

# Effects of Face-to-Face and Computer-Mediated Constructive Controversy on Social Interdependence, Motivation, and Achievement

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Cooperative learning capitalizes on the relational processes by which peers promote learning, yet it remains unclear whether these processes operate similarly in face-to-face and online settings. This study addresses this issue by comparing face-to-face and computer-mediated versions of *constructive controversy*, a cooperative learning procedure designed to create intellectual conflict among students. One hundred and one undergraduates were randomly assigned to a 1 (control: face-to-face)  $\times$  3 (medium: video, audio, text)  $\times$  2 (synchronicity: synchronous, asynchronous) experimental-control design. Cooperative perceptions declined and individualistic perceptions increased under asynchronous computer-mediated conditions, resulting in predicted declines in motivation (i.e., relatedness, interest, value) and academic achievement (i.e., completion rate). For practice, findings suggest that synchronicity but not medium plays an important role in computer-mediated constructive controversy. For theory, findings also suggest that social psychological theories based on face-to-face assumptions may need to be modified to indicate that predicted outcomes depend on synchronous social interaction.

**Keywords:** cooperative learning, technology, motivation, computer-mediated communication

Exponential growth in online course enrollment and ongoing concerns about the value and legitimacy of online education (e.g., Allen & Seaman, 2010) have made the effective integration of online technology, pedagogy, and content a top priority for policymakers, practitioners, and researchers alike (Mishra & Koehler, 2006). Accordingly, the purpose of this study is to move beyond general questions of the relative benefits of online and face-to-face (FTF) instruction by examining whether specific affordances of computer-mediated communication (CMC) affect cooperative learning procedures in which peers work together to achieve a shared educational goal (Johnson & Johnson, 1996; O'Donnell, 2006).

Numerous studies document the positive effects of cooperative learning (Johnson & Johnson, 1989, 2005; O'Donnell, 2006; Slavin, 1995), and its use is strongly encouraged in hybrid (combining FTF and online instruction) and online courses (more than 80% of content delivered online; e.g., Institute for Higher Education Policy, 2001; Western Association of Schools and Colleges, 2000). But there is a gap in knowledge about how to match the affordances of CMC with the demands of cooperative learning (Resta & Laferriere, 2007). This gap is more than a practical problem of improving online instruction because the ability of CMC to span temporal and geographical boundaries may also

reveal untested assumptions about the extent to which cooperative learning procedures depend on FTF interaction.

In this study we examine the relative impact of FTF and CMC versions of *constructive controversy*, a cooperative learning procedure designed to create intellectual conflict among students (Johnson & Johnson, 2007, 2009), on students' perceptions of social interdependence, motivation, and achievement. Constructive controversy is ideal for theory development because it is rooted in classic developmental (e.g., Kohlberg, 1969, 1975; Piaget, 1948, 1969), cognitive (e.g., Ames & Murray, 1982; Butera, Huguet, Mugny, & Prez, 1994; Doise & Mugny, 1984; Murray, 1972) and social (e.g., Deutsch, 1949, 1973; Johnson & Johnson, 1979) psychological theory and has been validated by over 40 years of research (see Johnson & Johnson, 2009). Thus, constructive controversy permits a reexamination of theoretical assumptions that may not generalize from FTF to CMC settings. Constructive controversy is also ideal for informing practice because it provides much needed information about how online versions of this and related cooperative learning procedures can best use the affordances of different CMC technologies.

The basic premise of this study is that whether CMC moderates the effects of constructive controversy depends on its *media richness*, or the ability of CMC "to clarify ambiguity and amplify understanding in a timely manner" (Maruping & Agarwal, 2004, p. 977). Communication researchers fiercely debate whether media richness affects the quality of interpersonal communication and relationships. On one side of the debate (e.g., Baltes, Dickson, Sherman, Bauer, & LaGanke, 2002; Short, Williams, & Christie, 1976), greater media richness is thought to offer higher quality communication and be more conducive to relational processes because it affords the transmission and reception of nonverbal social cues important to FTF interaction (e.g., vocal inflection, facial and emotional expressions, hand gestures, physical appear-

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ance). In contrast, less media richness is thought to offer lower quality communication by increasing the amount of time required for clear communication or by increasing ambiguity because it is less capable (or even incapable) of conveying the nonverbal social cues important to FTF relations. For this study, it follows that CMCs with less media richness may be less able to transmit the social cues essential to FTF constructive controversy, resulting in lower quality communication and undermining the relational processes upon which this and other FTF cooperative learning procedures depend.

On the other side of the media richness debate, the argument is made that communicators compensate for the absence of nonverbal social cues by adapting their language, style, and other cues to the affordances and constraints of whatever form of CMC they are using (e.g., Reicher, Spears, & Postmes, 1995; Walther, 1996). For example, using text-based CMC (e.g., e-mail, discussion forums, online chat), communicators may convey affective and relational information by employing emoticons and descriptive language (Walther, Loh, & Granka, 2005). Focusing on learning, Clark (2005) likewise argues that media richness is unrelated to educational outcomes, suggesting instead that media should be considered "mere vehicles that deliver instruction but do not influence student achievement any more than the truck that delivers our groceries causes changes in our nutrition" (Clark, 1983, p. 445; see also Bernard et al., 2004; Clark, 2005). For this study, it follows that there should be no differences between FTF and CMC versions of constructive controversy, either because students convey social cues by adapting to whatever form of CMC they are using or because media richness is unrelated to what really influences educational outcomes, namely, the instructional quality of the constructive controversy procedure.

Complicating the media richness debate is a lack of specificity about what relational processes are likely to be affected by media richness and why changes in these processes may be particularly important to educational outcomes like motivation, achievement, and interpersonal relationships. An important goal of this study was therefore to specify what relational processes may be affected by CMC media richness and why these processes in particular may affect constructive controversy outcomes. To this end, the present study is guided by two theoretical accounts of the relational processes underlying constructive controversy: social interdependence theory (Deutsch, 1949, 1973; Johnson & Johnson, 1989, 2005) and self-determination theory (Deci & Ryan, 2000). Before reviewing these theories, however, it is first necessary to define constructive controversy and briefly describe the procedure.

## Constructive Controversy

Constructive controversy is a cooperative learning procedure in which individuals argue incompatible views and together seek an agreement integrating the best evidence and reasoning from both positions (Johnson & Johnson, 2007). Constructive controversy differs from concurrence seeking, debate, and individualistic approaches to controversy by emphasizing both (a) deliberate discourse (i.e., the discussion of relative strengths and weakness of different positions) and (b) the shared goal of reaching an agreement integrating the best information from different positions. As detailed below, social interdependence theory suggests that it is the cooperative context created by this shared goal that results in constructive controversy's positive outcomes. Meta-analysis of over 40 years of research supports social interdependence theory's account of constructive controversy, showing that, compared with concurrence seeking, debate, and individualistic efforts, the procedure results in greater achievement, higher level reasoning, more accurate perspective-taking, greater motivation to achieve, more positive attitudes toward the task, and more positive attitudes toward individuals holding conflicting positions (Johnson & Johnson, 2009).

Briefly and as summarized in Table 1, the constructive controversy procedure includes five steps, with Steps 1 through 4 involving deliberate discourse and Step 5 the shared goal of reaching an integrative agreement. Before beginning the procedure, participants are first randomly assigned to pro and con sides of a controversy such as, in this study, whether schools should try to increase students' self-esteem (Abbeduto & Symons, 2008, pp. 117–130). In step one, same-side pairs then jointly prepare the best case for their assigned position (e.g., one same-side pair of students jointly prepares the best case for why schools should strive to increase students' self-esteem while another same-side pair of students jointly prepares the best case for why schools should not). In Step 2, new opposite-side pairs are created, and each student takes a turn presenting their best case to their opposite-side partner. In Step 3, opposite-side pairs then engage in an open discussion of the controversy, arguing forcefully and persuasively for their respective pro and con positions. In Step 4, opposite-side pairs reverse positions and present the opposing side's argument as accurately and forcefully as possible. Finally, in Step 5, opposite-side pairs drop all advocacy of their pro and con positions and jointly develop a written statement integrating the best information from both sides of the controversy. For greater detail about the

Table 1  
*Constructive Controversy Five Steps*

Step	Deliberate discourse				Shared goal
	1	2	3	4	
Position	Same	Same	Opposite	Opposite	None
Dyad #1	① + ③	① + ②	① + ②	② + ①	① + ②
Dyad #2	② + ④	③ + ④	③ + ④	④ + ③	③ + ④
Task	Prepare	Opening argument	Discussion	Reverse positions	Integrative agreement

Note. ① = student #1; ② = student #2; etc.

constructive controversy procedure, readers are referred to Johnson and Johnson (2007).

