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The Effect of Distance Education: A Meta-Analytic Assessment of Simonson's Equity Theory based on Synchronous and Asynchronous

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Abstract— *Simonson, Schlosser and Hanson (1999) argue that a new theory called "equivalency theory" is needed to account for the unique features of the "teleconferencing" (synchronous) model of DE that is prevalent in many North American universities. Based on a comprehensive meta-analysis of the comparative literature of DE (Bernard, Abrami, Lou, Wozney, Borokhovski, Wallet, Wade, Fiset, & Huang, in press), we are able to assess empirically whether equivalency has been achieved in prior comparative DE research. This paper includes a brief summary of the results of the split between synchronous and asynchronous patterns of DE, and addresses the implications these data have for developing separate theories of DE for synchronous (i.e., group-based) and asynchronous (i.e., individualized) applications. We examine data based on achievement, attitude and retention outcomes and coded study features (i.e., methodological, pedagogical and media) relating to them.*

Keywords—synchronous distance education , asynchronous distance education, meta-analytical assessment, simonson's equivalency theory

1 Introduction

Over the past several decades, two distinctly different patterns of distance education (DE) have emerged, along with a variety of combinations of them. Synchronous DE derives from early applications of closed circuit TV on college campuses (e.g., Carpenter & Greenhill, 1955; 1958). In this pattern, two or more classrooms in different locations are joined in real time and run, synchronously, usually from the originating site. Today, various forms of audio and video interactive teleconferencing technology are used to unite originating and remote classroom sites. According to Mottet (1998) and Ostendorf (1997), this form of "emulated traditional classroom instruction" is the fastest growing form of DE in U.S. universities, and so it is important for us to know how it affects learners who are involved in it.

Modern asynchronous DE is a derivative of correspondence education, where the "medium of instruction" was the post office and asynchronicity was a result of postal delay. In this pattern, students in remote locations work independently or in asynchronous groups, usually with the support of an instructor or tutor. Communication between the instructor and student and among students typically involves the Internet, although contact through other media is (e.g., telephone) is often used. Asynchronous DE, then, fits within Keegan's (1996) definitional criteria of teaching and learning "anyplace, anytime," whereas synchronous DE is both time and place dependent. Simonson, Schlosser and Hanson (1999) argue that separate theories of DE are needed to account for the different underlying premises of these two models. What we have referred to as asynchronous DE springs from theoretical perspectives that emphasize "independence and autonomy of the learner, industrialization of teaching, and interaction and communication.

These classical theories emphasize the notion that distance education is a fundamentally different form of education" (p. 74). By contrast, Simonson et al. argue that a theory of synchronous DE should focus on providing individual but equivalent experiences for the classroom and DE learners. They say that "Recent emerging theories based on the capabilities of new interactive

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telecommunication-based audio and video systems suggest that distance education may not be a distinct field of education" (p. 74). We can take no position on the theoretical arguments contained in the above quotations, except to say that there is one important distinction that is evident in the two patterns. Synchronous DE, by definition, is inextricably tied to classroom instruction. In this sense, it may be viewed as an extension of, or as a special case of classroom instruction. Asynchronous DE, by contrast, is not necessarily bound by conditions that exist in a classroom. This fact suggests that the two patterns may encompass different, but related, sets of teaching and learning skills. An issue that arises is upon what grounds should "equivalence" be judged. Simonson et al. (1999) offer this suggestion: "… the outcomes of a learning experience are those obvious, measurable, and significant changes that occur cognitively and affectively in learners because of their participation in the course or unit" (p. 72).

They distinguish between "instructor-determined outcomes" and "learner-determined outcomes." The former are presumably the traditional measures of achievement and course satisfaction (e.g., attitude measures), while the latter are delayed measures of skills application and follow-up enrollment in similar courses. We argue that another related measure of learner-determination is the retention rate (or conversely, the dropout rate) in a course. The research literature of DE contains many studies of both synchronous and asynchronous DE as they compare to traditional classroom instruction.

In 2001, we undertook to review, quantitatively (meta-analysis), these comparative studies dating from 1985 through 2002. These were some of the findings: 1) there is wide variability in achievement, attitude and retention outcomes (i.e., some classrooms vastly outperform DE and vice versa); 2) study features describing differences in research methodology account for a substantial proportion of the variance in outcomes; 3) overall, elements of pedagogy account for more variation than elements of media usage (Clark, 1983, 1994); and 4) a number of study features (both pedagogy and media) are predictors of the differences between DE and classroom instruction (Bernard, Abrami, Lou, Wozney, Borokhovski, Wallet, Wade, Fiset, & Huang, in press).

