

THE INTERACTION EQUIVALENCY THEOREM IN A
MULTIMODAL BLENDED COURSE

A Dissertation Presented to the
Faculty of the College of Education
University of Houston

In Partial Fulfillment
of the Requirements for the Degree

Doctor of Education

by

Chi-Liang Yu

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Abstract

With the rapid development of instructional technology, it is conceivable that learning experiences in the future will be blended, a combination of face-to-face and computer-mediated instruction. This form of education has raised questions about the integration of face-to-face and online interaction. In the research on interaction theory, Moore was one of the first investigators to systematically identify the three most common types of interaction, namely student-teacher, student-student, and student-content interaction. Anderson (2003a) suggested that the three types of interaction are equivalent, and instructors can substitute one interaction for another with little loss in learning effectiveness if they are at the same level. Blended learning has the potential to increase the quality and amount of interaction and to provide possible solutions for the problem of escalating costs. Understanding students' perceptions of interaction may help educators produce the right mix of interaction in a blended learning environment.

The purpose of this study was to examine students' perceptions of interaction and their learning experiences in a multimodal blended course, a course that provided face-to-face, blended, and online learning modes concurrently. Anderson's (2003a) theory was used as a guideline for the analysis of student-teacher, student-student, and student-content interaction. This study focused on the following questions: (1) How do students perceive the quality and amount of interaction in a multimodal blended course? (2) From the students' point of view, how does interaction affect their learning experiences in a multimodal blended course?

This mixed methods research collected quantitative and qualitative data through a survey and individual interviews. The quantitative data were analyzed using a descriptive approach and the qualitative data were coded by Carspecken's (1996) coding method. In addition, a peer reviewer helped the researcher check biases or omissions in the data analysis and interpretation.

The findings of this study suggest that students perceive interaction with the teacher and with the content as more valuable than the interaction with other students. The interaction in a face-to-face environment could lead to a closer relationship between teachers and students, and it should not be discounted when designing a blended course. For online interaction, students perceived online tutorial videos as one of the best aspects of this course but criticized some outdated online content. That would be improved if it were updated frequently. In addition, the lack of communication from instructors can create inconsistent course information, which may cause confusion and sabotage students' learning experiences.

This study found that the interaction with the teacher, students, and content were mostly equal and substitutable. Anderson's Interaction Equivalency Theorem was supported in this study. Instructors and instructional designers should combine and balance the interaction in face-to-face and online learning environments as seamlessly as possible when designing a blended course. The findings of this research suggest that interaction design in blended learning environments should include face-to-face and online dimensions, and all three types of interaction. Because the optimal blend of face-to-face and online interaction may vary in different subjects and courses, course

development should be an iterative process where instructors and instructional designers periodically refine the interaction design to meet the needs of students.

Table of Contents

Chapter I. Statement of the Problem.....	1
Description of the Study	5
Purpose of the Study	6
Research Questions.....	7
Significance of the Study.....	7
Chapter II. Review of Literature.....	10
Blended Learning Overview	10
Students' Perceptions of Blended Learning.....	15
Types of Interaction	18
Interaction Equivalency Theorem.....	21
Interaction in Blended Learning	24
Conclusion	26
Chapter III. Methodology	28
Research Questions.....	28
Research Design.....	28
Participants.....	29
Instrumentation	30
Data Collection	31
Data Analysis	32
Summary.....	33
Chapter IV. Data Analysis And Results	34
Descriptive Characteristics of Respondents.....	34
Analysis of Research Question One	39
Analysis of Research Question Two.....	56
Chapter V. Discussion	69
Discussion of Research Question and Findings.....	69
Interaction Equivalency	74
Recommendations.....	77

Limitations of the Study.....	78
Conclusions.....	79
References.....	81
Appendix A Student Survey	88
Appendix B Interview Protocol	92

List of Tables

Table 1. Course Classification	11
Table 2. Demographic Characteristics of Participants.....	35
Table 3. The Reason of Choosing Course Delivery Format.....	36
Table 4. Importance of Student-Teacher Interaction	40
Table 5. Interaction with the Teacher	41
Table 6. Importance of Student-Student Interaction.....	42
Table 7. Interaction with other Students	43
Table 8. Importance of Student-Content Interaction	44
Table 9. Interaction with Course Content.....	45
Table 10. Ranking of Teacher Element	46
Table 11. Ranking of Student Element.....	46
Table 12. Ranking of Content Element.....	47
Table 13. Successful vs. Unsuccessful Learning Experience	57
Table 14. Overall Learning Experience	57
Table 15. Time Devoted in This Course.....	61
Table 16. Rating of Course Elements	62