### **Relational Processes Underlying Constructive Controversy: Two Theoretical Accounts**

At least two theories account for the relational processes underlying constructive controversy: social interdependence theory and self-determination theory.

#### **Social Interdependence Theory**

Constructive controversy is rooted in social interdependence theory's (Deutsch, 1949, 1973; Johnson & Johnson, 1989, 2005) account of the way cooperative goals result in constructive controversy's positive outcomes. The basic premise is that the way in which social interdependence is structured determines how individuals interact, which, in turn, determines outcomes. Thus, when individuals' goals are structured cooperatively (*positive interdependence*), motivation increases as responsibility forces (i.e., feelings of obligation) impel each individual to do his or her fair share of the work. Achievement also increases as individuals tend to interact in ways that promote each other's success (e.g., providing assistance, sharing resources and information, and acting in trustworthy and trusting ways). More positive attitudes also tend to develop toward the activity and those who promoted one's success. In contrast, when individuals' goals are structured competitively (*negative interdependence*), interactions tend to promote personal goal attainment while being detrimental to the success of others (e.g., obstructing others' goal achievement efforts, hiding resources and information, and acting in distrustful and distrusting ways). As a result, both motivation and achievement tend to decrease when goals are structured competitively, especially for those individuals who believe there is little or no chance of winning. In addition, more negative attitudes also tend to develop toward the activity and those who obstruct one's success. Finally, the absence of goal structures (*no interdependence*) results in the absence of interaction and has no effect on motivation, achievement, or attitudes. To date, we know of no previous research testing whether CMC affects constructive controversy or, more precisely, whether CMC affects students' perceptions of social interdependence, motivation, academic achievement, and relatedness to their conflicting partner. This study addresses these issues.

#### **Self-Determination Theory**

Self-determination theory (Deci & Ryan, 2000) posits that students' psychological needs for competence (feeling of accomplishment that is derived from effective functioning), autonomy (the perception of control over one's own actions), and relatedness (feelings of security and belonging in the social environment) must be met to achieve self-regulation, intrinsic motivation, and personal well-being. Importantly, self-determination theory posits that students' psychological needs are interrelated and failing to fulfill one necessarily compromises the others. To date, we know of no research testing whether CMC affects students' self-determination needs or, more precisely, whether CMC affects students' perceptions of competence, relatedness, value, and interest. This study also addresses these issues.

There are at least two important distinctions between social interdependence theory and self-determination theory's accounts of the relational processes underlying constructive controversy. First, the two theories specify different relational processes underlying constructive controversy. Social interdependence theory posits that increasing motivation, achievement, and more positive attitudes are all outcomes of cooperative perceptions and promotive interaction patterns. In contrast, self-determination theory posits that fulfilling students' psychological needs for autonomy, competence, and relatedness creates the antecedent conditions necessary for intrinsic motivation and subsequent achievement. Second, only social interdependence theory specifies an operational mechanism (i.e., cooperative goal structures) that may be influenced by practitioners concerned with enhancing students' motivation, achievement, and interpersonal relationships. Self-determination theory specifies the necessary conditions for these outcomes without detailing how to create those conditions.

### **CMC and Cooperative Learning: Effects of Synchronicity and Medium**

In this study, media richness was operationalized in terms of two dimensions: synchronicity and medium (Baltes et al., 2002; Kozma, 1991; Moreno & Mayer, 2007). *Synchronous* interaction reflects the concurrent and dynamic nature of interpersonal interaction, allowing communicators to verify immediately that others understand the intended meaning of their message both explicitly and by way of communicating nonverbal social cues (Johnson & Johnson, 2006). *Medium* includes video, audio, and text-based CMC, and the relative abilities of each to communicate vocal, nonverbal, and physical cues typical of FTF interaction (Mayer & Moreno, 1998). To date, we know of no other studies comparing FTF constructive controversy or any other cooperative learning procedure with both synchronous and asynchronous forms of different CMC mediums. Instead, extant research focuses on limited combinations of synchronicity and medium and, as a result, offers little guidance about the relative impact of these factors on the relational processes underlying cooperative learning procedures.

#### **Synchronicity**

To date, we know of no other studies comparing FTF cooperative learning with both synchronous and asynchronous forms of CMC cooperative learning. Instead, extant research either compares FTF social interaction with one (e.g., synchronous) or the other (e.g., asynchronous) form of CMC synchronicity. For example, only one study has compared FTF and synchronous CMC versions of a cooperative learning task. Chou and Min (2009) compared FTF and synchronous CMC versions of a 3-hr cooperative learning task among Taiwanese business undergraduates. Results were mixed, with no significant differences between FTF and synchronous CMC in achievement (multiple-choice and essay questions) but greater depth and less breadth of information sharing in FTF compared with synchronous CMC. However, since the CMC condition included both FTF verbal discussion and CMC (i.e., Microsoft's JoinNet text-based chat), it is impossible to know whether these effects were due to CMC synchronicity, the text-based medium, the combination of synchronicity and text-based

medium, or the combination of these factors with additional FTF discussion.

Two other studies have compared FTF and asynchronous CMC versions of cooperative learning tasks, both finding positive effects for asynchronous, text-based CMC. Zion, Michalsky, and Mevarech (2005) compared FTF and asynchronous text-only versions of a cooperative learning task involving 10th grade students in Israel. Results showed that the asynchronous, text-only group outperformed FTF on tests of general scientific ability and inquiry skills. Likewise, Benbunan-Fich, Hiltz, and Turoff (2003) compared FTF and asynchronous text-only versions of a cooperative decision-making task involving undergraduates. Results showed that asynchronous, text-only groups submitted longer and more complete reports (measured by number of issues mentioned in the report) than FTF groups, but the two groups did not differ in terms of transferring this information to an integrated final report. These mixed findings make the study's implications difficult to interpret.

Taken together, both Zion et al. (2005) and Benbunan-Fich et al. (2003) suggest that asynchronous text-based CMC may outperform FTF, perhaps due to the affordances of increased time for thinking, decreased passivity of students compared with FTF peer discussions, and the ability of students to review documentation of their discussions. The empirical basis for this conclusion is weak, however, and it remains unknown whether the studies' results generalize to both FTF and synchronous CMC, other CMC mediums (e.g., video, audio), or to the constructive controversy method in particular.

## Medium

Turning to the question of whether medium affects the relational processes underlying cooperative learning, only one study compares synchronous versions of different mediums. In an experimental study, Yamada (2009) compared synchronous video, audio, and text versions of a 15-min decision-making task involving nonnative English speakers. Results showed that students in the synchronous audio and video conditions reported significantly higher social presence (i.e., perceptions of ease of communication and natural communication), supporting the view that greater media richness is more conducive to relational processes. However, since this study only tested synchronous mediums, it is unknown whether the results generalize to asynchronous CMC. It is also unknown whether the results are limited to relational outcomes like social presence or generalize to achievement and motivation. It is also unknown whether the short 15-min decision-making task used by Yamada (2009) generalizes to cooperative learning procedures with longer duration, such as constructive controversy.

Finally, only one study compares asynchronous versions of different mediums. Lin and Laffey (2006) compared the effects of asynchronous mediated interaction tools (discussion board, e-mail, Web-based document editor) on team members' perceived positive interdependence (i.e., cooperation). Results showed that the group using the discussion board least frequently also reported the lowest levels of positive interdependence. However, since all groups chose to use all the asynchronous interactions tools over the course of the study, it is impossible to know whether the finding was due to differential CMC effects or to the varied combinations of all these tools.

## The Present Study

To summarize, the purpose of the present study is to examine whether CMC media richness, operationalized in terms of synchronicity and medium, affects the relational processes and educational outcomes associated with the cooperative learning procedure, constructive controversy. Guided by social interdependence theory, we predict that to the extent that CMC decreases students' cooperative perceptions and increases competitive or individualistic perceptions, there will be corresponding decreases in motivation and achievement and more negative attitudes toward the activity and their conflicting partner. Guided by self-determination theory, we also predict that to the extent that CMC decreases students' perceptions of competence and relatedness, there will be corresponding decreases in motivation.