Here we will present a subset of these results relating to synchronous and asynchronous DE to describe how these patterns differ in terms of achievement, attitude and retention outcomes. We will focus especially on the comparative effects of synchronous DE and consider whether the DE part of this dyad differs from its classroom counterpart. We will also examine the effects of individual pedagogy and media study features in an attempt to suggest what might be changed in synchronous DE, in particular to increase its "equivalence" to classroom instruction.

2 Method

2.1 Data Sources and Search Strategies

The studies used in this meta-analysis were located through a comprehensive search of publicly available literature from 1985 through December of 2002. Electronic searches were performed on the following databases: ABI/Inform, Compendex, Cambridge Scientific Abstracts, Canadian Research Index, Communication Abstracts, Digital Dissertations on ProQuest, Dissertation Abstracts, Education Abstracts, ERIC, PsycInfo, and Social SciSearch. Web searches were performed using Google, AlltheWeb, and Teoma search engines. A manual search was performed in ComAbstracts, Educational Technology Abstracts; in several distance learning journals, including The American Journal of Distance Education, Distance Education, Journal of Distance Education, Open Learning, and Journal of Telemedicine and Telecare; and in several conference proceedings, including AECT, AACE, AERA, CADE, EdMedia, E-Learn, SITE, and WebNet. In addition, the reference lists of several earlier reviews were examined for possible inclusions. Although search strategies varied depending on the tool used, generally, search terms included "distance education," "distance learning," "open learning" or "virtual university," AND ("traditional," "lecture," "face-to-face" or "comparison").

2.2 Outcomes of the Searches

In total, more than 5,000 research abstracts concerning DE and traditional classroom-based instruction were examined and 862 full-text potential includes retrieved. Each of the studies retrieved was read by two researchers for possible inclusion using the inclusion/exclusion criteria. The initial inter-rater agreement as to inclusion was 89%. Any study that was considered for exclusion by one researcher was crosschecked by another researcher. Two hundred and thirty-two (232) studies met all inclusion criteria and were included in this meta-analysis; 630 were excluded.

2.3 Extraction of Effect Sizes

Effect sizes were extracted from each study. Where possible, descriptive data (i.e., means and standard deviations) were used to calculate Cohen's *d (see Equation 1)*.

$$d = \frac{\bar{Y}_{experimntal} - \bar{Y}_{control}}{s_{pooled}}$$

Where these data were not available, effect sizes were calculated or estimated from statistical test data (e.g., t -ratios, probabilities) based on equations provided by Glass, McGaw, and Smith (1981) and Hedges, Shymansky, and Woodworth (1989). Cohen's d was converted to Hedges' g (Hedges & Olkin, 1985) to correct for the influence of sample size. Hedges' g+ (i.e., average effect size) was then calculated for each relevant subgroup and for each of the three measures along with homogeneity of effect size statistics.

3 Findings And Discussion

Meta-analysis is a descriptive review technique and as such provides a characterization of a large body of quantitative evidence. While effect sizes are tested for significance (g+ = 0), this does not involve the same sort of inferential testing that is often done in original research. One way of thinking of a comprehensive metaanalysis is as an approximation of differences in the population that far surpasses the evidence provided by any single study.

3.1 Statistical Analysis

In total, 232 studies yielding 688 independent effect sizes (i.e., outcomes) were analyzed. This was based on totals of 57,019 students (k = 321) with achievement outcomes, 35,365 students (k = 262) with attitude outcomes, and (N = 57,916,029) students (k = 105) with retention outcomes. The N reported here for retention was reduced proportionally to 3,744,869 to avoid overestimation based on a longitudinal California study of retention in junior colleges. The number of outcomes was further reduced when they were classified as either synchronous or asynchronous patterns. The statistical findings that are relevant to the question being examined in this paper are shown in Table 1. In this table, zero defines no mean difference between the DE condition and the classroom condition. Positive mean effect sizes favor DE over the classroom. Negative effect sizes indicate the reverse. Bear in mind as you examine these mean effect sizes that wide variability surrounds each of them (i.e., homogeneity of effect size was violated). Hedges and Olkin (1985) warn against a strong interpretations of mean effect sizes when assumptions of homogeneity of effect size are violated. To dramatize this point, we found effect sizes for synchronous achievement outcomes to vary from –1.14 to 0.97.

For asynchronous outcomes, the minimum g was –1.31 and the maximum g was 1.31. That says that some applications of DE, both synchronous and asynchronous, far outperformed their classroom comparison group and some far underperformed it. However, the pattern of results is interesting and bears consideration. First, all but two average effects sizes are significantly greater than zero. As with all statistical tests, higher degrees of freedom provide more power and a more sensitive test, so that at least one test (synchronous, retention outcomes) may represent an artifact of this. There is evidence for synchronous DE, based on an analysis of achievement outcomes, that students in the

DE condition are not performing as well as their classroom companions, on average. This effect in favor of the classroom condition appears to be even more dramatic for attitude outcomes. By contrast, DE student experiencing asynchronous DE outperformed their classroom equivalents on achievement measures and performed equally well in terms of attitude outcomes (although the effect size is negative).