List of Figures

Figure 1. Educational Interaction.....	20
Figure 2. Visual Representation of the Interaction Equivalency Theorem.....	22
Figure 3. The Interaction Equivalency Theorem in Blended Learning Environments.....	76

Chapter I

Statement of the Problem

The traditional face-to-face learning environment has been around for centuries, and it is most likely still the mainstream method of teaching today. However, there has been a significant trend toward online learning in higher education and corporate training during the past decade. Research indicates that over 6.1 million students in higher education were taking at least one online course during 2010 in the United States (Allen & Seaman, 2011). In the past, face-to-face and online learning environments have remained somewhat separate. This is because face-to-face classes typically occurred with in-person interaction in a synchronous and teacher-centered environment, whereas online learning emphasized content interaction and self-paced learning in an asynchronous environment. Recently, the widespread use of learning technologies has led to the integration of face-to-face and online learning environments (Graham, 2006). The traditional face-to-face classroom may apply online learning activities as a part of the course, and online courses can use communication technology to increase person-to-person interaction or require face-to-face meetings for course orientation and final presentations. This delivery format that combines traditional face-to-face and online learning elements has emerged from this intersection of the two historically separated models of the learning environment, and it is labeled as blended learning.

Blended learning can be simply defined as a learning system that combines face-to-face instruction with computer-mediated instruction (Graham, 2006). Researchers regard it as one of the most prominent instructional delivery methods in both industry and higher education (Bonk, 2009; Bonk & Graham, 2005; So & Bonk, 2010; Young, 2002).

The form of education has changed dramatically in the twenty-first century. With the rapid development of mobile devices, it is inevitable that more and more students will use personal Internet-connected devices in school. Students are able to learn in a face-to-face learning environment and also have access to online learning materials instantaneously. In addition, integrating technology into the classroom for teachers is no longer something unique. Masie (2003) indicated that the “e” of e-learning is disappearing. It will be increasingly difficult to distinguish between face-to-face and online learning in the future. Some researchers believe that there will be no bi-polar classification of online learning and off-line learning as all learning experiences will be blended to some extent (Graham, 2006; Picciano, 2009; So & Bonk, 2010).

A new generation of technology savvy students represents unique learning styles and personality types. They can use digital technologies and the Internet for learning without difficulty. Many educators believe that instructional design should implement multiple communication technologies both in face-to-face and online learning environments to meet the needs of a wide variety of students (Picciano, 2009), but the problem is how to get the right mix of interaction from those two learning environments. Research studies have indicated that integrating face-to-face and online interaction effectively and efficiently to create a holistic and seamless learning experience for students is essential in blended learning (Picciano, 2009; So & Bonk, 2010). With the emergence of blended learning, the research of interaction in blended learning has become more critical.

Interaction is one of the most discussed topics in educational research (Abrami, Bernard, Bures, Borokhovski, & Tamim, 2011; Anderson, 2003b; Miyazoe, 2012; Moore,

1989; Sutton, 2001). It is a fundamental element of a quality learning environment, and it serves as the foundation for educators to understand the phenomenon of learning in many learning approaches (Anderson, 2003a; Picciano, 2009). For the purpose of this study, the researcher uses Wagner's (1994) definition of interaction as "reciprocal events that require at least two objects and two actions. Interaction occurs when these objects and events mutually influence one another" (p. 8). This definition of interaction emphasizes the "learning events" rather than the "media" of interaction.

In the research of interaction theory, Moore (1989) was one of the first researchers to systematically identify the three most common types of interaction in distance education, namely student-teacher, student-student, and student-content interaction. To extend Moore's framework, Anderson and Garrison (1998) proposed teacher-teacher, teacher-content, and content-content interaction to cover additional forms of interaction.