## Method

### Participants

This study was conducted in seven face-to-face (FTF) introductory-level educational psychology courses at a large, public Midwestern university. These courses are required of all teacher education students, the majority of whom (>80%) are female. Eligibility criteria for the study included voluntary participation and signed consent of an undergraduate student between the ages of 18 and 24. Exclusion criteria included the inability to read and write in English and unwillingness to follow procedural directions. We recruited participants by contacting course instructors and, pending instructor approval, inviting students to participate by having the primary investigator describe the study in each of the course sections. Participants received course credit for participation. In all, 80% ( $N = 118$ ) of recruited students agreed to participate in the study, with  $n = 28$  absent on the day of the study and  $n = 2$  choosing to complete an alternative class activity. Procedures associated with the study were reviewed and approved by the sponsoring university's institutional review board (IRB No. 10-194).

### Procedures

A 1 (FTF: control)  $\times$  2 (synchronicity: synchronous, asynchronous)  $\times$  3 (medium: video, audio, text) between-subjects experimental-control design was used in this study. The seven class sections were randomly assigned to the FTF (one section), synchronous CMC (three sections), and asynchronous CMC conditions (three sections). Within each CMC condition, individual participants were randomly assigned to video, audio, or text groups, respectively. Individual participants were also randomly paired as partners, and each one was randomly assigned to the constructive controversy's pro or con position. All participants in all conditions worked on the same controversy ("Should schools try to increase students' self-esteem?") and, prior to starting the controversy, received the same background readings and bulleted review sheets pertaining to the pro or con sides, respectively.

### Materials

Materials in this study included paper-based resources and technologies used to facilitate synchronous and asynchronous commu-

nication. Dependent measures were presented at the end of the controversy procedure via a Web-based survey. During the controversy procedure, all participants in all conditions were shown the same video recordings that explained each of the constructive controversy's five steps. For all conditions save the FTF control, an online activity scaffold (see Appendix A for the complete scaffold) was used to guide the controversy procedure. Specifically, each dyad in the synchronous and asynchronous CMC conditions was assigned one unique online activity scaffold allowing the dyads to co-compose and co-edit the integrated essay in Step 5 of the controversy procedure. For the asynchronous CMC condition, the activity scaffold was also used to share their statements with their partners during Steps 1 through 4 of the controversy procedure. Table 2 summarizes materials for all conditions.

**Paper-based resources.** Participants in all conditions were randomly assigned to either the pro or con position of the controversy and, 1 day prior to the controversy activity, given readings pertaining to the side of the argument that they were randomly assigned. Participants assigned to the pro side were given an article by Robert Sylwester, entitled "Yes: The Neurobiology of Self-Esteem and Aggression" (Abbeduto & Symons, 2008, pp. 117–121), while participants assigned to the con side were given an article by Carol Dweck, entitled "No: Caution—Praise Can Be Dangerous" (Abbeduto & Symons, 2008, pp. 122–130). Prior to starting the controversy activity, participants were also given one-page bulleted sheets outlining the main arguments of their respective articles.

**Synchronous CMC.** Each participant in the synchronous CMC condition was given a laptop computer with an integrated Web camera and microphone to use for the duration of the controversy procedure. All synchronous CMC dyads used the Skype software application; the audio, video, and text groups used only those respective capabilities of the software to communicate. Each synchronous CMC dyad was also assigned a unique, co-editable online activity scaffold created with Google Docs (<http://docs.google.com>). The Google Docs activity scaffold allowed for

near real-time co-editing (often less than 3-s delay in updating recent edits) of written text.

**Asynchronous CMC.** Participants in the asynchronous CMC group were trained in class on how to record and share statements (video, audio, or text) with their partners, and participants who did not own the necessary equipment to record their statement (e.g., personal computer, web camera, and/or microphone) were given these materials to use for the controversy activity. Asynchronous CMC participants in the video and audio group used the ViewPoint Flash-based Web application (available from <http://clear.msu.edu/viewpoint>) to record video and audio statements. Asynchronous CMC participants in the text-only group typed their statements in the online Google Docs activity scaffold.

## Independent Variables

The independent variables were synchronicity and medium. For synchronous CMC, participants completed the controversy procedure during the regular 70-min class period. For each medium in synchronous CMC, the video, audio, and text-based dyads followed this same constructive controversy procedure outlined above, save for using different forms of CMC (i.e., video, audio, and text-only conditions). For asynchronous CMC, the five-step constructive controversy procedure was modified to extend over a week's time. For each medium in asynchronous CMC, the video, audio, and text-based dyads received roughly 20 min of technological training in class before following the constructive controversy procedure in short increments each day over the following week. The control condition was FTF constructive controversy, with participants completing the controversy procedure during the regular 70-min class period.

## Dependent Variables

There were three dependent variables: social interdependence, motivation, and achievement. Except for the integrative essay,

Table 2  
Materials

Synchronicity	Medium			Duration
	Video	Audio	Text	
FTF <sup>a</sup>	Video instructions Review sheet <sup>b</sup>	Video instructions Review sheet	Video instructions Review sheet	70 min
Synchronous <sup>c</sup>	Skype Google Docs scaffold <sup>d</sup> Video Instructions Review sheet	Skype Google Docs scaffold Video instructions Review sheet	Skype Google Docs scaffold Video instructions Review sheet	70 min
Asynchronous	ViewPoint <sup>e</sup> Google Docs scaffold Video instructions Review sheet	ViewPoint Google Docs scaffold Video instructions Review sheet	Google Docs scaffold Video instructions Review sheet	7 days

Note. Face-to-face (FTF) conditions did not involve the use of video, audio, or text-based communication.

<sup>a</sup> Video instructions for the five steps of the controversy procedure were recorded and presented in identical form to each group in the study. <sup>b</sup> A review sheet was given to each participant pertaining to the main points of their respective position in the controversy. <sup>c</sup> The Skype communications computer application was used in conjunction with computer webcams and microphones to facilitate video, audio, and text communication. <sup>d</sup> The Google Docs editable online platform was used to scaffold the activity and facilitate the collaborative completion of the activity by dyads (see Appendix A). <sup>e</sup> The ViewPoint Flash-based web application (available from <http://clear.msu.edu/viewpoint>) was used to record video and audio statements for each step of the constructive controversy procedure.

participants completed all measures independently (e.g., after completing Step 5 of the constructive controversy procedure), and all dependent variables were based on student ratings of scale items ranging from 1 (*not at all*) to 7 (*very much so*).

**Social interdependence.** Attitudes toward three forms of social interdependence were assessed using the Social Interdependence Scale (Johnson & Norem-Hebeisen, 1977): cooperation (seven items;  $\alpha = .94$ ), competition (seven items;  $\alpha = .91$ ), and individualism (seven items;  $\alpha = .91$ ).

**Motivation.** Motivation was assessed using four subscales of the Intrinsic Motivation Inventory (Ryan, 1982): Perceived Competence (six items;  $\alpha = .89$ ), Interest (seven items;  $\alpha = .93$ ), Value (seven items;  $\alpha = .94$ ), and Relatedness (eight items;  $\alpha = .87$ ).

**Achievement.** Knowledge and understanding of background readings associated with the controversy topic (i.e., “Should schools try to increase students’ self-esteem?”; Abbeduto & Symons, 2008, pp. 117–130) was assessed using four multiple-choice items ( $\alpha = .55$ ). Critical thinking in the final joint essay was assessed using an adapted form of the three-factor Critical Thinking Rubric (Bleifield & Paulus Critical Thinking Group, 2006; see Appendix B for complete rubric): knowledge ( $\kappa = .83$ ), application ( $\kappa = .77$ ), and synthesis ( $\kappa = .88$ ). Reliability was determined by comparing independent coding for 25 essays by each of the three authors.

## Results

### Participant Flow

There were  $n = 17$  participants in the asynchronous conditions (video = 6, audio = 7, text = 4) who did not complete the experiment, nor did they report why this occurred. Therefore, the

final number of participants used in the data analyses was  $n = 101$  (77 women), with a mean age of 19.7 years ( $SD = 1.6$ , range = 18–28). Table 3 summarizes participant flow by condition and also reports descriptive statistics for each dependent variable.

### Correlational Analyses

Relationships between dependent measures were examined by computing Pearson-product correlations. Supporting the statistical validity of this approach, visual inspection of scatterplots and boxplots provided no evidence of univariate outliers. Table 4 reports the results.

Focusing first on students’ perceptions of social interdependence, cooperative perceptions were highly negatively correlated with individualistic perceptions ( $r = -.73$ ,  $p < .01$ ), and a small positive correlation was found between cooperative and competitive perceptions ( $r = .20$ ,  $p = .03$ ). There was no significant association between competitive and individualistic perceptions. Results suggest that cooperative and individualistic perceptions were inversely related, whereas cooperative and competitive perceptions were moderately positively related.

