

Media Naturalness and Online Learning: Findings Supporting Both the Significant- and No-Significant-Difference Perspectives

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ABSTRACT

Is the use of an online course delivery format, when compared with the more traditional face-to-face format, good or bad in the context of university education? Those who subscribe to the no-significant-difference perspective argue that online delivery is good, because it allows students with time and geographic distance constraints to obtain the education that they need, with no significant negative impact on the quality of the learning experience. Others argue that online delivery is bad, advocating a version of the competing significant-difference perspective, because the electronic communication media used for online delivery are not rich or natural enough to enable effective learning. This study contrasted students perceptions and grades in two different sections of the same course: one delivered entirely online and the other delivered face to face. Data were collected and analyzed at two points in time, namely, at the middle and end of a long semester. The study found support for both the no-significant- and significant-difference perspectives. At the middle of the semester, students in the online condition perceived communication ambiguity as significantly higher, and also obtained significantly lower grades, than students in the face-to-face condition. At the end of the semester, no significant differences were found.

Subject Areas: Communication Media, Compensatory Adaptation, Distance Education, Media Richness, Media Naturalness, Nonparametric Statistics, Online Learning, and Quasi-Experimental Design.

INTRODUCTION

The emergence of commercial Internet-based learning tools has led to an increasing realization by many higher education institutions that there are certain advantages

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in offering online courses (Day, Lou, & Van Slyke, 2004; Lee, Tan, & Goh, 2004). At the same time, there have been many voices against online education in colleges and universities (Calvert, 2005). Often those against the proliferation of online education have claimed that the use of electronic media for delivery of university courses prevents the use of nonverbal cues that are important for student learning (Hirschheim, 2005), leading to higher levels of communication ambiguity and cognitive (or mental) effort and generally less excitement in connection with the learning experience.

Proponents of online education generally argue that, while online courses do not have a negative impact on student learning outcomes, they do offer flexibility and convenience. The flexibility and convenience offered by online courses is especially useful for students who have time or distance constraints that prevent them from taking courses offered in a face-to-face (or traditional) format. Among those students are working adults, who often have difficulty attending classes offered during business hours, and students living in geographically isolated areas (e.g., certain rural areas). Those proponents argue that the quality of learning outcomes is usually not affected by the mode of delivery, which finds some support from studies where those outcomes are measured through course grades obtained by students (Newlin, Lavooy, & Wang, 2005). The perspective that the online delivery format has no effect on student learning outcomes has been dubbed the “no-significant-difference” perspective (Summers, Waigandt, & Whittaker, 2005).

One of the key arguments presented by those who are against the indiscriminate use of online education in university settings is that electronic media are not rich enough to enable successful student learning. This argument is very similar to that espoused by the proponents of the media richness theory (Daft & Lengel, 1986). The theory essentially takes the position that communication media that eliminate nonverbal cues present in face-to-face interaction lead to lower quality task outcomes (where the task in question can be that of online course delivery) than if the task were accomplished face to face. The media richness theory has been criticized for being deterministic (El-Shinnawy & Markus, 1998; Markus, 1994a), in spite of there being many empirical studies conducted over the years that provide general support for it (Graetz, Boyle, Kimble, Thompson, & Garloch, 1998; Kahai & Cooper, 2003; Lengel & Daft, 1988). This argument forms the basis for the perspective referred to here as the significant-difference perspective, which is presented as a competing perspective to the no-significant-difference perspective, and where the significant difference of online learning is for the worse.

The study reported here addresses the debate between proponents of the no-significant- and significant-difference perspectives, discussed above, by comparing student perceptions and grades in two sections of an introduction to management information systems course. The course in question was a required undergraduate course in the management information systems major program of a midsized university in the southern United States. One of the sections was delivered entirely online, and the other face to face. The final conclusion is that both significant and no significant differences may be found, depending on the stage of the course at which data is collected. The more time students have to adapt to the new course delivery medium, the further they will move from a significant-difference scenario and the closer they will be to a no-significant-difference scenario.

RESEARCH BACKGROUND AND HYPOTHESES

One of the fundamental premises of the significant-difference perspective discussed above is that online learning relies on electronic communication media that remove many of the desirable elements found in face-to-face interaction. That, in turn, creates problems for both students and instructors. The premise is consistent with more contemporary theoretical views of electronic communication, as well as with earlier theoretical views.

Among the earlier theoretical views that are consistent with the premise that electronic communication media suppress useful elements found in face-to-face interaction are the social presence (Short, Williams, & Christie, 1976) and media richness theories (Daft & Lengel, 1986). Both theories build heavily on the notion that communication media that suppress key face-to-face interaction elements, such as the ability to convey body language and oral speech, do not have enough “bandwidth” to enable “rich” communication. (This has also been called the “cues filtered out” view of electronic communication media—see, e.g., Markus, 1994b.) The problem with this notion is that its focus on the communication medium leaves out the communicators, which themselves may possess characteristics that make communication through different media more or less difficult (Kock, 2004; Lee, 1994; Markus, 1994a).