Anderson (2003a) proposed the Interaction Equivalency Theorem to analyze the cost and value of interaction, and to help teachers select the most effective, efficient, and appropriate mix of interaction in distance learning. More recently, Miyazoe and Anderson (2010a) conducted empirical research on the theory to examine the key issues regarding the three interaction elements: teacher, student, and content. They indicated that the main feature of the theory can be condensed into two theses. First, 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. Second, 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 (Miyazoe & Anderson, 2010b, p. 94). The theory attempts to use interaction design to increase learning effectiveness and efficiency, and it has become a part of the development of interaction research in education (Miyazoe, 2012; Moore & Kearsley, 2011).

Anderson's theory suggests that instructional designers can substitute one interaction for one another with little loss in learning effectiveness if it is at the same level. For example, some web-based forms of student-teacher interaction (emails, video, or text chats) can be substituted through the use of rich student-content interaction (teacher video, tutorials, FAQs). Thus, student-teacher interaction is usually substituted by student-content interaction in mass education systems because it reduces the teacher's workload.

Educational institutions have recognized the value of interaction and have made an effort to foster various types of interaction to meet students' needs. When blending face-to-face and online learning has become an indispensable part of the learning experience for university students, getting the right mix of interaction has become more challenging. Instructional designers not only need to harmonize the interaction of teacher, student, and content, but also have to balance the interaction between face-to-face and online learning environments. Anderson's assumption appears particularly attractive to administrators because it has the potential to meet the needs of learners and to make budget cuts.

Anderson's theory originated in terms of distance education. However, it has much wider validity in face-to-face, blended, and online learning environments (Miyazoe

& Anderson, 2010a, 2010b). Blended learning has the potential to increase the quality and amount of interaction and to provide possible solutions for the problem of escalating costs. If providing extensive interaction brings little effect on students' learning, it would be more effective to focus on the interaction that students value the most when designing a course. "The magic is in the mix" (Masie, 2002), and there is no single recipe that will create the perfect blend for every learning situation. Understanding students' perceptions of interaction may help to get the right mix of interaction in a blended learning environment.

Description of the Study

The Jack J. Vanlanti School of Communication at the University of Houston has offered the Information and Communication Technologies course to a large group of undergraduate students for over a decade. There were multiple sections of this course and each section was taught by a different teacher. In order to increase the amount of interaction between students and teacher and to provide students with efficient support, the teachers of this course decided to teach collaboratively. They combined different course sections into a multimodal blended course and offered the course in face-to-face, online, and blended mode of learning simultaneously. The teachers used identical course content in these three learning modes. Each student chose a designated mode for his or her main course delivery system but was encouraged to make use of the other modes at will. A multimodal blended course provides students with a flexible learning environment that best fits their needs, and it gives students opportunities for learning in other possible ways as well (Picciano, 2009).

The interaction design of this course was flexible. For instance, the course was delivered through the Blackboard learning management system (LMS) with a variety of computer-mediated communication tools and combined with a face-to-face environment for teachers and students to interact with each other. Students from different learning modes can potentially interact with the teachers and peers within the system and/or in the classroom. In other words, the students in the face-to-face class could take advantage of online learning, and online students can opt to join weekly face-to-face meetings or make an appointment with the teachers if they desire in-person communication. The students in the blended learning mode had the interaction in both face-to-face and online learning modes. For the content interaction, the students from three learning modes can access abundant course content on the course Blackboard site, which includes course syllabus, course introduction and weekly lecture videos, an electronic textbook, course podcasts, assignment tutorial videos, and so on. The interaction in this multimodal blended course could be extensive if the students take advantage of the course design.

Purpose of the Study

The purpose of this study was to examine students' perceptions of interaction and their learning experiences in a course that was offered with face-to-face, blended, and online formats concurrently while validating Anderson's (2003) Interaction Equivalency Theorem. The researcher investigated how students perceived the quality and amount of interaction in face-to-face, blended, and online learning modes, and how interaction affected their learning experiences. Anderson's theory was used as a guideline for the analysis of interaction in this study.

Research Questions

The main goal of this study was to shed light on getting the right mix of interaction in blended learning environments by examining students' preferences of interaction in different learning modes. This study focused on the following questions.

1. How do students perceive the quality and amount of interaction in a multimodal blended course?
2. From the students' point of view, how does interaction affect their learning experiences in a multimodal blended course?