Cooperative perceptions were also highly positively correlated with all four motivational measures (i.e., relatedness, interest, competence, value;  $rs$  ranging from .60 to .76, all  $ps < .01$ ), and individualistic perceptions were highly negatively correlated with all four motivational measures ( $rs$  ranging from  $-.48$  to  $-.68$ , all  $ps < .01$ ). Results suggest that cooperative perceptions were associated with increased motivation while individualistic perceptions were associated with decreased motivation. Interestingly, small positive correlations were also found between students’ competitive perceptions and interest ( $r = .27$ ,  $p < .01$ ), competence ( $r = .19$ ,  $p = .04$ ), and value ( $r = .24$ ,  $p = .01$ ), even as there

Table 3  
Demographics and Descriptive Statistics

<i>n</i> /Dependent variable	FTF	Video		Audio		Text	
		Async	Sync	Async	Sync	Async	Sync
Eligible <i>n</i>	22	22	18	22	24	22	18
Enrolled <i>n</i>	18	14	16	16	20	17	17
Analyzed <i>n</i> ( <i>n</i> female)	18 (15)	8 (8)	16 (11)	9 (8)	20 (14)	13 (9)	17 (12)
	<i>M</i> ( <i>SD</i> )						
Achievement							
Multiple-choice	3.39 (0.97)	3.00 (1.06)	3.44 (0.72)	3.60 (0.89)	3.10 (1.11)	2.92 (1.18)	3.00 (0.93)
Critical thinking							
Knowledge	2.00 (0.84)	2.13 (0.64)	2.13 (0.61)	2.80 (1.30)	1.90 (0.96)	2.38 (0.76)	1.76 (0.66)
Application	1.89 (0.58)	1.63 (0.51)	2.00 (0.73)	2.60 (1.34)	2.00 (0.91)	2.00 (0.57)	1.53 (0.71)
Synthesis	1.67 (0.84)	1.63 (0.51)	1.88 (0.61)	2.00 (1.00)	22.00 (1.02)	1.85 (0.68)	1.59 (0.61)
Motivation							
Relatedness	47.44 (5.22)	30.75 (7.32)	41.25 (7.16)	34.33 (11.16)	44.30 (7.11)	35.58 (6.54)	41.29 (8.43)
Interest	33.89 (6.77)	23.50 (9.62)	29.62 (7.18)	17.66 (6.91)	31.05 (11.73)	24.83 (8.10)	30.82 (9.26)
Competence	31.67 (4.89)	26.00 (6.94)	27.62 (5.34)	24.00 (5.10)	28.65 (8.20)	26.25 (6.09)	25.88 (7.89)
Value	39.89 (6.50)	30.25 (8.53)	33.00 (8.50)	25.00 (10.67)	32.55 (10.45)	29.00 (6.96)	32.52 (6.14)
Social interdependence							
Cooperative	40.88 (7.33)	33.00 (9.28)	36.25 (5.84)	23.11 (8.92)	36.70 (8.71)	30.50 (6.55)	34.23 (7.85)
Competitive	26.00 (9.69)	23.50 (11.68)	22.43 (8.23)	17.56 (7.02)	26.60 (11.65)	28.16 (10.33)	22.94 (10.91)
Individualistic	12.50 (6.15)	22.87 (9.46)	17.06 (9.31)	25.33 (9.51)	14.75 (7.67)	18.67 (7.24)	16.94 (8.47)

Note. FTF = face-to-face; Async = asynchronous; Sync = synchronous.

Table 4  
*Intercorrelations Between Dependent Variables*

	1	2	3	4	5	6	7	8	9	10	11
Achievement											
1. Multiple choice	—	.13	.11	.01	.14	-.05	.18	.13	.13	-.13	-.14
Critical thinking											
2. Knowledge	—		.86**	.67**	-.21*	-.21*	-.01	-.10	-.19	-.10	.09
3. Application		—		.77**	-.13	-.15	.01	-.06	-.17	-.07	.01
4. Synthesis			—		-.13	-.20*	-.04	-.16	-.13	-.08	-.06
Motivation											
5. Relatedness					—	.52**	.44**	.52**	.63**	-.04	-.68**
6. Interest						—	.65**	.75**	.68**	.27**	-.55**
7. Competence							—	.69**	.60**	.19*	-.48**
8. Value								—	.76**	.24*	-.50**
Social interdependence											
9. Cooperation									—	.20*	-.73**
10. Competition										—	-.01
11. Individualism											—

\*  $p < .05$ . \*\*  $p < .01$ .

was no significant correlation with relatedness. Results suggest that competitive perceptions were also associated with increased motivation as measured by interest and competence, but not as measured by relatedness.

For achievement, there were no significant correlations between the multiple-choice scores and the three critical-thinking scores, even as the critical thinking scores were all highly positively correlated ( $r_s$  ranging from .67 to .86, all  $p < .01$ ). Findings suggest that multiple-choice scores did not predict the critical thinking scores. Surprisingly, multiple-choice scores were also not significantly correlated with motivation and social interdependence measures. However, small negative correlations were found between knowledge and relatedness ( $r = -.21$ ,  $p = .03$ ) and interest ( $r = -.21$ ,  $p = .03$ ), and between synthesis and interest ( $r = -.20$ ,  $p = .04$ ). Results suggest that achievement was unrelated to motivation and perceptions of social interdependence, with the exception of small negative associations between knowledge and synthesis ratings and the motivation variables relatedness and interest.

### Factorial Analyses of Experimental CMC Conditions

Next, because a full factorial using the FTF control was impossible (e.g., asynchronous FTF does not exist), experimental main effects and interactions were analyzed using a 2 (synchronicity: synchronous, asynchronous)  $\times$  3 (medium: video, audio, text) multivariate analysis of variance (MANOVA), and post hoc tests were conducted using Bonferroni multiple comparisons, where  $\alpha = .05/c$ , and  $c$  = the number of pairwise comparisons. Supporting the statistical validity of this approach, there was no evidence of multivariate outliers, and nonsignificant tests of Box's  $M$  suggested that the homogeneity of variance–covariance matrix assumption was not violated.

**Social interdependence.** For perceptions of social interdependence, results showed a significant multivariate omnibus for synchronicity, Wilks's  $\lambda = 0.83$ ,  $F(3, 74) = 4.79$ ,  $p < .01$ ,  $\eta_p^2 = 0.16$ , and the synchronicity–medium interaction, Wilks's  $\lambda = 0.84$ ,  $F(6, 148) = 2.22$ ,  $p = .04$ ,  $\eta_p^2 = 0.08$ . For synchronicity, the

between-subjects test was significant for cooperation,  $F(1, 76) = 14.07$ ,  $p < .001$ ,  $\eta_p^2 = 0.15$ , and individualism,  $F(1, 76) = 9.25$ ,  $p < .01$ ,  $\eta_p^2 = 0.10$ , but not significant for competition,  $F(1, 76) = 0.14$ ,  $p = .70$ ,  $\eta_p^2 < 0.01$ . For cooperation, synchronous ( $M = 35.72$ ,  $CI_{95\%} = 33.57$  to 37.88) was greater than asynchronous CMC ( $M = 28.87$ ,  $CI_{95\%} = 25.93$  to 31.80). And for individualism, asynchronous ( $M = 22.29$ ,  $CI_{95\%} = 19.10$  to 25.48) was greater than synchronous CMC ( $M = 16.25$ ,  $CI_{95\%} = 13.91$  to 18.58). Results suggest that, compared with synchronous CMC, asynchronous CMC resulted in decreased cooperative perceptions and increased individualistic perceptions.

For the synchronicity–medium interaction, the between-subjects test was significant for cooperation,  $F(2, 76) = 3.42$ ,  $p = .03$ ,  $\eta_p^2 = 0.08$ , and competition,  $F(2, 76) = 3.29$ ,  $p = .04$ ,  $\eta_p^2 = 0.08$ . For cooperation, synchronous audio ( $M = 36.70$ ,  $CI_{95\%} = 33.21$  to 40.18) was greater than asynchronous audio ( $M = 23.11$ ,  $CI_{95\%} = 17.91$  to 28.30). There were no significant post hoc comparisons for competition. Results suggest that cooperative perceptions decreased more under asynchronous audio compared with synchronous audio.