A more contemporary theoretical view that is consistent with the premise that electronic communication media often pose obstacles to communication is summarized into what has been called the “media naturalness” model (Kock, 2004, 2005b). The basic idea here is that human beings evolved a biological communication apparatus through millions of years of Darwinian adaptation and that such apparatus is largely designed for face-to-face communication. This is so for the simple reason that, during more than 99% of their evolutionary history, human beings and their ancestors communicated face to face, as there were no other communication media available. Given that, it is very unlikely that the human biological communication apparatus is designed to employ communication media elements that are too far removed from those found in face-to-face communication.

Electronic communication media often suppress key face-to-face communication elements, with the goal of creating other advantages. For example, Web-based bulletin boards and discussion groups enable asynchronous (or time-disconnected) communication, but at the same time make it difficult to have the same level of feedback immediacy found in face-to-face communication. That often leads to frustration from users who expect immediate feedback on their postings.

In spite of their completely different theoretical bases, the media naturalness model does espouse similar arguments to those put forth by the social presence (Short et al., 1976) and media richness theories (Daft & Lengel, 1986). However, there are differences in key areas of the theoretical models. One of those areas refers to the independent constructs put forth by the models and their hypothesized relationships.

The social presence and media richness theories have as their main independent constructs those of media choice and task outcome quality. That is, those theories often try to predict which media a user will choose given a certain task, generally assuming that users will choose rich media whenever available. If media

choices are constrained, the social presence and media richness theories generally predict that task outcome quality will be negatively affected by the choice of a lean medium.

The media naturalness model (Kock, 2005b), on the other hand, has as its main focus three main dependent constructs: communication ambiguity, cognitive effort, and excitement. The model hypothesizes that media that suppress elements found in face-to-face interaction (e.g., the ability to convey oral speech and facial expressions), even if selectively, will be seen by users as less natural than the face-to-face medium. The media naturalness model also hypothesizes that a decrease in a communication medium's naturalness will lead to an increase in communication ambiguity, an increase in cognitive effort (or mental effort) required from the users, and a decrease in the excitement experienced by the users when accomplishing a task through the medium.

The focus on media choice as a dependent construct by the social presence and media richness theories is not very useful when we try to understand the effects of online learning on students' perceptions and behavior. There is strong evidence that the perceived richness of a communication medium used in online learning is not the main reason why those students choose, or avoid, that delivery format (Hirschheim, 2005). Students may in fact see the communication medium as poor and still choose the online delivery format to avoid certain problems, such as traffic and long commute times.

The above discussion allows for the development of the hypotheses listed below. Following the media naturalness model, three of the hypotheses below refer to perceived ambiguity, perceived excitement, and perceived cognitive effort. Following the social presence and media richness theories, one of the hypotheses refers to students' grades, which reflect the hypothesized effect of media on task outcome quality. The hypotheses below refer to the middle of the semester, for reasons that will be explained in the paragraphs following the hypotheses.

- H1a: At the middle of the semester, perceived ambiguity will be significantly higher in the online section than in the face-to-face section of the course.
- H1b: At the middle of the semester, perceived cognitive effort will be significantly higher in the online section than in the face-to-face section of the course.
- H1c: At the middle of the semester, perceived excitement will be significantly lower in the online section than in the face-to-face section of the course.
- H1d: At the middle of the semester, grades will be significantly lower in the online section than in the face-to-face section of the course.

It is not uncommon to find in the online learning and electronic communication literatures investigations that carefully compare online and face-to-face courses (Newlin et al., 2005; Summers et al., 2005). However, there are few longitudinal studies of electronic communication media effects in the context of online learning courses. Most studies seem to focus on a one-shot cross-sectional analysis of effects, usually at the end of a course.

Longitudinal studies, by definition, rely on data collection and analysis at different points in time (Creswell, 2002; Pettigrew, 1991). The importance of

conducting longitudinal studies in the context of online learning comes from recent empirical evidence suggesting that users' reactions to electronic media can vary over time. More specifically, there is evidence that users of electronic communication media can adapt their behavior in such a way as to overcome what they perceive as some of the limitations of those media (DeSanctis & Poole, 1994; Kock, 2001; Qureshi & Vogel, 2000).

One theoretical model that incorporates the above notion is the compensatory adaptation model (Kock, 2001, 2005a). The model embraces the media naturalness view in connection with media effects on communication ambiguity experienced by users, cognitive effort required from them, and excitement experienced by users. The model also allows for effects regarding task outcome quality, as proposed by the social presence and media richness theories. However, the compensatory adaptation model essentially argues that those effects wane over time as users become more familiar with a particular communication medium (even if the medium is significantly less natural or rich than the face-to-face medium). This perspective can only be observed in longitudinal studies and provides qualified support for the no-significant-difference view of online education. The hypotheses below formalize this perspective by referring to what would be expected to happen at the end of the semester of a course whose two sections are taught online and face-to-face, respectively.

- H2a: At the end of the semester, perceived ambiguity will not be significantly different in the online section and the face-to-face section of the course.
- H2b: At the end of the semester, perceived cognitive effort will not be significantly different in the online section and the face-to-face section of the course.
- H2c: At the end of the semester, perceived excitement will not be significantly different in the online section and the face-to-face section of the course.
- H2d: At the end of the semester, grades will not be significantly different in the online section and the face-to-face section of the course.

