the groups, one student was dominant and provided more than a half of the verbal responses, irrespective to the media used. Blau and Barak (2009) found equalization effect in written communication but not in audio communication, and explained their results by the ability of audio conferencing to clearly transmit social cues (like gender or race), which is an important source of status differences between the participants who interact at zero acquaintance.

Three limitations appeared in the laboratory study. First, it is possible that students were unfamiliar with the audio-written medium. After gaining more experience with this medium, the differences we found may disappear (Kock, et al., 2007). Second, we tested the students shortly after the lesson. It is possible that advantages of one mode of instruction or another have a long term effect that we did not uncover. Third, the pre- and post-tests used mainly factual questions, typified of relatively lower-level of thinking. Perhaps higher-level questions that call for integration or resolution of details would result in different findings.

4. GENERAL DISCUSSION

The effect of two media on three major dependent variables was tested. We found no significant difference in terms of achievement. In addition, we found significant differences between media in emotional satisfaction, but not in perceived learning. Significant differences between media were also found in behavioral variables: participation, risk taking, immediacy and flaming, but equalization effect did not occur.

The no significant difference in students' achievement that we documented in the laboratory experiment joins hundreds of similar research designs that found non-significant differences between instructional media (Arbaugh et al., 2009; Bernard et al., 2004; Russell, 1999). In more natural conditions, when students' actual grades are the dependent variable, one common explanation is that even though mediated communication tools may make

learning more difficult, students' motivation may force them to overcome the medium's obstacles by investing more cognitive efforts or by turning to out-of-the-educational-design resources. Clearly, students in our experiment preferred face-to-face instruction over audio-written conferencing; yet their outcomes were similar. Since in contrast to earlier documentations, students in our study could not turn to alternative resources, we may conclude that they invested more cognitive resources to overcome the uncomfortable learning condition. This compensatory process is proposed by Media Naturalness Theory and received some empirical support (Kock, 2001; Kock et al., 2007; Kock et al., 2008). This conclusion, however, is somehow weakened by students' report of perceived difficulty. Alternatively, MNT proposed that a medium that support conveyance of oral speech is considered natural to a higher degree relative to a medium that conveys facial expression and body language without enabling oral speech transactions. In that sense, face-to-face and audio-written conferencing are relatively close to each other in terms of naturalness, and the mental effort required might be similar (see also: Graetz, Boyle, Kimble, Thompson, & Garloch, 1998, for similar explanation).

A strong matching between perceived- and actual achievement was found. Such compatibility was reported in some studies (Dunlosky & Matvey, 2001; Koriat, 1997; Koriat & Bjork, 2006), when students learned pairs of words from a list. Nevertheless, unlike the current study, in these studies a significant difference was found between perceived and actual learning. A possible explanation for this difference between the studies is that we instructed and tested inter-related, coherent content, not an arbitrary list of words. The more ecological learning condition we had in the current study may help students both recall the learned material, and monitor the learning process more adequately, since learning may generate more memory cues that assist the process.

Caspi and Blau (2008) argued recently that perceived learning may rely on two independent sources: Cognitive and socio-emotional. The current results support the distinction Caspi and Blau suggested. The difference between the two instructional settings directly influenced the socio-emotional source, and perhaps only indirectly, if at all, the cognitive source. The cognitive source reflects the sense that new knowledge has been acquired, that some new understanding has been achieved, and other cognitive-based processes. In the current study "conceptions of learning" may indicate these sensations. When asked about their perception of learning (using the five conceptions of learning) students rated their perceived learning as high (Means about 5 in a scale ranged from 1 to 6) in three out of five concepts (increasing one's knowledge, memorization, and understanding) and at moderate level (Means about 3) in the remaining two concepts (implementation and change of perspective, two concepts of learning that probably need more time to be attained). Generally, there were no significant differences between media, a result that may strengthen what we found regarding achievement.

The socio-emotional source reflects experience and feelings. These are "peripheral" aspects of learning (Blau & Caspi, 2008), that in the present study were measured by the emotional evaluations, such as students' concentration and interest, learning satisfaction, and enjoyment from the interaction with tutor or peers. While conception of learning was similar in both instructional settings, emotional aspects of perceived learning were not. Although perceived difficulty did not statistically differ, after learning via audio-written conferencing students reported more attention loss, boredom, more difficulties, and less enjoyment. Our participants' emotional report supports Media Naturalness Theory. Kock (2005) suggested that "communication interactions in which certain elements of natural face-to-face communication are suppressed (e.g., the ability to employ / see facial expressions) involve a corresponding suppression of physiological arousal, and, in turn, a consequent decrease in the perceived excitement in connection with the communication interaction." (p. 123).

4.1 The influence of invisible communication on learning

The behavioral data found in the two studies are summarized as follows: Participation was higher in audio-written conferencing than in the face-to-face setting, but an equalization effect did not occur. Students answered more questions in audio-written conferencing, implying more risk-taking. Learning via audio-written conferencing resulted in more immediacy and in more flaming. We suggest that these results are due to the invisibility afforded by this tool, which instigated the Online Disinhibition Effect. Being invisible while communicating, students loosen their behavior, even when their identity is known. They may feel more secure, less prone to social criticism, and thus participate more and take more risks.

The influence of invisibility on learning is an important result of the two studies. A medium that affords invisibility is regarded as less natural (in terms of MNT) or less rich (in terms of MRT). Together, we may expect a detrimental impact of invisible communication on learning. Clearly, this is not what we found. Students participated more, took more risks, and expressed more immediacy. But these observed behaviors *did not* influence their achievements nor did they become more satisfied. Interacting without being seen (yet being known) may encourage students to be more active, an effort that may render satisfaction.

Some constructivist theories emphasize social learning and suggest active participation as a route to deeper learning (Garrison, 1989; Perkins, 1991). One interpretation of the current results may be that participation has an immediate price, which does *not* directly cause *better* outcomes. The current study was not designed to test whether this cost has any long term benefits. If such benefits exist, then invisible communication may be recommended.

Educational practitioners are sometimes worried about the negative consequences of anonymity in online learning. In the field study, students interacted with a weak level of anonymity and some occurrences of flaming were indeed found. It is noted again that we employed only invisibility, a "soft" kind of anonymity, which may reduce the level of negative disinhibited behavior. The trade-off between levering participation and negative disinhibited behavior should be considered when designing learning via communication media. Most evidence so far has suggested that there are more pros then cons for anonymity in educational setting. It seems that further investigation is needed.

5. SUMMARY

Communication media afford different degrees of anonymous interaction. The current studies manipulated invisibility among students that know each other well (in the field study) or have zero acquaintance (in the laboratory experiment). In both cases the behavioral data was similar: Students participated more and took more "cognitive" risks in invisible condition, results that are welcomed by constructivist theorizers. However, this type of interaction resulted in lower satisfaction, perhaps because it demanded a higher level of effort invested to compensate for the less natural communication conditions. In turn, achievement was similar in both instructional conditions, which might point to immediate cost (good achievement for low satisfaction). A possible long term benefit is yet to be tested.

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