**Motivation.** For motivation, MANOVA results showed a significant multivariate omnibus for synchronicity only, Wilks's  $\lambda = 0.71$ ,  $F(4, 73) = 7.37$ ,  $p < .001$ ,  $\eta_p^2 = 0.28$ , and the between-subjects tests were significant for relatedness,  $F(1, 76) = 24.14$ ,  $p < .001$ ,  $\eta_p^2 = 0.24$ ; interest,  $F(1, 76) = 15.30$ ,  $p < .001$ ,  $\eta_p^2 = 0.16$ ; and value,  $F(1, 76) = 5.32$ ,  $p = .02$ ,  $\eta_p^2 = 0.06$ . For all three measures, synchronous was greater than asynchronous CMC. Specifically, for relatedness, synchronous ( $M = 42.28$ ,  $CI_{95\%} = 40.19$  to 44.37), was greater than asynchronous CMC ( $M = 33.55$ ,  $CI_{95\%} = 30.70$  to 36.40). For interest, synchronous ( $M = 30.50$ ,  $CI_{95\%} = 27.94$  to 33.05) was greater than asynchronous CMC ( $M = 22.00$ ,  $CI_{95\%} = 18.50$  to 25.49). And for value, synchronous ( $M = 32.69$ ,  $CI_{95\%} = 30.34$  to 35.04) was marginally greater than asynchronous CMC ( $M = 28.08$ ,  $CI_{95\%} = 24.87$  to 31.29). Results suggest that compared with synchronous conditions, relatedness, interest, and value all decreased under asynchronous CMC.

**Achievement.** MANOVA results showed a significant multivariate omnibus for synchronicity, Wilks's  $\lambda = 0.85$ ,  $F(4, 70) = 3.05$ ,  $p = .02$ ,  $\eta_p^2 = 0.14$ , and between-subjects tests showed that the effect was unique to the knowledge rating of the final essay,  $F(1, 73) = 6.21$ ,  $p = .01$ ,  $\eta_p^2 = 0.07$ . This finding was hardly conclusive, however, as the asynchronous CMC knowledge rating ( $M = 2.43$ ,  $CI_{95\%} = 2.09$  to  $2.77$ ) was only marginally greater than synchronous CMC ( $M = 1.93$ ,  $CI_{95\%} = 1.70$  to  $2.15$ ). Results suggest that, compared with synchronous CMC, knowledge ratings increased marginally under asynchronous CMC.

### Control Group Comparisons

Finally, the FTF control group was compared with all six experimental conditions using MANOVA, and post hoc tests were again conducted using Bonferroni multiple comparisons. Supporting the statistical validity of this approach, there was no evidence of multivariate outliers, and nonsignificant tests of Box's  $M$  suggested that the homogeneity of variance–covariance matrix assumption was not violated.

**Social interdependence.** For social interdependence, MANOVA results showed a significant multivariate omnibus, Wilks's  $\lambda = 0.61$ ,  $F(18, 257) = 2.68$ ,  $p < .001$ ,  $\eta^2 = 0.14$ , and the between-subjects tests were significant for cooperation,  $F(6, 93) = 6.27$ ,  $p < .001$ ,  $\eta_p^2 = 0.28$ , and individualism,  $F(6, 93) = 3.52$ ,  $p < .01$ ,  $\eta_p^2 = 0.18$ , but not for competition,  $F(6, 93) = 1.34$ ,  $p = .24$ ,  $\eta_p^2 = 0.08$ . For cooperation, post hoc results showed that FTF was greater than asynchronous audio ( $p < .001$ ) and asynchronous text ( $p = .001$ ). For individualism, FTF was less than asynchronous audio,  $p < .001$ . As displayed in Figure 1, results suggest that, compared with FTF, asynchronous audio CMC resulted in decreased cooperative perceptions and increased individualistic perceptions.

**Motivation.** For motivation, MANOVA results showed a significant multivariate omnibus, Wilks's  $\lambda = 0.50$ ,  $F(24, 315) = 2.83$ ,  $p < .001$ ,  $\eta^2 = 0.15$ , and the between-subjects tests were significant for relatedness,  $F(6, 93) = 8.15$ ,  $p < .001$ ,  $\eta_p^2 = 0.34$ , interest,  $F(6, 93) = 4.58$ ,  $p < .001$ ,  $\eta_p^2 = 0.22$ , and value,  $F(6, 93) = 4.14$ ,  $p < .01$ ,  $\eta_p^2 = 0.21$ . For relatedness, post hoc results showed that FTF was greater than asynchronous video, audio, and text (all  $p < .001$ ). For interest, FTF was greater than asynchronous audio only ( $p < .001$ ). For value, FTF was greater than asynchronous audio and text (all  $p < .001$ ). As displayed in Figure 2, results suggest that, compared with FTF, asynchronous CMC resulted in decreased relatedness regardless of medium. For interest and value, however, the effect of asynchronous CMC varied by medium, with interest decreasing as a result of asynchronous audio only, and value decreasing with both asynchronous audio and text.

**Achievement.** For achievement, only 63.8% ( $n = 30$  of 47) of students in the asynchronous condition completed the controversy activity (i.e., completed multiple-choice test and submitted final consensus statement), compared with 100% ( $n = 53$ ; Fisher's exact test:  $p < .001$ ) of students in the synchronous condition and 100% ( $n = 18$ ; Fisher's exact test:  $p < .001$ ) of students in the FTF condition. This suggests that achievement, at least as defined by completion rates, decreased under asyn-

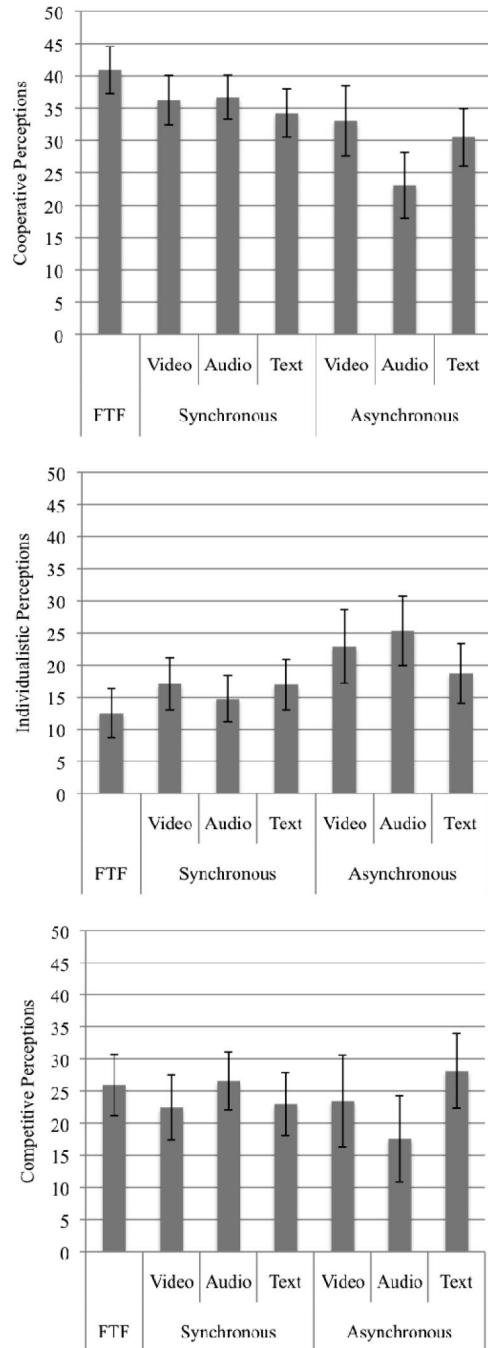


Figure 1. Social interdependence perceptions by condition. Error bars depict standard error. FTF = face-to-face.

chronous conditions compared with synchronous and FTF conditions. For other achievement measures (i.e., multiple choice and critical thinking), MANOVA results showed a marginally significant multivariate omnibus, Wilks's  $\lambda = 0.67$ ,  $F(24, 304) = 1.54$ ,  $p = .05$ ,  $\eta^2 = 0.09$ , but the between-subjects tests were all nonsignificant. Results suggest that, at least among those students who completed the constructive controversy activity, achievement outcomes did not differ between FTF and experimental CMC conditions.