The research design of this study involved collecting both qualitative and quantitative data. Mixed-methods research uses both quantitative and qualitative approaches and provides a more thorough understanding of complex systems like teaching and learning than using a quantitative or qualitative method alone. Researchers can gain broader perspectives as a result of using mixed methods (Creswell, 2009). It helps to clarify and explain relationships between variables and allows us to explore those relationships in depth (Fraenkel & Wallen, 2008).

Significance of the Study

Interaction is a critical element for quality learning experiences (Anderson, 2003b; Miyazoe, 2012; Moore, 1989). Learners may feel isolated if insufficient interaction is provided, whereas excessive interaction may create a course that is ineffective and unsustainable. Anderson argues that if any one of the student-student, student-teacher, or student-content interaction is extensive, the other two types of interaction could be reduced or even eliminated without affecting learning experiences. This hypothesis is gaining more and more attention because it tries to create a means of developing and

delivering education that is cost effective and affordable. It also addresses limitations on the amount of teacher, student, and content interaction. More research is needed to test the validity of Anderson's theory in various contexts and learning environments (Miyazoe & Anderson, 2010b).

The question of getting the right mix remains significant for the research on distance education and blended learning (Miyazoe & Anderson, 2012). The transition to blended learning presents an opportunity for teachers to combine different types of interaction into a more vigorous learning model that takes full advantage of the face-to-face and online learning environments. Picciano (2009) suggests that blended learning "should be more a mixture of different colors of paint to create new colors or new learning environments" (p. 16). The understanding of students' needs for interaction is critical in the decision-making of how much interaction should take place in face-to-face or online settings, and how to integrate these two modes of interaction in a seamless way (Picciano, 2009; So & Bonk, 2010).

Miyazoe and Anderson (2010a) indicated that learners tend to prefer student-teacher interaction in face-to-face mode, student-content interaction in online mode, and all three types of interaction with emphasis on online student-student interaction in blended mode. However, students' perceptions and preferences of interaction may vary in different subjects and learning environments. More research is needed to clarify the expectations and preferences of students in terms of necessary interaction in blended learning.

This research helped us understand the expectations and preferences of students in terms of necessary interaction in a multimodal blended learning environment. The

understanding of students' needs is essential to balance the interaction between face-to-face and online settings, and how to integrate these two modes of interaction in a seamless way. The findings of this research contributed to the body of research on Anderson's theory and provided guidelines for the design and development of blended courses.

Chapter II

Review of Literature

The purpose of this study was to examine students' perceptions of interaction and their learning experiences in a multimodal blended course while validating Anderson's (2003) Interaction Equivalency Theorem. This chapter provides an overview of blended learning and reviews relevant research of major issues of blended learning, students' perceptions of blended learning, types of interaction, Interaction Equivalency Theorem, and current interaction research in blended learning.

Blended Learning Overview

The development of high-speed Internet enabled web-based and online instructional strategies and tools to penetrate the traditional face-to-face learning environment in recent years. Instructors have incorporated online tools as an enhancement to classroom instruction. On the other hand, there has been a significant trend toward online learning in higher education and corporate training during the past decade. Blended learning, which combines the best of online and face-to-face learning environments, has come to the attention of people in education and corporate settings (Bonk & Graham, 2005).

Graham (2006) presented the three most common definitions of blended learning: (1) combining instructional modalities (or delivery media); (2) combining instructional methods; and (3) combining online and face-to-face instruction. The third definition more accurately reflects that blended learning is the combination of two historically separate models of teaching and learning. Graham's (2006) proposition "blended learning

systems combine face-to-face instruction with computer-mediated instruction” (p. 5) was the definition adopted for this study.

Allen and Seaman (2011) provided a guideline of course classification (see Table 1) based on how much online content is involved in the class. Blended course is defined as having between 30 to 79 percent of the course content delivered online. Blended learning offers greater flexibility of interaction in both face-to-face and online learning environments. With the development of instructional technology, it is believed that there will be no bi-polar classification of online or offline learning as learning experiences will be blended to some extent (So & Bonk, 2010).

Table 1

Course Classification

Proportion of Content Delivered Online	Type of Course	Typical Description
0%	Traditional	Course with no online technology used. Content is delivered in writing or orally.
1 to 29%	Web-Facilitated	Course that uses web-based technology to facilitate what is essentially a face-to-face course. May use a course management system (CMS) or web pages to post the syllabus and assignments.
30 to 79%	Blended/Hybrid	Course that blends online and face-to-face delivery. Substantial proportion of the content is delivered online, typically uses online discussions, and typically has a reduced number of face-to-face meetings.
80+%	Online	A course where most or all of the content is delivered online. Typically have no face-to-face meetings.