In essence, hypotheses H2a to H2d propose that the effects hypothesized through H1a to H1d will not be observed. That is, H2a to H2d are what one could call a set of null hypotheses (or no-effect predictions) derived from the H1a to H1d hypotheses set. They are not actually null hypotheses because they hypothesize effects at a different point in time. Nevertheless, they capture the essence of the argument put forth by the compensatory adaptation model (Kock, 2001, 2005a), which is that, given enough time, low media richness or naturalness effects will significantly subside.

RESEARCH METHOD

This study involved 70 undergraduate students from a midsized state university in the southern United States. Approximately half of the students took an introductory information systems course online over a long academic semester (i.e., not a summer semester). The other half of the students took the same course face to

face. Overall, the students' ages ranged from 19 to 43 years, with a mean age of approximately 23. The percentage of male students was 54.

The online and face-to-face sections had the same content and used the same materials. The demographics for each of the sections generally mirrored those for the whole group. The ages of the students enrolled in the face-to-face section ranged from 19 to 37 years, with a mean age of approximately 23. In the online section, ages ranged from 19 to 43 years, with a mean of approximately 24. Among the students enrolled in the face-to-face section of the course, 58% were male. In the online section, 42% of the students were male.

The courseware suite used in the online section of the course was WebCT. For the face-to-face section, course materials were provided through a static Web page. In the online section, there were no face-to-face meetings, that is, all of the interaction took place online. Weekly sessions were made up of two main components: lectures and discussions based on readings. In the online section, the lectures were delivered as audio clips linked to a set of PowerPoint (Microsoft Corporation) slides. The content of those audio clips was essentially the same as that delivered orally by the instructor in face-to-face sessions.

The course readings were primarily book chapters and small articles made available electronically (as PDF files) to the students of both course sections. In the online section's discussions, the instructor played the role of an online discussion facilitator, essentially encouraging comments and questions on the readings and answering several of the questions. Class participation was measured online by the number and quality of electronic postings by each student. In the face-to-face section, class participation was measured by the number and quality of oral contributions. Quality contributions were seen as those that added to the material already provided by the instructor and that stimulated further discussion by leading to follow-up comments and questions.

The online discussion facilitator role was played much like the role the instructor played in the face-to-face section of the course, with the difference that online the facilitation was conducted primarily via text-based electronic postings, whereas the face-to-face facilitation was conducted orally. Most of the online interaction was asynchronous, through discussion boards. A comparatively small amount of the online interaction was conducted synchronously, through a course chat room. Appendix A provides additional details on the course.

The experimental design employed here is that referred to by Campbell and Stanley (1963) as the nonequivalent control group design, a form of quasi-experimental design. This design assumes no preexperimental sampling equivalence between the conditions being compared. In this study's case, students were not randomly distributed across the experimental conditions, namely the online and face-to-face course sections at the middle and the end of the semester. The students self-selected those conditions by enrolling in the online or the face-to-face course section. Once enrolled, they remained in the section for the duration of the course.

Given the quasi-experimental research design employed, the hypotheses were tested using nonparametric statistical analysis techniques (Siegel & Castellan, 1998). Statistical tests were applied on measures associated with key variables. Some of those variables were latent (Nunnally & Bernstein, 1994; Rosenthal & Rosnow, 1991) and thus had their underlying measurement models tested for reliability and validity prior to their use in the hypotheses-related tests. A latent variable

is a variable that is not measured directly, instead relying on a triangulation of perceptual indicators to be measured.

Latent variables are distinguished from manifest variables, in that manifest variables are measured directly and objectively. For example, age is a manifest variable, whereas vitality is a latent variable. Usually latent variables are measured through the use of two or more question statements that are answered on a Likert-type scale and whose answers are combined to reduce quantification error. One example of question statement for vitality could be "I feel a lot of energy," answered on a seven-point scale going from *very strongly disagree* to *very strongly agree*.

Additionally, the results of nonparametric tests were triangulated with summaries generated based on qualitative data analyses. This study contrasted different modes of course delivery at different points in time, which characterizes it as a longitudinal study. Both quantitative and qualitative data were collected at the middle and the end of the semester.

QUANTITATIVE DATA VALIDATION AND DESCRIPTIVE STATISTICS

Table 1 shows factor loadings and Cronbach alpha coefficients for the three latent variables of the study, namely, ambiguity, excitement, and cognitive effort. The extraction method used to calculate the factor loadings was principal component analysis. The rotation method employed was varimax with Kaiser normalization. The indicators (e.g., Ambig1, Ambig2, etc.) for each latent variable (Ambig) are shown in the same order as in Appendix B, where the question statements that refer to each indicator are listed.

These indicators, used for each latent variable, form a data collection instrument (or questionnaire) that has been previously validated in two communication media studies (Kock, 2005a; Kock, Verville, & Carmona, 2006). Those validations, when combined with the validation performed here, add to the confidence in the instrument's ability to yield trustworthy measurements of the latent variables in question.

The convergent validity of an underlying measurement model in connection with latent variables can be assessed based on whether factor loadings are above a certain threshold. The factor loadings in question are those associated with the

Table 1: Factor loadings and alpha coefficients.

	Ambig	Excite	Cogeff	Alpha
Ambig1	.78	.37	.11	.91
Ambig2	.85	.11	.24	
Ambig3	.92	.00	.23	
Ambig4	.89	.00	.22	
Excite1	.10	.90	.09	.75
Excite2	.08	.83	.32	
Cogeff1	.21	.19	.90	.79
Cogeff2	.40	.28	.74	

Notes: Extraction method: Principal component analysis.
Rotation method: Varimax with Kaiser normalization.