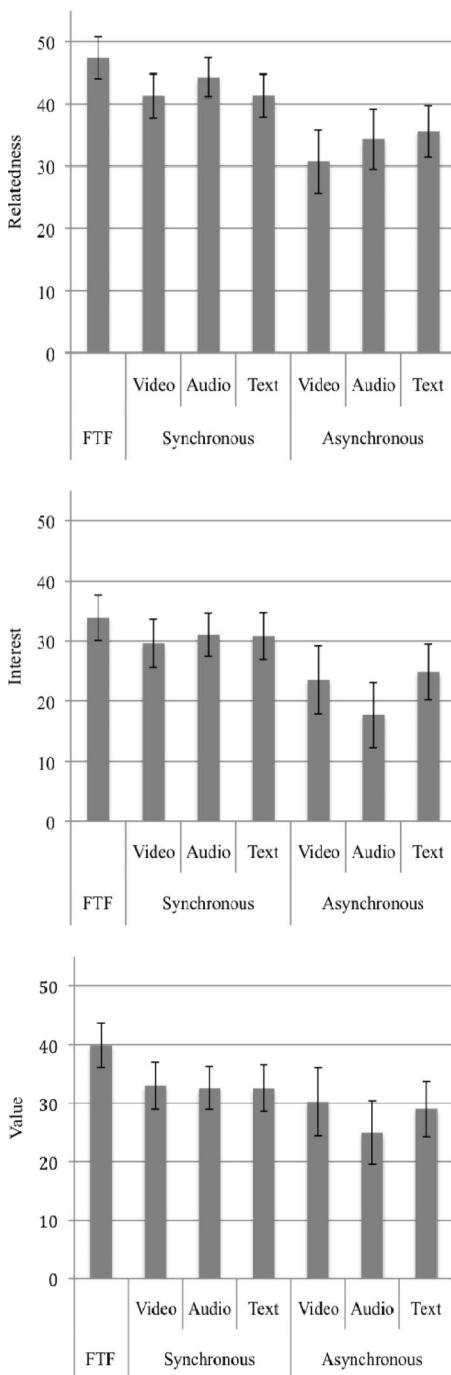


Figure 2. Motivation measures by condition. Error bars depict standard error. FTF = face-to-face.

## Discussion

Cooperative learning capitalizes on the relational processes by which peers promote learning, yet little is known about whether these processes operate similarly in face-to-face (FTF) and online computer-mediated (CMC) settings. This study addressed this issue by comparing FTF and CMC versions of constructive controversy, a cooperative learning procedure designed to create in-

tellectual conflict among students. Specifically, this study investigated whether media richness, operationalized in terms of synchronicity (synchronous, asynchronous) and medium (video, audio, text), moderates the effects of constructive controversy on students' social interdependence, motivation, and achievement.

## Social Interdependence

Correlational results showed that cooperative perceptions were strongly associated with increased relatedness, interest, competence, and value, while individualistic perceptions were strongly associated with decreasing relatedness, interest, competence, and value. Comparing FTF and CMC versions of constructive controversy, results also showed that students' cooperative perceptions were higher in FTF and synchronous CMC, while individualistic perceptions were higher in asynchronous CMC. Results suggest that students' perceptions of social interdependence in constructive controversy may depend on relational processes unique to FTF and synchronous CMC. Specifically, FTF and synchronous CMC may enhance cooperative perceptions and decrease individualistic perceptions, while asynchronous CMC does the opposite, decreasing cooperative perceptions and increasing individualistic perceptions.

According to social interdependence theory (Deutsch, 1949, 1973; Johnson & Johnson, 1989, 2005), decreasing cooperative perceptions and increasing individualistic perceptions may be the relational process by which student motivation and achievement decrease under asynchronous CMC. Specifically, social interdependence theory posits that when goals are structured cooperatively, individuals perceive they can obtain their goals if and only if the other individuals with whom they are cooperatively linked also reach their goals. Motivation and achievement increase as responsibility forces resulting from cooperative perceptions impel each individual to interact in ways that promote each other's success, and successful goal attainment in turn leads to more positive attitudes toward the activity and those individuals who promoted one's success. To the extent that FTF and synchronous CMC versions of constructive controversy support cooperative perceptions between conflicting partners, we therefore expected corresponding increases in motivation, achievement (i.e., completion rates), and more positive attitudes toward conflicting partners (i.e., relatedness), which is exactly what this study demonstrated.

For individualistic perceptions, social interdependence theory posits that, in the absence of interdependent goals, individualistic perceptions lead to the absence of interaction and, as a result, neither enhance nor detract from student motivation, achievement, or attitudes. To the extent that asynchronous CMC versions of constructive controversy facilitate individualistic perceptions, we therefore expected no effect on other outcomes save the opportunity cost of not benefiting from the positive effects of cooperative perceptions. This study's results also support this aspect of social interdependence theory.

What is not clear from the study's results is whether asynchronous CMC actually decreases students' cooperative perceptions, enhances individualistic perceptions, or both. It may be the case that asynchronous CMC introduces distractions that dampen cooperative perceptions, a notion supported by empirical work in FTF contexts showing that time delay in a partners' response decreases influence acceptance (Sheldon, Thomas-Hunt, & Proell, 2006), reduces persuasion (Moon, 1999) and increases goal decay

(Monk, Trafton, & Boehm-Davis, 2008). Accordingly, future research on CMC versions of constructive controversy and related cooperative learning procedures should examine ways of ameliorating the potentially deleterious effects of asynchronous interaction by, for example, scaffolding cooperative activities (e.g., Kreijns, Kirschner, & Jochems, 2003; Nussbaum, Winsor, Aqui, & Poliquin, 2007), developing rule structures for group processes (e.g., Lin & Laffey, 2006; Strijbos, Martens, & Jochems, 2004), or only using asynchronous technologies for those constructive controversy steps, or “tasks,” that may be less dependent on cooperative perceptions. More will be said below about possible “task-technology fit” (Maruping & Agarwal, 2004) issues in constructive controversy.

## Motivation

Motivation was assessed four ways: relatedness, perceived competence, interest, and value. Results indicated that relatedness and value were both greater under FTF compared with asynchronous CMC, and in synchronous over asynchronous CMC. Results also indicated that interest was greater under FTF compared with asynchronous CMC, and in synchronous over asynchronous CMC. Results are consistent with research reporting not only lower student interest in asynchronous learning but also a gradual decline in student motivation over time as students continued to use these technologies (Xie, Debacker, & Ferguson, 2006). Results also support the view that motivation in constructive controversy depends on FTF and synchronous CMC and that relatedness and value may be particularly enhanced by the relational processes uniquely supported by FTF interaction.

As previously detailed, social interdependence theory posits that this study’s motivational increases resulted from increasing cooperative perceptions under FTF and synchronous CMC, while motivational decreases resulted from increased individualistic perceptions under asynchronous CMC. Self-determination theory (Deci & Ryan, 2000) offers an alternative explanation, positing that motivational increases resulted from fulfilling students’ self-determination needs under FTF and synchronous CMC, while motivational decreases resulted from thwarting these needs under asynchronous CMC. In particular, results suggest that differences in value and interest were due to differential fulfillment of students’ relatedness needs, which decreased in both synchronous and asynchronous CMC compared with FTF. Results also suggest that asynchronous CMC may be especially deleterious to the development of interest and value and thus intrinsic motivation in online learning.

What is not clear from this study is how exactly CMC and, in particular, asynchronous CMC affects students’ perceptions of social interdependence and fulfillment of relatedness needs. For example, while social interdependence theory specifies that motivational differences are most likely due to students’ perceptions of social interdependence, it remains unclear what exactly about asynchronous CMC actually decreases cooperative perceptions and/or increases individualistic perceptions. Likewise, while self-determination theory specifies that differences are most likely due to differential fulfillment of students’ psychological needs, it remains unclear what exactly about asynchronous interaction actually thwarts relatedness needs.

According to this study’s results, synchronicity by whatever medium is most supportive of the relational processes underlying constructive controversy. This finding has important implications for communication researchers’ debate about whether CMC media richness affects the quality of interpersonal communication. Specifically, this finding suggests that rather than the transmission and reception of nonverbal social cues (e.g., vocal inflection, facial and emotional expressions, hand gestures, physical appearance) determining the quality of interpersonal communication, it may be that synchronous interaction and the affordance of immediate clarification of contrasting views is most important for enhancing cooperative perceptions, decreasing individualistic perceptions, and fulfilling relatedness needs.

## Achievement

For achievement, student completion rates were significantly greater in FTF and synchronous conditions, with 100% of FTF and synchronous students completing the constructive controversy activity compared with only 63% of asynchronous students. This result is consistent with others who have found higher attrition rates in online compared with FTF settings (see, e.g., Carr, 2000; Tyler-Smith, 2006), with attrition rates in online courses possibly 10%–20% higher than in FTF settings. This finding supports the view that achievement in constructive controversy, at least as defined as completion rates, depends on FTF and synchronous CMC. This finding also supports both social interdependence theory and self-determination theory’s accounts of how increased achievement and motivation results from, respectively, cooperative and individualistic perceptions or fulfilling relatedness needs under FTF and synchronous CMC.

