The Interaction Equivalency Theorem

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Abstract

This paper examines the key issues regarding The Interaction Equivalency Theorem posited by Anderson (2003a), which consists of the three interaction elements found in formal education courses among teacher, student, and content. It first examines the core concepts of the theorem and argues that two theses of different dimensions can be articulated in the theorem, namely, value and amount (or quality and quantity). Prior studies in distance education and blended learning that have tested the validity of the theorem concepts are also examined: all research results support the first thesis; however, further research is required to examine the second thesis. The paper highlights the key issues for further exploration as research schemes.

Introduction

The equivalency theorem was developed by Anderson (2003a) initially to clarify the interaction mechanism in distance education. It argues that different economies exist between independent-oriented and interactive-oriented learning strategies and activities, and that these need to be taken into consideration when designing and delivering distance education that meets the diverse needs of learners in an effective and efficient way. Taking the definition of Wagner (1994), interactions are first defined as "reciprocal events that require at least two objects and two actions. Interactions occur when these objects and events mutually influence each other" (p.8). This definition focuses more on the "learning events" than the "media" of interaction (p.6). The primary goal of this paper is to articulate "a theoretical basis for judging the appropriate amounts of each of the various forms of possible interaction." The main features of his theorem are condensed into the following theses:

Thesis 1. Deep and meaningful formal learning is supported as long as one of the three forms of interaction (student–teacher; student–student; student–content) is at a high level. The other two may be offered at minimal levels, or even eliminated, without degrading the educational experience.

Thesis 2. High levels of more than one of these three modes will likely provide a more satisfying educational experience, although these experiences may not be as cost- or time-effective as less interactive learning sequences.

The main point of the first thesis is the equivalency in *value*; that is, the *quality* consideration of interaction. In its extreme case, it proposes that only one of the interaction elements could

assure quality learning. For example, a student achieves a quality learning experience through intense interaction with other peers (collaborative or cooperative learning), although the instructor was not available and the course content was not appropriate. The second thesis, on the other hand, refers more to the *quantity* of interaction. That is, there might be an educational condition in which there is a great deal of interaction with both the course instructor and the course content, and perhaps, there is high student-student interaction as well. Such course would likely provide a high quality of learning, but the cost of producing the content and the time commitments required of the students and the teacher would likely create a course that is expensive and unsustainable. Figure 1 is a tentative visualization of the theorem.
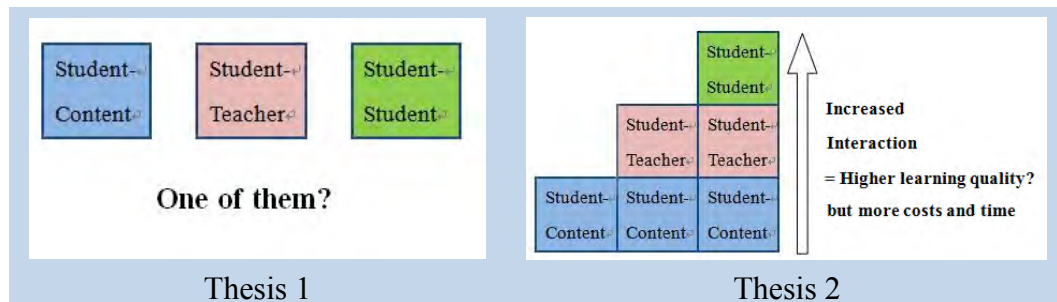

Figure 1. Visual representation of the equivalency theorem by Anderson (2003a).

The two theses refer to the different dimensions of interaction, and each is likely to assume a different educational delivery context. The first is associated with *closed* systems in which interaction is limited by the design to ensure effective and efficient learning, such as in the case of a predesigned course in distance education. The second is an *open* system where positively accidental surplus of interaction could occur; an example is an unexpected guest lecturer in a course, although it is possible for a distance course to be planned, providing a high level in all three interaction elements in exchange for *cost* or *time*.

The theorem puts itself in the mainstream theoretical framework in the history of distance education, succeeding Moore's (1989) three-part model of interaction. This is regarded as the first theorem to systematically define interaction in distance education, which consists of three types of "learner–content interaction, learner–instructor interaction, and learner–learner interaction" (p.1). Anderson's theorem advanced and developed the model into a new conceptual form through the perspective of quality and quantity that he forwarded, as well as three more dyads of interaction to make the constructs measurable, which will be explained later.