Table 1. Weighted Mean Effect Sizes for Achievement, Attitude and Retention Outcomes (Synchronous and Asynchronous)

Categories of DE	***Achievement***		***Attitude***		***Retention***	
	g+	*SE*	*g+*	*SE*	*g+*	*SE*
Synchronous DE	-0.012* (k=92)	0.024	-0.185* (k=83)	0.022	0.005 (k=17+	0.034
Asynchronous DE	0.053* (k=174)	0.012	-0.003 (k=71)	0.019	-0.093* (k=53)	0.021

**p < .05 Note: All mean effect sizes are heterogeneous*

The situation for retention outcomes is essentially the reverse of the above. The retention rate (i.e., opposite of dropout) for synchronous comparisons was zero, while significantly more students dropped out of asynchronous DE than their classroom equivalents. This problem with DE has existed from the early days of correspondence education (e.g., Bernard & Amundsen, 1988). This analysis does not suggest that DE and classroom conditions in synchronous DE cannot be equivalent, just that when they have been comp ared in a large number of studies, they are not. Beyond the intuitive notion that remote-site students, being on the receiving end of a technologically mediated classroom (virtual classroom), may not feel as included, may not get to participate as much, find it harder to concentrate, and/or may not get the timely feedback that they need, we have little evidence to explain this apparent disparity. A scarcity of information in the literature, especially of the conditions in the classroom, made it difficult for us to find sets of robust predictors that would have helped us develop a more complete picture or empirical model of the instructional characteristics that make a difference. See Bernard et al., (in press) and for the complete analysis and Bernard, Abrami, Lou, and Borokhovski (in press) for an extended discussion of the methodological state of DE research.

3.2 Study Feature Predictors of Outcomes

In an attempt to further explain the results just presented, we used weighted multiple regression (WMR, where the weighting factor is the inverse of the population variance, $1/\hat{\sigma}_d^2$, approximated in an equation from Hedges & Olkin, 1985, p. 174) using individually coded study features as predictors and g as the outcome variable. The study features were categorized as: 1) 13 methodological predictors; 2) 9 pedagogical predictors; and 3) 9 media use predictors, and were entered into blocks in WMR. Methodology was entered first, followed by pedagogy. In a second analysis, methodology again was entered first, followed by media use. In this way we were able to assess the effects of pedagogy and media use, independently, after variation due to methodological differences was removed. We did this for synchronous and asynchronous DE outcomes separately. In presenting these findings, we must warn against the over-interpretation of individual study features. While all of the ones that are described here were significant, a certain degree of collinearity among them makes drawing strong conclusions problematic.

Synchronous DE. The question that we will be attempting to answer here is: If synchronous DE and its classroom counterparts are not equivalent, how can we make them more so? Since from our overall analysis, we have established that in synchronous DE, the classroom condition had better achievement and better attitudes towards instruction than the DE condition, what can be added to or changed about the DE condition to ameliorate the situation? In looking at Table 2, which displays the significant predictors of achievement and attitudes (an analysis of retention outcomes produced no significant predictors), we see study features that favor the classroom on the left and those that favor DE on the right (this was determined by the sign of the regression weight associated with each predictor).

The most striking feature contained in the set of predictors for synchronous DE is the large role that personal contact with the instructor and other students, either face-to-face or mediated by technology, plays in achievement and attitude outcomes. This agrees with much of the previous literature of DE, which cites feelings of isolation as a significant contributor to problems such as dropout. Two other predictors were significant, "Use of one-way TV-video" and "Use of systematic instructional design." In this case, TV-video does not refer to the means of communication (i.e., videoconferencing). It is, instead, the use of televised materials and content delivered at a distance. It is conceivable that such materials offer a welcome alternative to lecture and other forms of teacher-dominated instruction. It is not surprising to find that explicit prior planning improves the

quality of DE. Had there been more information about classroom conditions, we might have found the same thing for face-to-face instruction.

Table 2. Summary of Study Features that Significantly Predict Outcomes in Synchronous DE

Synchronous DE	
Favor Classroom Instruction (–)	**Favor Distance Education (+)**
Achievement • Face-to-face meetings with the instructor • Use of the telephone to contact instructor	Achievement • Face-to-face contact with other students • Use of one-way TV-video
Attitudes • Opportunity for face-to-face contact with other students • Use of one-way TV-video	Attitudes • Use of systematic ID • Opportunity for mediated communication with the instructor • Instructor/student contact encouraged • Use of the telephone to contact instructor

Asynchronous DE. Table 3 is structured in the same way as the previous table. Here again, communication and the use of mediated content delivery play important roles. However, in contrast to synchronous DE, an explicit learning strategy, "Problem-based learning" emerged as an important predictor of both achievement and attitude outcomes. This is particularly interesting when combined with the appearance of computer-mediated communication. It is possible that this pairing suggests a positive effect for computer-based collaborative learning.