Interestingly, among those students who completed the constructive controversy activity, there was no evidence of significant differences in achievement outcomes between FTF and experimental CMC conditions and only marginally significant evidence of knowledge ratings favoring asynchronous over synchronous CMC. While marginal, this last finding is consistent with other studies demonstrating increased achievement in asynchronous learning (e.g., Benbunan-Fich et al., 2003; Hara, Bonk, & Angeli, 2000; Nussbaum et al., 2007; Zion et al., 2005); it supports the view that, compared with FTF and synchronous CMC, asynchronous CMC may afford increased time for the processing and review of concepts, which in turn enhances knowledge. We are cautious about endorsing this interpretation, however, as this study’s marginal achievement finding only applied to one of three ratings of critical thinking and, moreover, only applied to the 63% of asynchronous students who actually completed the constructive controversy procedure.

We are also cautious about endorsing the conclusion that FTF and CMC versions of constructive controversy are equally effective in enhancing learning and critical thinking, as there are several explanations for the nonsignificant differences. For example, it may be that the multiple-choice and critical thinking measures were insufficiently sensitive to detect differences in participants’ understanding of the background readings. It should also be noted that the four-item multiple-choice measure demonstrated low reliability ( $\alpha = .55$ ) and failed to correlate with the three critical-thinking scores. This raises concerns about the extent to which all achievement items measured the same construct.

Another possible explanation is that providing all participants with a one-page summary of the main arguments in the background readings contributed to reduced variation in participants' achievement scores. We examined this possibility for the final essays by assessing the extent to which bulleted items from the summary sheets were included in responses. Overall, evidence of direct use of the summary sheet was minimal, with no evidence of word-for-word copying, three instances of direct quotation, and six instances of paraphrasing. Nevertheless, future research should consider either not providing participants with a summary sheet or including this affordance as an independent variable.

## Medium

There were no significant main effects of medium on the dependent variables. Results provide partial support for Clark's (1983, 2005) assertion that medium does not matter for learning, and specify that it is the medium (and not synchronicity) dimension that is merely a vehicle for information (Clark, 1983). Results also provide partial support for Walther et al.'s (2005) view that communicators convey social cues by adapting to whatever form of CMC they are using, specifying again that this may be true of different mediums but not of both synchronous and asynchronous CMC.

Qualifying this last point, results also showed some significant interactions between synchronicity and medium. Specifically, compared with synchronous CMC, cooperative perceptions decreased most under asynchronous audio CMC; compared with FTF, both interest and value decreased under asynchronous audio, and value decreased under asynchronous text. Notably, these findings do not support the media richness view that text-based communication is less able than audio to transmit nonverbal social cues (e.g., voice inflection). Future research is needed to confirm these interactions and to determine what about audio interaction constrains constructive controversy processes.

One view that may help to explicate the interaction of media and synchronicity is media synchronicity theory (Dennis, Fuller, & Valacich, 2008; Dennis & Valacich, 1999; Maruping & Agarwal, 2004), which posits that different media fit better with different types of tasks and developmental stages of group processes. For example, it has been found that media affording lower synchronicity fit better with conveyance tasks (simple dissemination of information; Burke & Chidambaram, 1999), while high synchronicity fits better on convergence tasks (development of shared meaning; Murthy & Kerr, 2003). Likewise, Maruping and Agarwal (2004) argued that groups with little shared social history require more synchronous communication during initial task phases, whereas the reverse is true for well-established groups. This is especially true for distributed groups whose task is likely to involve conflicting views and ideas (Mortensen & Hinds, 2001).

Applying media synchronicity theory to the adaptation of constructive controversy for online settings, it may be that the procedure's steps should be differentiated as conveyance and convergence tasks and that different CMC technologies should be used to fit with the tasks' different interpersonal demands. For example, while media with lesser synchronicity may facilitate the initial conveyance steps (1 and 2) of the controversy activity, media with greater synchronicity may be required for later convergence steps (3 through 5). We are currently developing this exact paradigm,

testing whether varying synchronicity over the course of constructive controversy provides better fit between CMC media richness and the varying conveyance and convergence demands of the procedure.

## Limitations

This study's results are limited by the characteristics of the sample, type of task and CMC technologies, and specific operationalizations of the dependent variables. Specifically, it remains unclear whether the preponderance of women (76%) in the sample limits the generalizability of findings. Many researchers argue that social role expectations orient men toward agency and women toward cooperation (see e.g., Eagly & Carli, 1981; Tannen, 1990), and consequently women may be especially sensitive to CMC contexts that constrain relationship formation. Only preliminary evidence supports this view, however, with two studies (i.e., Dennis, Kinney, & Hung, 1999; Guadagno & Cialdini, 2002) demonstrating that for women but not men, synchronous text-based CMC (i.e., chat and e-mail) led to decreased performance and less agreement compared with FTF interaction. Future research is needed to determine the extent to which this study's results may be conditioned by the differential impact of FTF and CMC versions of constructive controversy on male and female participants.

Another possible limitation is that this study did not control for students' perceptions of CMC technologies. Many communication researchers (e.g., Gunawardena, 1995; Hwang & Park, 2007; Mykota & Duncan, 2007) suggest that users' perception of a particular CMC technology (e.g., e-mail, audio, video, etc.) contributes largely to whether they used that CMC to develop relational bonds. For example, Gunawardena (1995) found that as opposed to the communication method, users' perceptions of the method as a social place was the most influential determinant of social presence. Evidence also suggests that individual-level perceptions of technology affect motivation (Shroff, Vogel, & Coombes, 2008) and self-efficacy (Wang & Newlin, 2002). It follows that student motivation may have decreased in the asynchronous group because, working asynchronously, they were less comfortable with, accepting of, or competent in using the technologies for this particular task than students in the synchronous group (Davis, 1989; Davis, Bagozzi, & Warshaw, 1992; Venkatesh & Speier, 2000). Future research on CMC versions of constructive controversy should incorporate controls for users' subjective perceptions of and self-efficacy with specific CMC technologies.

Regarding the study's sample, the extent to which nonsignificant findings were reflective of sampling error also remains unclear. For example, FTF cooperative perceptions ( $M = 40.88$ ) were greater than all CMC conditions (mean range = 23.11 to 36.70), whereas FTF individualistic perceptions ( $M = 12.50$ ) were less than all CMC conditions (mean range = 14.75 to 25.33). These means suggest that with larger samples (and lower variance) and lower attrition rates in asynchronous CMC, results might have demonstrated that FTF tends to facilitate more positive effects on social interdependence than all forms of CMC. Likewise, for motivation, inspecting the means in Table 2 suggests that with larger samples and lower attrition rates in asynchronous CMC, FTF relatedness, interest, competence, and value would have exceeded all forms of CMC. Future research is needed to determine

the extent to which nonsignificant findings and observed variation was due to sampling error or factors not directly measured in the present design.

Finally, for asynchronous CMC, the length of the constructive controversy procedure may also be a limitation, though the effect of distributing the procedure over longer periods of time is not necessarily clear. For example, extending the procedure over several days may introduce additional cognitive and time management demands (Song, Singleton, Hill, & Koh, 2004), the result of which is reducing cooperative perceptions, relatedness, interest, and value. On the other hand, the additional time may also enhance achievement by affording more time for processing and review of concepts (e.g., Hara et al., 2000). Additional time may also enhance communication quality by providing students with more opportunity to adapt their communication to the constraints of asynchronous CMC (Walther et al., 2005). Additional research is needed to clarify this issue as it is unlikely that time alone accounts for the dramatic rates of attrition demonstrated by this and other studies of asynchronous learning.

## Implications

Despite these limitations, this study contributes to the literature in several important ways. First, this study's findings have strong internal validity, as the use of random assignment, an experimental-control design, and video-taped instructions all served to strengthen confidence that differences between conditions were due to the independent variables. Second, by systematically comparing the effects of different CMC affordances (i.e., synchronicity and medium) with a FTF version of a theoretically grounded and empirically verified instructional procedure (i.e., constructive controversy), this study avoids unnecessary reinvention of instructional procedure and instead builds on solid psychological and educational foundations. Third, guided by two theoretical accounts (i.e., social interdependence theory and self-determination theory), this study specifies what relational processes are most likely to be affected by CMC media richness and why these processes in particular may affect constructive controversy.