Research on the Equivalency Theorem

Although studies on interaction that use concepts such as communication and collaboration are abundant, little attempt has been done to test the core nature of the equivalency theorem. Research that denotes the concept of the equivalency theorem and that concerns all three elements of interaction is considered to be more relevant and is therefore closely reviewed here. Two are doctoral dissertations, and one appeared in the *Review of Educational Research*, a leading publication in educational research in the field.

Rhode (2008 and 2009). The doctoral study of Rhode (2008), published as a journal article in 2009, is probably the first to examine the theorem of Anderson when it phrases two of its research questions as follows (italics added):
1. What forms of interaction do adult learners *value the most* in self-paced online courses?
2. What forms of interaction do adult learners *identify as* equivalent in self-paced online courses?

The study was held in a one-year, self-paced online certificate undergraduate program in educational technology in a private American higher education institution for adult learners. The students in this study were required to use both a learning management system (Blackboard) and a social networking system (Elgg), so the researcher could examine the students' interaction preferences for *formal* and *informal* orientation. Ten students, who were concurrently taking two sections in the self-paced program for August 2007 and September 2007, participated out of 15 course takers. Phone interviews were conducted, consisting of 94 predetermined questions and additional follow-up questions for clarification, and these were analyzed using a constant comparison approach to find emerging themes (the exact question statements are found in Rhode, 2008, pp.235–244).

The study found that the students in this study valued interaction with the instructor and content most highly, that is, the answer for research question 2. Furthermore, they also identified a nearly equal value between instructor and content but not with student, that is, the answer for research question 3. Moreover, its specific research scheme of informal and formal interaction analysis reveals that the students admitted placing equal value to both informal blog reading and writing, regarding them as important as formal or required discussion forums in the course design. However, the students in this study did not support the concept that interaction with the instructor and content could be "diminished or eliminated" and could be compensated for by other forms of interaction (p.14), which means that the student felt the need of having all three interactions although their extent could differ. This result, although initially contrary to Thesis1, can be understood through Anderson's Thesis 2, which states that students felt a course with high levels of all three interactions would likely be not only more satisfactory but also more costly.

Based on the interview research, Rhode further develops his idea of the equivalency theorem into a series of matrices, two of which are shown in Figures 2 and 3, giving the tentative modeling of the theorem by Anderson (2003a).
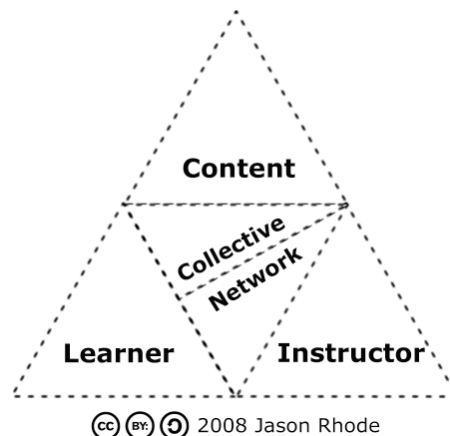
Figure 2. Interaction matrix core (Rhode, 2008).

In Rhode's conception, content, learner, instructor, collective, and network are all essential elements of the learning environment (2008). The network and the collective, which are conceptualized by Anderson and Dron (2007), express "emerging catalytic components" where learners interact with one another informally (p.197). In conclusion, Rhode (2008) proposes Figure 3 to represent the final product of his idea that integrates Anderson's equivalency theorem (2003), Dron's (2007) collective and network, and his formal and informal dimension of interaction.

Figure 3. Interaction Matrix (Rhode, 2008).

A point to be argued about this study is its relatively small sample size of 10 participants even with the qualitative research approach. Another concern relates to the concept of interaction that may be uniquely used in this specific paper. Even though 30 questions were prepared to ask research question 2 on the form of interaction the students valued, further clarification is needed; for example, in which categories (student–instructor, student–student, and student–content) shall "Course Podcast" (Q.6-3) and "Reflective activities" (Q.6-24) be classified? Also, the series of questions regarding "Interaction with Content" (Formal and Informal, Q.50-57) may seem ambiguous if it asks more about instructional design and preferred *format* of interaction than the value of interaction between the student and the content itself; for example, Q.50 asks, "Thinking of all the different types of instructional content in the course, which aspects of the course content or activities were most helpful?" This demonstrates one of the challenges and perhaps the value of the equivalency theorem. The multi-media recording and content production capacity of the net creates opportunities for interaction to morph among student, teacher, and content, as demonstrated by the production of a podcast by either teacher or students. Finally, as the study itself admits, the students' weak preference for student–student interaction could be a simple reflection of the reason why the students in this study chose the self-paced study mode; that is, they chose the self-paced program because they had reasons to find difficulty in synchronizing their schedules to the learning pace of others. This said, Rhode's (2008) study claims high value to be the first to test the equivalency theorem in a tangible way, and its significance is its finding a support for the theorem, further suggesting that the forms of interaction valued by learners could be different under varying circumstances.