Table 3. Summary of Study Features that Significantly Predict Outcomes in Asynchronous DE

Synchronous DE	
Favor Classroom Instruction (–)	**Favor Distance Education (+)**
Achievement • No significant predictors	Achievement • Use of problem-based learning strategies • Opportunity for mediated communication with the instructor • Advance information given to students • Use of one-way TV-video
Attitudes • Use of the Web	Attitudes • Use of problem-based learning strategies • Use of computer-mediated communication • Use of computer-based instruction

4 Discussion

One of the things that meta-analysts quickly come to realize is that they are "prisoners" of the data and the previous efforts of primary researchers. Findings are based, by necessity, on what can be gleaned from the literature; nothing new can be added. In this study, lack of study information, particularly regarding to the unreported characteristics of the classroom condition, frustrated our efforts to delve more deeply into the nature of instructional study features and their relationship to the overall findings. Why do effect sizes vary so widely, even after they are categorized as synchronous or asynchronous? What should be included in synchronous DE to make it as effective

as (equivalent to) classroom instruction, or at least the best it can be? What practices should be avoided? What are the ranges of instructional practices and learning strategies that best support achievement and satisfaction in asynchronous DE? Answers to these kinds of questions did not emerge as clearly as they could have if the literature were more complete.

Nevertheless, some interesting findings did emerge concerning the nature of synchronous and asynchronous DE. We found that synchronous DE, in particular, produced average effect sizes that favored the classroom condition for both achievement and attitude outcomes. We also found wide variation around these means. This suggests that synchronized DE classrooms can produce outcomes that are at least equivalent to "live" classrooms but that this doesn't always happen (in fact, in a majority of cases it doesn't). The reasons for this may be manifold, ranging from the application of teacher-centered instructional techniques, which might not be as engaging in a mediated form, to failures associated with the technologies involved (either through poor application or failures of the technology itself). It is very likely that a new set of instructional skills, beyond those applied in the classroom, is required for instructors to meet the challenges of synchronous DE. While the tested principles of pedagogy (e.g., motivation, engagement, interactivity, evaluation, feedback) may generally apply, their application in synchronous mediated DE environments may require experience and possibly even special training. It is likely that many of the students involved in these studies had little if any prior experience with DE, and consequently did not know what to expect from DE or how to engage effectively in this new form of educational experience. If that is the case, this situation may change radically as more learning opportunities are offered and more students partake of them.

One of the prescriptions that did emerge regarding synchronous DE, in particular, is that it should involve more direct personalized contact between students and the instructor and among students. This is tantamount to saying: "make synchronous DE more like face-to-face instruction," and it is arguable that this is not a bad idea if in fact synchronous DE is to be regarded as a special case of face-to-face instruction. If this is not feasible, as it often is not in DE, serious efforts should be made to compensate for this deficit through various mediated options (Simonson, Schlosser & Hanson make this very point). We also found some interesting relationships regarding asynchronous DE. In another paper (Bernard et al., in press) we provide evidence of the precedence that pedagogy takes over media in DE, especially in asynchronous settings, a point that Richard Clark (1983, 1994) has made for years regarding all forms of technology applied to instruction. While it is axiomatic that DE requires technology, it must function in the service of something— content delivery (e.g., TV/video, Web resources), communication between student and instructor (e.g., clarification and feedback), and/or communication among students (e.g., mediated communication)—that leads to learning success.

We have found direct evidence here of all of these elements. We have found indirect evidence that collaborative learning (i.e., the combination of mediated communication and problem-based learning) is present. Direct evidence of the effectiveness of collaborative learning strategies may emerge as more studies of this relatively recent approach to learning are conducted. It is also possible that advances in multi-media, CBI, simulation media etc. may herald the new era of interactiveness posited by Ullmer (1984) and Cobb (1997). This empirical assessment of the comparative state of affairs in studies of synchronous and asynchronous DE begs the question of whether a new theory—"equivalency theory" or any other, for that matter—is required to understand and to make progress in the development of DE. Meta-analysis cannot answer such questions, even when the question involves a testable hypothesis. This meta-analysis has demonstrated, however, that we have a long way to go before we can say with certainty that either form of DE will reliably offer educational opportunities that equal or exceed that which is currently called "traditional classroom instruction."

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