This study also contributes to theory development by examining untested assumptions about the extent to which FTF relational processes generalize to CMC contexts. This study's results validate social interdependence theory's accounts of the relational processes underlying constructive controversy while also suggesting that it may need to be modified to indicate that perceptions of social interdependence depend on FTF and synchronous CMC. Likewise, this study's results also validate self-determination theory while suggesting that it may need to be modified to indicate that fulfilling relatedness needs may also depend on FTF and synchronous CMC.

Finally, this study also contributes to practice by suggesting that instructors striving to integrate constructive controversy and related cooperative learning procedures into online education should not simply assume that asynchronous CMC supports the relational processes underlying such procedures. Put simply: While "anytime, anywhere" asynchronous CMC may be highly convenient, it may not support the relational processes required by cooperative learning procedures such as constructive controversy. More positively, this study also suggests that practitioners may not need to

worry about the medium used for online cooperative learning, as video, audio, and text seemed to have minimal impact on outcomes. Most broadly, this study also reinforces Mishra and Koehler's (2006) assertion that researchers and practitioners must go beyond simply comparing the relative impact of FTF and CMC instruction, using theory-guided systematic research to determine how to effectively integrate online CMC technologies, pedagogy, and content.

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(Appendices follow)

## Appendix A

### Constructive Controversy Activity Scaffold: Video

Controversy Topic: Should Schools Try to Increase Students' Self-Esteem?

"Yes" Participant Name: [Enter Name Below]~

"Yes" Participant E-mail: [Enter E-mail Below]~

"Yes" Participant ID: [Enter ID Below]~

"No" Participant Name: [Enter Name Below]~

"No" Participant E-mail: [Enter E-mail Below]~

"No" Participant ID: [Enter E-mail Below]~

--> [Click Here to Watch the Activity Intro Video Again](#)

#### Step 1: Open Debate #1

--> [Click here for video explaining Step Three](#)

Directions for Recording Rebuttal Statement 1:

- [View the other side's Initial Position Statement from Step 2.](#)
- Record your Rebuttal Statement 1 to the other side's Initial Position Statement and post the URL below.

3) Link to YES Rebuttal Statement 1 video: [Paste URL Below]~

4) Link to NO Rebuttal Statement 1 video: [Paste URL Below]~

#### Step 2: Open Debate #2

--> [Click here for video explaining Step Three](#)

Directions for Recording Rebuttal Statement 1:

- [View the other side's Initial Position Statement from Step 2.](#)
- Record your Rebuttal Statement 1 to the other side's Initial Position Statement and post the URL below.

3) Link to YES Rebuttal Statement 1 video: [Paste URL Below]~

4) Link to NO Rebuttal Statement 1 video: [Paste URL Below]~

(Appendices continue)

<b><u>Step 3: Reverse Perspectives</u></b>
--> <a href="#">Click here for video explaining Step Four</a>
<b>Directions for Recording Reverse Perspectives Statement:</b>
<ul style="list-style-type: none"> <li>• <u>Review again the other side's initial Position Statement.</u></li> <li>• Review again the other side's Rebuttal Statement <u>1</u> and <u>2</u>.</li> <li>• Record your Perspective Taking Statement of the other sides' position.</li> </ul>
7) Link to YES Perspective Taking Statement video: [Paste URL Below]~ <input type="text"/>
8) Link to NO Perspective Taking Statement video: [Paste URL Below]~ <input type="text"/>
<b><u>Step 4: Synthesis #1</u></b>
--> <a href="#">Click here for video explaining Step Five</a>
<b>Directions for Drafting Consensus Statement</b>
<ul style="list-style-type: none"> <li>• Student advocating the "Yes" position will create a first draft of the Consensus Statement. Please follow the directions closely and <u>make your statement around 125-250 words</u>. This statement will be graded by your instructor.</li> </ul>
9) Consensus Statement Draft 1 by "Yes" Participant: [Type Text in the Box Below]~ <input type="text"/>
<b><u>Step 5: Synthesis #2</u></b>
<b>Directions for Editing Draft Consensus Statement:</b>
<ul style="list-style-type: none"> <li>• Student advocating the "No" position will edit the above draft of the Consensus Statement, producing the final draft as directed below. Please follow the directions closely, making the final statement approximately 250 words. This statement will be graded by the research team.</li> <li>• Remember, both students must read and approve the final Consensus Statement, indicating your approval by entering your initials below. Your initials indicate that you fully agree with the final Consensus Statement.</li> </ul>
10) Consensus Statement Draft 2 by "No" Participant: [Type Text in the Box Below]~ <input type="text"/>
"Pro" Participant - I fully agree with the content of this Integrative Statement: [Initial Below]~ <input type="text"/>
"Con" Participant - I fully agree with the content of this Integrative Statement: [Initial Here]~ <input type="text"/>
~ALMOST FINISHED! PLEASE PROCEED TO THE FINAL SECTION~
<b><u>Conclusion, Quiz, and Survey</u></b>
Please click on <a href="#">THIS LINK</a> and complete the short quiz and survey. It will take you approximately 20 minutes to complete.

(Appendices continue)

## Appendix B

### **Critical Thinking Rubric (Adapted From Bleifield & Paulus Critical Thinking Group, 2006)**

Table B1

*Critical Thinking Rubric: Knowledge and Comprehension Category*

<p>The work demonstrates understanding of the relevant facts/data/theories/terms as well as the ability to organize the information for application, presentation, documentation, and/or further examination</p>			
1 point Inadequate <ul style="list-style-type: none"><li>• Off topic</li><li>• Inaccurate</li><li>• Unbalanced and somewhat off topic</li><li>• Poor organization</li></ul>	2 points Uneven and shaky <ul style="list-style-type: none"><li>• Generally on topic</li><li>• Unbalanced account of both sides</li><li>• Generalities related to the readings</li><li>• Some inaccurate statements of readings</li><li>• Poor organization</li></ul>	3 points Adequate <ul style="list-style-type: none"><li>• Accurate, though broad understanding of main points of both sides</li><li>• Cites specific, relevant information from readings</li><li>• Good organization</li></ul>	4 points Confident <ul style="list-style-type: none"><li>• Consistently clear, accurate, detailed, and comprehensive</li><li>• Detailed and salient information from readings for position</li><li>• Good organization</li></ul>

Table B2

*Critical Thinking Rubric: Application and Analysis Category*

The work demonstrates ability to work with the key concepts/information/process/theory, applying or extending them with very limited success to new problems or contexts, making predictions, recognizing hidden meanings, drawing inferences, analyzing patterns and component parts, communicating insightful contrasts and comparisons, and situates application within specific context.

1 point Extremely limited <ul style="list-style-type: none"><li>• Analysis not present or unrelated to readings</li><li>• No attempt at application for readings</li><li>• Some misinterpretation</li></ul>	2 points Uneven and shaky <ul style="list-style-type: none"><li>• Superficial evaluation</li><li>• Fails to analyze, just presents facts</li><li>• Misinterprets some of the readings</li><li>• Some attempt at application of at least one of the readings</li></ul>	3 points Adequate <ul style="list-style-type: none"><li>• At least one application statement of concepts for both readings</li><li>• Accurately interprets both readings broadly</li></ul>	4 points Confident <ul style="list-style-type: none"><li>• Fair-minded application of readings throughout final statement</li><li>• Accurately interprets both readings specifically</li></ul>
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Table B3

*Critical Thinking Rubric: Synthesizing and Evaluating Category*

The work demonstrates ability to take ideas/theories/processes/principles further into new territory, broader generalizations, hidden meanings and implications, as well as to assess discriminatively the value, credibility and power of these ideas (etc.) in order to decide on well-considered choices and opinions.

1 point Little <ul style="list-style-type: none"><li>• Does not include synthesis statement or unrelated to readings or does not flow from analysis</li></ul>	2 points Uneven and superficial <ul style="list-style-type: none"><li>• Attempts synthesis statement, but lists or states two opposing points with no connection</li><li>• Very general or no synthesis attempted</li><li>• Generally states "there are two sides"</li></ul>	3 points Adequate <ul style="list-style-type: none"><li>• At least one sentence with well-developed synthesis/evaluation of opposing points</li><li>• Personal voice evident in synthesis statement (not just rephrasing readings)</li></ul>	4 points Surprising/insightful <ul style="list-style-type: none"><li>• Demonstrates insight, well-developed synthesis of opposing points throughout final statement</li><li>• Multidimensional evaluative statements</li><li>• Personal voice evident in synthesis statement (not just rephrasing readings)</li></ul>
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