Miyazoe (2009). Although held without knowledge of Rhode's study, this study can be regarded as a follow-up to the unanswered questions of Rhode in that it attempted to test the validity of the theorem in different learning modes and content orientations. This study was executed in an Asian context in Japan and Taiwan over the period 2007– 2008 in a blended learning form in higher education and involved four universities and four instructors. It asked the priority order of interaction elements among instructor, student, and content to determine the students' perception of learning quality. Blended learning in this study is defined as a mixed course design of face-to-face and written online interaction components: the participants had experienced the blended learning form for a minimum of ten weeks to one year, and the online interaction intervention was the threaded forum discussion regularly done throughout the course at all institutions. Following the two theses posited by Anderson (2003a), a tentative equivalency theorem indicator questionnaire was made and tested with a total of 236 valid respondents with consent for analysis and publication (255 questionnaire distributions; 100% collection rate; out of 236 valid samples, Japanese 200: Taiwanese 36). The questionnaire consists of two pair questions comparing (1) the different learning modes of face-to-face versus online class, and (2) skill-based versus knowledge-based course content orientations. The inventory configuration tested the combinatory concepts of Anderson's Thesis 1 and 2. It hypothesized that (1) if one of the interactions is valued over the others, students could rank the three interaction elements, with one being the most valued–referring to Thesis 1, and (2) customizing a course design of varied focus fittings to the priority order could produce higher learning for the least cost and time–referring to Thesis 2. Below is the model answer quoted here in order to give the basic idea on how the inventory works.

2. <u>For you</u>, when comparing face-to-face class (during the class) and online class (the class developed on Moodle), the "interaction" elements that are important are, in order of importance:

Face-to-face class:

Teacher	1
Students	2
Content	3

Online class (on name of LMS):

Teacher	3
Students	2
Content	1

The data were coded into six patterns of priority order of interaction as in Table 1, which were processed usong SPSS for analysis.

Table 1

Six patterns of priority order of interaction

Pattern	Rank 1	Rank 2	Rank 3
1	teacher	student	content
2	teacher	content	student
3	student	teacher	content
4	student	content	teacher
5	content	teacher	student
6	content	student	teacher

Figure 4 expresses the study's understanding of the theorem: this considers that first-rank interaction can differ depending on the learning modes and other factors if Thesis 1 is supported. However, it implies that the increased level of more than one kind of interaction may not increase learning effectiveness proportionally, but the degree of effectiveness will gradually decrease with the combination of more than one kind of interaction.
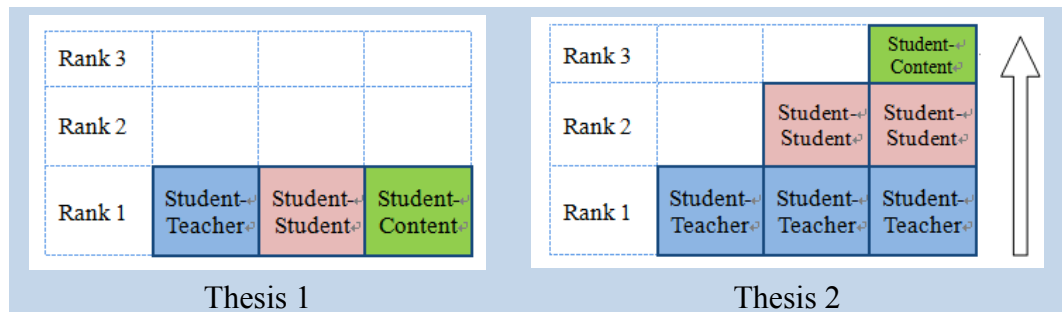

Figure 4. Equivalency Theorem Thesis 1 and 2 in Miyazoe's study.