Table 2: Descriptive statistics.

	Ambig	Excite	Cogeff
Ambig	(.79)		
Excite	.27	(.81)	
Cogeff	.56	.46	(.83)
Mean	4.36	5.61	5.47
SD	1.55	1.20	1.09

Notes: Coefficients shown are bivariate correlations and average variances extracted (diagonal). All bivariate correlations are significant at the .01 level (two-tailed test). *SD* = standard deviation.

indicators expected (based on the data collection instrument design) to load on a specific latent variable. All of the factor loadings in Table 1 are significantly above the recommended threshold of .5 (Hair, Anderson, & Tatham, 1987), which suggests that the underlying measurement model has acceptable convergent validity.

Similarly to convergent validity, the reliability of an underlying measurement model in connection with latent variables can be assessed based on whether Cronbach alpha coefficients are above a certain threshold, usually .7 (Nunnally, 1978). As can be seen from Table 1, all Cronbach alpha coefficients are above that threshold, suggesting an acceptable reliability for the underlying measurement model.

Table 2 shows the bivariate correlations among the latent variables and the average variance extracted for each latent variable. Also shown in Table 2 are the means and standard deviations for each latent variable. Bivariate correlations are shown on the intersection between each pair of latent variables. Average variances extracted for each latent variable are shown on the diagonal.

The discriminant validity of a measurement model associated with latent variables can be assessed based on a comparison of bivariate correlations between latent variables and the average variances extracted for each variable. A fairly conservative assessment of the discriminant validity of a measurement model would require that the average variance extracted for each variable be higher than any of the bivariate correlations between that variable and any other variable in the model (Fornell & Larcker, 1981). As can be seen from Table 2, this is the case for the measurement model used in this study, suggesting that the measurement model has acceptable discriminant validity.

QUANTITATIVE ANALYSIS RESULTS

Table 3 shows the mean values for both the online and face-to-face class conditions obtained at the middle of the semester. The values are listed for each of the variables mentioned in the hypotheses. Table 3 also shows the *Z* and *P* coefficients calculated through a Mann-Whitney *U* test. This test is the nonparametric (Siegel & Castellan, 1998) equivalent of a *T* test (Rosenthal & Rosnow, 1991), and its goal is to assess the likelihood that the difference between means across the two conditions (i.e., online and face to face) is due to chance.

Table 3: Results at the middle of the semester.

	Mean Online	Mean Face to Face	Z	P
Ambig	4.77	4.03	2.33	<.05
Cogeff	5.56	5.16	1.64	.10
Excite	5.50	5.45	.17	.86
Grade	78.59	91.89	4.47	<.001

Note: Z and P scores were generated through a Mann-Whitney U test.

As can be seen from Table 3, the differences between the online and face-to-face means for the variables associated with perceived cognitive effort and perceived excitement were not statistically significant. Conversely, the differences between means for the variables associated with perceived ambiguity and grade (i.e., the grade obtained by a student in the midterm exam) were statistically significant. The difference between means for perceived ambiguity was significant at the .05 level, meaning that the probability that the difference is due to chance is lower than 5%. The difference between means for grade was larger, which is reflected by the higher Z coefficient and the P value of <.001 (suggesting a chance probability of <.1%).

Table 4 shows the mean values for both the online and face-to-face class conditions obtained at the end of the semester. As with Table 3, the values are listed for each of the variables mentioned in the hypotheses, and the Z and P coefficients shown were calculated through a Mann-Whitney U test.

The final exam grades were used in the analysis and are shown in Table 4 instead of the final course grades. The reason for this is that the final course grades would in part incorporate performance measures associated with the first half of the course (i.e., up to the middle of the semester) and thus make the analysis more difficult. If that were the case, one could argue that the analysis could not rely on a straight comparison of means, as done here. Instead, the performance in the first half of the course would have to be either statistically controlled for or factored out through a mathematical transformation of the final grade.

Table 4 suggests that the differences between the online and face-to-face means for the variables associated with perceived cognitive effort, perceived ambiguity, perceived excitement, and grade (i.e., the grade obtained by a student in the final exam) were all statistically insignificant. When compared with Table 3, the values in Table 4 suggest that the significant differences observed at the middle of the semester generally disappeared as the students moved toward the end of the semester.

Table 4: Results at the end of the semester.

	Mean Online	Mean Face to Face	Z	P
Ambig	4.56	4.15	1.33	.18
Cogeff	5.55	5.65	.43	.66
Excite	5.66	5.82	.61	.54
Grade	72.42	80.27	.75	.45

Note: Z and P scores were generated through a Mann-Whitney U test.

QUALITATIVE ANALYSIS RESULTS

The data for the qualitative analysis were obtained from the qualitative section of a questionnaire administered to the student subjects at the middle and end of the semester, in which the students were asked to provide comments on the positive and negative aspects of the course (see positive and negative aspects questions in Appendix B). Two techniques were employed in the qualitative analysis. The first technique involved finding “patterns” (Miles & Huberman, 1994; Yin, 1989) across the textual data. Using this technique the data were categorized into several patterns, and the frequencies of the patterns were calculated as percentages.