Figure 5 highlights the findings of the study: the number from one (left) to six (right) in the X-axis in each graph corresponds to the pattern number of the above-mentioned priority order; for example, in the figure in the middle, the higher percentage of categories 5 and 6 signifies that the most number of students valued student-content interaction the most. Four universities are named University A, B, C, and D; A to C are Japanese and D is Taiwanese.
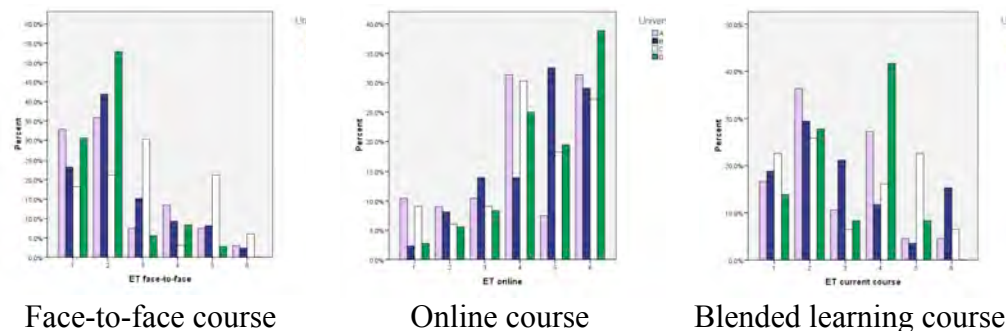
Figure 5. Priority of interaction elements in different learning modes.

The study found that the perceived priority order of interaction elements by the students clearly had certain patterns: the students place a higher value on the teacher element for the face-to-face mode and content for online courses; however, the preference is divided in all three elements for the blended learning form with increased online interaction among students. It also found that a skill-based course called for a high value on teacher elements, whereas the preference is divided with knowledge-based course. These suggest that the valued interaction elements differ in learning modes and content orientations. Varying the emphasis on the interaction elements in our course design depending on the contexts is therefore more efficient and hence is recommended.

In conclusion, this study supports both Theses 1 and 2: the students did admit more valued interaction elements over others, and the kind of first priority interaction differs depending on the other variables; that is, they admitted equal value on all three interactions (Thesis 1). Furthermore, the varied rank order of interaction suggests that the customization of a course following the priority order of the interaction pattern of a specific context will possibly produce a better learning environment in the most effective and efficient way (Thesis 2). A caveat to be clarified in this study is reliance on the students' perceptions of the priority order, which is similar to other research that relies on the participants' self-reports. Also, the

study did not reach the point of elucidating the correlational mechanism with time and cost variables. On the other hand, insofar as the inventory directly asks the students about their learning quality assurance interaction elements, this helps quantify and answer the question of learning quality in a quite straightforward way. This study was published in a research paper by Miyazoe and Anderson (2010).

Bernard et al. (2009). As the most recent comprehensive approach to the issue, this meta-analysis (Glass, 1976; Lipsey & Wilson, 2001; Shadish et al., 2002) examined distance education research from January 1985 to December 2006. It uses the special term interaction treatments (ITs) for interaction intervention, which are defined as "the instructional and/or media conditions designed into DE [distance education] courses, which are intended to facilitate student–student (SS), student–teacher (ST) or student–content (SC) interactions" (p.2).

In accordance with the interpretation that the present paper articulated above, Bernard et al., (2009) use the term *value* (or importance) for Thesis 1 and *strength* (or magnitude) for Thesis 2 for its conceptualization. Six research questions are broken down as follows:

1. What are the effects of the three kinds of interaction (student–student, student–teacher, and student–content) on achievement?
2. Does more overall interaction treatment strength promote better achievement?
3. Do increases in treatment strength of the three different forms of interaction result in better levels of achievement?
4. Which combinations of student–student (SS), student–teacher (ST), and student–content (SC) interaction affect achievement the most?
5. Are there differences among synchronous, asynchronous, and mixed forms of DE in terms of the effects of ITs on achievement?
6. What is the relationship between treatment strength and effect size for achievement outcomes in asynchronous-only DE studies?

The first four questions are directly relevant to the theorem testing: the first relates to Thesis 1 and the second, to Thesis 2; the third and fourth further break down the sub-issues regarding Thesis 2. The fifth and sixth questions come from another parameter of asynchronous versus synchronous distance education that is derived from another major meta-analysis identified by the same authors (Bernard et al., 2004).