The second qualitative analysis technique employed was content analysis. Content analysis is a “catch-all term covering a variety of techniques for making inference from text data” (Boyle, 1994, p. 179). Wilson (1989) identified two different types of content analysis: manifest (semantic) content analysis and latent (inferred) content analysis. According to Robson (1993), the degree of inference (high or low) when categorizing and coding items determines whether the data is manifest or latent.

Manifest data are defined as data items that are physically present in the data. Manifest data are therefore considered to have a low degree of inference. In this study, examples of manifest data that were found included the words “learning” and “discussion.” Latent content is a “matter of inference or interpretation” (Robson, 1993, p. 276) on the part of the researcher and is considered to have a high degree of inference. One example of latent content in the data, again on the issue of “learning,” was found in the responses where the participants wrote about the knowledge acquired from the course and yet never mentioned the word “learned.” The technique used allows one to extrapolate what is being conveyed from statements that have the same general meaning.

Using the two techniques discussed above in an iterative way, participants’ responses were grouped along four categories: “Group/Team Interaction,” “Class Environment,” “Learning Outcomes,” and “Class Discussions.” These categories were then partitioned into four conditions: “Positive—Face-to-Face Condition,” “Negative—Face-to-Face Condition,” “Positive—Online Condition,” and “Negative—Online Condition.” The “Positive” and “Negative” qualifiers in the name of the conditions refer to positive and negative comments, respectively, made by the students about the course.

Tables 5 and 6 summarize the results of the qualitative data analysis of students’ textual responses provided at the middle (Table 5) and end (Table 6) of the semester. The top portion of each table summarizes positive and negative aspects identified by students in connection with the face-to-face condition. The bottom portion summarizes positive and negative aspects in connection with the online condition.

Students’ comments concerning group work make up the “Group/Team Interaction” category. The responses which form part of the “Class Environment” grouping refer to any conditions perceived by the students that may have an effect on their opinion regarding different class aspects. In other words, while for the online students there was no physical class environment because they were not in a traditional face-to-face course, there can still be environmental factors (similar

Table 5: Summary of positive and negative aspects at the middle of the semester.

Positive – Face-to-Face Condition	Negative – Face-to-Face Condition
<p>Group/Team Interaction (9.52%) ... team projects ... it gives us the opportunity to present our ideas ... help me a lot with working with teammates ... communicate and collaborate with other students ...</p>	<p>Group/Team Interaction (13.33%) ... team projects are difficult and time consuming ... was part of a group which lacked both responsibility and communication ... I was not completely in agreement to work on case studies or projects in a team or group. To work with individuals that lack initiative and responsibility ...</p>
<p>Class Environment (9.52%) ... interesting information and presentations ... it is very interesting class, especially when there are class discussions, it motivates me as a student to give my opinion and feel free to give them when I agree or disagree on an issue ...</p>	<p>Class Environment (73.33%) ... would feel more comfortable if a specific book was used ... the only negative aspect of this course is that it would be great if their was a field trip included in the course to help a person compare IT in other parts of the world ...</p>
<p>Learning Outcomes (54.76%) ... learning more of what technology has to do with business ... I have learned some concepts that I didn't know before taking it ... [and] ... learned how to communicate with other people.</p>	<p>Learning Outcomes (13.33%) ... some information is irrelevant to management ... If the course itself would maybe be based a bit more on management and maybe more "real world" scenarios, it would make it better.</p>
<p>Class Discussions (26.19%) ... enjoy coming to class to hear what is being said ... "open discussions" that took place during the class ... it gave rise to an interesting Q&A session ... I can actually look around the room during this session and see "wheels" turning stimulating the minds of the students ...</p>	<p>Class Discussions (0%) (None)</p>
<p>Positive – Online Condition Group/Team Interaction (30.76%) ... interaction with my classmates in an online environment ... forces students to really communicate amongst each other ... teamwork ... teammates really performed under a lot of stress extremely well ...</p>	<p>Negative – Online Condition Group/Team Interaction (71.43%) ... lack of communication between group members ... Some are young adults that don't take any pride nor responsibilities for their work ... Group members tend to depend 100% on Crew leaders.</p>

(Continued)

Table 5: Continued

Positive – Face-to-Face Condition	Negative – Face-to-Face Condition
<p>Class Environment (23.07%)</p>	<p>Class Environment (21.43%)</p>
<p>... you can work at own pace ... The positive aspect of this course have been that it is really interesting and useful. I can also move along in my own pace....</p>	<p>... easily fall behind and get lost, or forget about the posting ... I wasn't sure where to locate assignments and deadlines ... I wasn't familiar with computers ... You can fall easily behind, and it is hard to understand what exactly is meant to be done and where to post and what to post and with who to post ...</p>
<p>Learning Outcomes (38.46%)</p>	<p>Learning Outcomes (7.14%)</p>
<p>... learning same material as a regular class ... I think the positive aspects of this course is that I am learning stuff that I didn't know about computers ...</p>	<p>... no face-to-face contact ... diminishes the learning experience because there is no one there to share it with you, only your computer.</p>
<p>Class Discussions (7.69%)</p>	<p>Class Discussions (.0%)</p>
<p>The positive aspect has been learning about IT ... I don't have a lot of knowledge about computers ... I know some basic terms and information but only what I have learned from on the job training or experiences ... I struggle with the discussions because I don't feel confident about my knowledge of IT ... as the class moves forward I am getting familiar with general terms reading ... and opinions the class is posting.</p>	<p>(None)</p>

Note: The percentages shown represent the percentage of students providing comments on the different aspects of the course.

Table 6: Summary of positive and negative aspects at the end of the semester.

Positive – Face-to-Face Condition	Negative – Face-to-Face Condition
<p>Group/Team Interaction (28.57%) ... learned to work with a team. The team projects helped me to see how it is like in the field of business ... I had the opportunity to experience working as a team ... I liked the case studies and the final project because it gave me the opportunity to develop certain characteristics that you only [received] when you interact with people in their working environment.</p> <p>Class Environment (57.14%) ... the class was very interactive. Everybody participated in the class with questions and discussions ... enjoyed the presentations and explanations on the different topics covered in class.</p> <p>Learning Outcomes (0%) (None)</p> <p>Class Discussions (14.29%) ... working in groups and hearing different viewpoints. ... it opens my mind up to new ways of thinking.</p> <p>Positive – Online Condition</p> <p>Group/Team Interaction (30%) ... forces students to really communicate amongst each other ... teamwork ... The team projects have helped me to see how it is like in the field of business ...</p>	<p>Group/Team Interaction (60%) ... group which lacked both responsibilities and communication ... The negative part ... were the team projects. Most of us work and that is the main reason I am taking this online course, because it is supposed to save me time from meeting with any team members. Although it was a good experience to actually get to know my team members, it was kind of difficult because of our schedules.</p> <p>Class Environment (0%) (None)</p> <p>Learning Outcomes (40%) ... case studies and final project are time consuming and require great effort ... Sometimes it seemed like you were teaching at a very fast pace...</p> <p>Class Discussions (0%) (None)</p> <p>Negative – Online Condition</p> <p>Group/Team Interaction (25%) The negative aspects of this class are that sometimes you do not talk face-to-face with some partners, and it seems weird because you get to work together yet never meet, and I believe that it makes the projects a little harder.</p>

(Continued)

Table 6: Continued

Positive – Face-to-Face Condition	Negative – Face-to-Face Condition
<p>Class Environment (20%) ... the posting of audio files was great. It really helped a lot to understand each chapter ... and PowerPoint slides ... everything was available to us online.</p>	<p>Class Environment (58.33%) ... not to have a book ... I fell that I was missing something out ... like the classroom experience ... no personal class interaction ...</p>
<p>Learning Outcomes (40%) The positive aspect of this course is that the students get to learn about the ever changing world of computers ... gained knowledge about the topics covered in the sessions ... learned at our own pace. These type of courses stimulates students to think for themselves ...</p>	<p>Learning Outcomes (8.33%) There are some times where you are at home and you can't figure out how to do something.</p>
<p>Class Discussions (10%) ... communicating your opinions of related topics ... Interaction with my classmates in an online environment ...</p>	<p>Class Discussions (8.33%) ... discussions were not discussions but just vague descriptions of the lecture. A real discussion would use a real interaction between students ... I was unclear at the start about the group discussions and when and where postings should be done.</p>

Note: The percentages shown represent the percentage of students providing comments on the different aspects of the course.

to those in a face-to-face course), which can influence the individuals' perceived class experience. Finally, a number of comments regarding their learning experience ("Learning Outcomes") and their comments regarding class discussions ("Class Discussions") were also provided by the students. The quotation snippets provided under each of the four categories shown in Tables 5 and 6 are illustrative of the gist of the statements provided by the students.

Tables 5 and 6 suggest the interplay of a number of issues that have not been fully captured in the quantitative analysis. For example, no textbook was used in the course, with the required readings being various articles and papers provided online to the students. Arguably a textbook would provide the students with more structure, an issue that surfaced at the middle of the semester (but not at the end) in the face-to-face condition and at the end of the semester in the online condition. These observations are consistent with the notion that it is easier to make up for the lack of course structure face to face than it is online and help put the findings of the quantitative analysis in perspective. It is clear from Tables 5 and 6 that the quantitative analysis has captured only part of a more complex picture.

The qualitative analysis summarized in Tables 5 and 6 also suggests one interesting pattern that complements, and to some extent helps explain, some of the quantitative analysis results. Namely, "Group/Team Interaction" was the top category in terms of negative aspects perceived by the students in the online condition at the middle of the semester. This is consistent with the significantly higher perceived ambiguity revealed by the quantitative analysis in the online condition at the middle of the semester. This situation changed at the end of the semester, with only 25% of the students voicing negative aspects that could be categorized under "Group/Team Interaction." Again, this is consistent with the nonsignificant difference shown by the quantitative analysis in perceived ambiguity at the end of the semester.

Moreover, the above pattern suggests, in light of the quantitative analysis results, that the significant impact of the delivery mode on the students' grades at the middle of the semester might have been caused primarily because of communication ambiguity associated with online interaction. Cognitive effort and excitement differences are not mentioned prominently in the students' perceptions of negative aspects. This suggests that they may play a less prominent role than expected based on extant theoretical frameworks addressing communication media effects on perceptions and behavior.