The analysis includes the blended type of distance courses (less than 50% of face-to-face components), following strict criteria for analysis inclusion. Out of 1,034 potential courses, a total of 77 satisfied all the criteria for the final analysis; the total number studies examined for inclusion/exclusion was more than 6,000. The kinds of interaction treatment of SS, ST, and SC are codified, and two categories of *achievement* and *attitude* are focused on as the outcome of calculating the effect size. Table 2 below summarizes their findings (Bernard et al., 2009).

Table 2

Summary of the findings for achievement and attitude outcomes for each research question

Research Questions	Findings	
	Achievement	Attitudes
Question 1: Categories of interaction (SS, ST, SC)	All categories > 0.25, SS and SC > ST.	SS > ST and SC.
Question 2: Overall strength of interaction categories	Increase in strength for moderate and high strength over low strength. Regression is significant.	Increase in strength for moderate over low strength. Not enough data to evaluate high strength. Regression is not significant.
Question 3: Strength of individual categories	Increase in strength for high over low and moderate for SC only.	Increase in strength for moderate over low for SC only.
Question 4: Combinations of categories	Increasing relationship between strength and effect size for SS + SC and ST + SC.	No finding.
Question 5: Asynchronous versus Synchronous versus Mixed DE	No difference among types of DE.	Synchronous and asynchronous greater than mixed DE.
Question 6: Interaction in Asynchronous DE only (achievement outcomes)	Strength of SC affects outcomes in asynchronous settings more than in other settings.	N/A

The basic findings regarding the theorem of the study are as follows: (1) Thesis 1 was supported, especially SS and SC interaction treatments showing a higher value than ST for both achievement and attitude; (2) not all combinations of interaction treatments necessarily strengthen achievement and attitude, but (3) only SC shows a certain level of contribution to higher achievement and attitude, and (4) among three possible combinations of SS+ST, ST+SC, and SS+SC, the combinations of SS+SC and ST+SC contribute to the increase of achievement; however, SS+ST and attitude items did not support the thesis regarding increased effectiveness.

With the study's particular focus relevant to the equivalency theorem, it found that (5) asynchronous, synchronous, and mixed modes did not show any difference in achievement; moreover, the mixed mode of classroom instruction and distance education in one course was more weakly received than the other two modes, and (6) among three interaction treatments, a higher SC leads to a higher achievement in asynchronous DE.

Regarding by-products, the sampling process found that 68% of achievement studies and 80% of attitude studies were conducted between 2000 and 2006 (p.36). This signifies that the traditional classroom instruction versus distance education research scheme has seen a rapid shift in focus, and also, there is lack of research data on synchronous and mixed-mode contexts.

One point to be noted is that research questions 5 and 6 are based on the categorization of distance education into three delivery modes, namely, asynchronous, mediated synchronous, and mixed (or blended or hybrid) modes in this study. The mixed mode is defined as the combination of classroom instruction and distance education (pp.9–10). This is congruent to some extent to the study of Miyazoe (2009) reviewed above, if we consider that the online instruction outside the classroom is equivalent to that in distance education. Hypothetically, there should be more variations in the combination of mixed modes in distance education because now, we have such cases as the combination of the bulletin board system (asynchronously mediated) and live conference (synchronously mediated), or as in the case in Rhode's study, a combination of two different kinds of formal and informal asynchronous mediated systems. More and more studies that do not fit the three categorizations of asynchronous, synchronous, and mixed face-to-face and distance education would have been rapidly executed. Accordingly, a re-examination of the coding categories for distance education meta-analysis would be required.

Another concern is the meta-analysis coding process at the general level. The process requires setting up the experimental versus the control group to compare the effect size, consisting of the sample number, standard deviation, and means. Although the study found higher effect sizes on SS interaction treatment over SC and ST, this could be a reflection of the research and instructional design development where the increased human intervention of SS interaction has been increasingly executed in distance education, and therefore, more studies that bore higher effectiveness are more likely to have been reported in recent years. If this is the case, although the support by meta-analysis for the theorem is intact, it would be possible that a larger sampling with the traditional interaction components of SC and ST may bring different priority results than the ones reported by this study.