DISCUSSION

This study suggests differential effects of the use of an online learning delivery format at the middle and end of the semester. At the middle of the semester, the online learning delivery format seems to have had a significant effect on two variables—communication ambiguity and grades. It increased communication ambiguity perceptions on average by approximately 18% and reduced grades on average by 14%. At the end of the semester, the online learning delivery format appears to have had no significant effects.

Table 7 summarizes the conclusions in connection with the hypotheses, based on the data analysis results. As can be seen, not all hypotheses were supported.

Table 7: Hypotheses and related conclusions based on the study's results.

Hypothesis	Conclusion
H1a: At the middle of the semester, perceived ambiguity will be significantly higher in the online section than in the face-to-face section of the course.	Supported.
H1b: At the middle of the semester, perceived cognitive effort will be significantly higher in the online section than in the face-to-face section of the course.	Not supported.
H1c: At the middle of the semester, perceived excitement will be significantly lower in the online section than in the face-to-face section of the course.	Not supported.
H1d: At the middle of the semester, grades will be significantly lower in the online section than in the face-to-face section of the course.	Supported.
H2a: At the end of the semester, perceived ambiguity will not be significantly different in the online section and the face-to-face section of the course.	Supported.
H2b: At the end of the semester, perceived cognitive effort will not be significantly different in the online section and the face-to-face section of the course.	Supported.
H2c: At the end of the semester, perceived excitement will not be significantly different in the online section and the face-to-face section of the course.	Supported.
H2d: At the end of the semester, grades will not be significantly different in the online section and the face-to-face section of the course.	Supported.

Notably, this study failed to find significant effects at the middle of the semester in connection with perceived cognitive effort and excitement. While the difference in cognitive effort (8% higher online than face to face) was just short of significant (the probability that it was due to chance is only 10%), the difference in terms of excitement was clearly insignificant. (It should be noted that these 2%, 8%, and 10% refer to very different calculations. The 8% difference was calculated by dividing the difference between the means for the online and face-to-face sections by the face-to-face section mean. The 10% chance probability was calculated through the nonparametric Mann-Whitney *U* comparison of means test.)

The above lack of significance for the difference in cognitive effort might have been due to the wording used in the question statements associated with the excitement construct (see Appendix B), as indicated by the qualitative analysis. If a reverse scale had been used for excitement, essentially indicating the level of lack of excitement (or dullness), the results might have been different. Incidentally, this is the direction hinted at by Kock (2005b), which was not followed in this study, and which is recommended in future research.

It is possible that unexpected factors influenced some of the communication media effects suggested by the results. For example, as suggested by the qualitative analysis, the lack of a textbook might have acted as a moderating effect by intensifying the sense of ambiguity at the middle of the semester. Having a textbook, as well as other structure-enhancing aids, could have mitigated or even eliminated

some of the effects observed at the middle of the semester. The same is true, as indicated again by the qualitative analysis, of group work. Having to work in groups seemed to have intensified some of the problems associated with the online course delivery format. These are issues that highlight the need for further research on the topic, particularly research employing more elaborate designs and involving longitudinal data collection and analysis.

If taken in isolation, the results obtained at the middle of the semester could be seen as supporting the significant difference perspective, discussed earlier. Similarly, had the results at the end of the semester been taken in isolation, they could have been seen as supporting the no-significant-difference perspective. The combined results, however, provide qualified support for both perspectives. More importantly, they call for a revision of extreme versions of both perspectives (for a more detailed discussion, see, e.g., Summers et al., 2005), and suggest the need for a middle-ground perspective on the impact of online course delivery formats on students' perceptions and performance in university courses.

The results presented also provide the basis for important theoretical insights. The main proponent of both the media naturalness (Kock, 2004, 2005b) and compensatory adaptation models (Kock, 2001, 2005a) has presented those models as possible replacements for the older (and, in some circles, more established) social presence (Short et al., 1976) and media richness theories (Daft & Lengel, 1986). This study suggests that those models and theories can be seen as complementary, rather than competing, views of the same phenomena. Some address constructs that others do not, the same being true of several of their predictions. In fact, this study is one of the first to employ those theoretical frameworks in complementary ways and find general support for the integrated resulting framework.

CONCLUSION

Due to the emergence of Internet-based learning tools, the presence of online education in colleges and universities has become more common. Those supporting online education claim that students in distant geographic locations, and students lacking the time to attend business-hour classes, can benefit from the flexibility of online programs by acquiring a quality education similar to that in a classroom. This view has been dubbed the no-significant-difference perspective.

However, those against online education believe that many of the face-to-face aspects of communication, which are essential for successfully educating students, are not present in electronic communication and therefore do not provide an effective learning experience. This argument can be seen as the opposite to the one above and is referred to here as the significant-difference perspective, where the significant difference of online learning is for the worse.

Both the social presence and media richness theories hold that the face-to-face elements of communication are needed in order to allow a rich communication (Short et al., 1976; Daft & Lengel, 1986). Hence, suppressing these elements can make effective communication more difficult to attain. Supporting these theories is the "media naturalness" model (Kock, 2004, 2005b), which states that throughout the Darwinian evolution of human beings face to face was the only available method

of communication, becoming the method that the human brain is designed for. This may cause successful online communication to become difficult to achieve.

The compensatory adaptation model (Kock, 2001, 2005a) holds that, while at some point there may be some differences in the levels of ambiguity, cognitive effort, and excitement experienced by electronic media users, these effects even out with time; leaving no significant differences between person-to-person and online communication. This study tests this theory by studying 70 undergraduate students, half of them taking an online information systems course and the other half taking the same course in a traditional classroom setting. Data were collected at the middle and end of the semester in order to measure differences in perceived ambiguity, perceived cognitive effort, and perceived excitement as well as class grades in both class formats.

The results of this study provide support for both the significant-difference and no-significant-difference perspectives. These results also suggest that the presence of perceived differences in ambiguity and grades throughout a course may become insignificant toward the end of the course. This supports the compensatory adaptation theory by implying that students will overcome differences existing in the two course formats, that is, online and face to face, as they progress through a course. In other words, students have the ability to become adapted to the differences between electronic media and face-to-face communication and eventually overcome the related communication media obstacles arguably posed by electronic media.

While providing general support for the compensatory adaptation theory, this study also suggests that the effects of media naturalness and compensatory adaptation are stronger for some constructs than for others. For example, low naturalness seems to have a stronger effect on communication ambiguity than on cognitive effort or excitement. Also, it seems that the strong and negative effect on communication ambiguity is closely related to a strong and also negative effect on objective performance, which in this study is measured through exam grades. Based on these findings, it seems reasonable to consider refining the compensatory adaptation model, by making communication ambiguity one of its central constructs and perhaps replacing cognitive effort or excitement with other constructs (or dropping those constructs from the model).

The findings of this study suggest some implications for those making decisions as to whether to use online instruction in their courses and to what extent. Instructors of courses delivered entirely online should try to get their online instruction departments to administer a questionnaire to students prior to their taking the online course, with the goal of advising and alerting them to the possible problems of taking the course online. That questionnaire should incorporate questions aimed at assessing the students' flexibility and ability to compensate for the obstacles posed by the less natural communication medium used. Depending on the answers, students should be advised not to take the course online (if at least one face-to-face session is available) or to prepare for the possible frustration resulting from the use of the less natural medium. Alternatively, instructors may decide to adopt a mixed approach, with a mix of online and face-to-face sessions during a course. In that case, it seems to make sense to concentrate the face-to-face sessions in the first half of the course, leaving the online sessions to the second half of the course.

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APPENDIX A: ADDITIONAL COURSE DETAILS

The goal of the course was to give students an understanding of management information systems issues arising from the increasing need for accurate, complete, and timely information within organizations. Traditional as well as emerging information technology management issues were covered. The course introduced, at a basic level, several issues in connection with networking, databases, and systems analysis and design.

Readings

The course included several readings—primarily book chapters and small articles. These were indicated in the course schedule and were provided to the students online. The course had no required textbook.

Team Case Studies

Each student team developed and wrote reports on two case studies of the implementation of technologies in real organizations. Each case study gravitated around the business impact of an information technology on an organization. The technologies selected were related to one or more of the topics covered in the course. It was a requirement that the case studies be based on interviews with actual organizational members (conducted face to face or by electronic means—e.g., phone or e-mail). An outline of the report to be written by teams for each case study was made available on the course Web site.

Team Project

Each student had to work on a course project. The project consisted of meeting (face to face or electronically) with members of a client organization (e.g., a department at a large company or a nonprofit organization), gathering relevant information from them, and developing a document (whose outline was available from the course Web site) containing the following elements:

- A set of organizational problems that could potentially be solved through the implementation of a technology related to one or more of the topics covered in this course. For example, a team might have studied a manufacturing plant and found out that the deployment of a particular information technology could solve key problems in one of its assembly lines.
- A detailed description of a technology solution to the problems above. This description included hardware and software details, as well as details

in connection with how the technology was integrated with existing technologies.

- A detailed description of the costs and potential benefits, from an organizational perspective, associated with the technology solution.

Grading

30% Team project, evaluated through: Project document and client perceptions of the team project. A letter from the main contact person the client organization, discussing the project, must have been provided to the instructor. The letter contained the contact information of the person writing so the instructor could call him/her up and inquire about the project.

30% Reports of the case studies (15% each).

30% Midterm and final exams (15% each).

10% Class participation (online or face to face, depending on the course section), evaluated through the ability of students to add to the material already provided by the instructor in (online or face-to-face) discussions. Students were encouraged to vary their types of contributions, alternating between questions, answers to other students' questions, and comments.

APPENDIX B: QUESTIONS USED

The question statements listed below were used for the collection of the quantitative and qualitative data analyzed in this study. The question statements in connection with the perceived ambiguity, excitement, and cognitive effort constructs were answered on a Likert-type scale going from 1 (*Very strongly disagree*) to 7 (*Very strongly agree*).

Ambiguity

- Ambig1: The communication of facts and knowledge has often been ambiguous.
- Ambig2: The communication of facts and knowledge has often been vague and confusing.
- Ambig3: I have often been unclear as to what was meant.
- Ambig4: Often I couldn't understand what was being conveyed.

Cognitive Effort

- Cogeff1: Taking this course has been a demanding and complex task.
- Cogeff2: Taking this course has entailed a lot of time pressure due to the pace at which the course progressed.

Excitement

- Excite1: I haven't felt bored at all while taking this course.
- Excite2: I felt that taking this course has been very stimulating.

Positive Aspects

What are the positive aspects of this course so far?

Negative Aspects

What are the negative aspects of this course so far?

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