Implications and Further Suggestions

The three studies, applying different research methodologies held in different contexts arrive at the same conclusion; Anderson's first thesis regarding interaction equivalency is so far supported. All admit that one kind of interaction can be given a higher value than the others not only in distance education but possibly in a blended learning context as well. Also, the form of interaction valued most differs among these studies: instructor and content in Rhode's study, different elements depending on learning modes and content orientations in Miyazoe's study, and student and content in Bernard et al.'s study as Thesis 1 supposed. The second thesis was also supported by the meta-analysis of Bernard et al. and partially by Miyazoe's study: the increased interaction brought by a combination of different interaction treatments could lead to higher achievement, although the effects it found were more minimal than proportional.

Besides the original theorem of Anderson, each of the three studies has contributed to advancing the research scheme by adding an original dimension to the theorem: formal versus informal interaction with Rhode, learning modes and content orientations with Miyazoe, and synchronous versus asynchronous learning with Bernard et al.

The first two studies and the meta-analysis help fortify the Theorem complementarily: the first two verified the Theorem in specific contexts at the expense of generalization, whereas the strength of meta-analysis is its test of generalizability at the expense of numerous different variables in numerous research contexts. Both approaches are needed for a higher level of verification of the Theorem especially in educational settings where no one single educational event could be repeated in reality.

There are arguments to be developed further regarding the research methodology. Although this paper articulates the core concepts of the theorem, that is, value and strength (or quality and quantity), it is still a question whether or not the current research scheme has successfully measured the two learning qualities defined by Anderson (2003a) above, that is, "deep and meaningful" learning and "satisfying" educational experience. There may be a gap between whether or not a student felt that learning occurred and if he/she was satisfied–that is, if quality learning indeed happened–and whether or not a high course grade given by a

course instructor in a distance education could, in reality, refer to very different experiences. Furthermore, the three studies reviewed in this paper did not examine the cost and time variables to correlate interaction and learning quality, which consist of the core elements of Thesis 2. This will be a challenging and meaningful research question to be further undertaken, as will be noted later.

It is noteworthy that the research made has so far covered only partial events of interaction rather than the whole vision of interaction concept developed by Anderson: that is, the research has tested three combinations of interaction, which are pairs with students' perspective only. As phrased in another book chapter by Garrison and Anderson (2003), as well as Anderson (2003a) and Anderson (2003b), three more pairs of interaction elements (teacher–content, teacher–teacher, and content–content) exist, which could be further developed into the following new theses:

Thesis 3: Deep and meaningful formal *teaching* is supported as long as one of the three forms of interaction (*teacher–student; teacher–content; teacher–teacher*) is at a high level. The other two may be offered at minimal levels, or even eliminated, without degrading the educational experience.

Thesis 4: Deep and meaningful formal *teaching and learning* is supported as long as one of the three forms of interaction (*content–student; content–teacher; content–content*) is at a high level. The other two may be offered at minimal levels, or even eliminated, without degrading the educational experience.

Teacher-teacher and content-content interaction may sound counter-intuitive at first look; however, the recent emphasis on faculty and professional development in education is a familiar example for teacher-teacher interaction to improve teaching, and consequently, the students' learning. Also, the recent intelligent programs that compile information on specific individual learning styles such as unit study progress and scores, and that propose a customized study plan may be a familiar example of preinstalled content-content interaction before student-content interaction. By finding ways to quantify these theses, we may be able to look at educational events in much different ways than we have always been accustomed to.

Several directions regarding the equivalency theorem are suggested for the next step of the research scheme:

-   clarifying the concepts of "learning quality" in the Theses in measureable ways
-   testing Thesis 1 in varied contexts to detect the predicators that lead to higher learning quality
-   testing Thesis 2 to identify if it can claim validity
-   testing Thesis 2 with the cost, time, and interaction variables
-   finding the way to test the new Theses 3 and 4 and check their validity.

Although the research so far reviewed supports Thesis 1, further examination of Thesis 2 is also important because if in reality, doubling or tripling the quality interaction elements bring little or no effect on improving the learning, it would be much wiser and more effective to concentrate on pursuing the Thesis 1 mechanism to customize the most valued interaction that the students hope to have in an instructional design beyond the distinction of distance education and other modes of learning. In this regard, testing Thesis 1 may eventually result in the most efficient and effective instruction with the least time and cost.

There is reason to believe that further studies related to the equivalency theorem are being undertaken and will soon be published. As far as the core interaction components of teacher, student, and content in education remain, the value of exploring the equivalency theorem remains promising.

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