Blended learning shows advantages compared to fully face-to-face or online learning environments. Combining the best of both face-to-face and online instruction is the most common reason for the adoption of blended learning. However, blended learning can also combine the least effective elements if it is not properly designed. Graham (2006) indicated six major issues of blended learning approach: (1) the role of live interaction; (2) the role of learner choice and self-regulation; (3) models for support and training; (4) finding balance between innovation and production; (5) cultural adaptation; and (6) dealing with the digital divide.

The Role of Live Interaction

Human interaction is essential for the learning process and learner satisfaction. Some research studies indicated that learners prefer the face-to-face component in a blended experience when computer-mediated and face-to-face elements are provided. Students usually place a greater value on the face-to-face feature of the learning experience (Hanson & Clem, 2005; Hofmann, 2005). More studies are needed to clarify the role of face-to-face interaction in a blended learning environment.

The Role of Learner Choice and Self-regulation

Research studies indicated that learners select blended learning primarily out of convenience and access. The question is how much guidance should be provided to learners in making their choices of blended learning. In addition, the online learning component often requires self-regulation of the learner. Designing blended learning to support learner maturity and capabilities for self-regulation is critical (Huang & Zhou, 2005).

Models for Support and Training

The issues of support and training in blended learning include the increased demand on the instructor's time, providing learners with adequate technological support in both face-to-face and computer-mediated environments, and changing organizational culture to accept blended approaches. There is a need to provide professional development for instructors who will be teaching blended courses. Technological support, organizational acceptance, and successful blended learning models drawn from the experiences of instructors and students are paramount (Lee & Im, 2005; Lindquist, 2005).

Finding Balance between Innovation and Production

There is a constant tension between innovation and production when it comes to design. The ultimate question has always been to explore the possibilities that new technological innovations can offer while maintaining a cost-effective production. Because of the changing nature of technology, finding a balance between innovation and production will remain challenging for instructional designers of blended learning (Graham, 2006).

Cultural Adaptation

One of the strengths of online learning is the ability to distribute consistent learning materials within a short period of time. It is important to make learning material culturally relevant and to find a balance between global and local interests. The issue of cultural adaptation is challenging for designers in blended learning (Jagannathan, 2005; Selinger, 2005).

Dealing with the Digital Divide

The availability of information and communication technology to individuals and societies of different socioeconomic status, the so-called “digital divide,” has shown to vary greatly. People often regard online learning as an environment that only favors those advantaged. However, online learning can also be perceived as mass education because of its low cost and wide distribution. Whether or not blended learning can provide affordable education and address the needs of different socioeconomic populations will remain an inviting topic (Jagannathan, 2005; Massy, 2005).

In order to identify and predict the role of blended learning in computer-supported collaborative learning environments, So and Bonk (2010) conducted research with thirty-two experts who had contributed to the *Handbook of Blended Learning* (Bonk & Graham, 2005). Their research focused on the pros and cons, and the future of blended learning. The research indicated that increased time required for course preparation and interaction with students presents challenges for faculty members. Simply transferring classroom lectures into an online format is not good enough to provide students meaningful learning experiences with rich interaction and engagement.

So and Bonk (2010) found that the coordination between face-to-face and online learning components is critical, and interaction design is one of the key factors. Combining human interaction and technology-mediated interaction is a complex decision involving instructional design considerations. Blended learning offers greater flexibility and possibilities for interaction and collaboration. The question is how to get the right mix. More research is needed to reach a better understanding of the design issues and to create a seamless integration of face-to-face and online interaction.

Students' Perceptions of Blended Learning

“The magic is in the mix” (Masie, 2002), and there is no single recipe that will create the perfect blend for every learning situation. Understanding students' perceptions may help instructional designer get the right mix of interaction in blended learning environments. Compared to the volume of research on students' perceptions of face-to-face and online learning, the research on blended learning is sparse.

Pritchard (2006) examined students' perceptions of a blended learning program at a private college. The purpose of the study was to describe how students perceived the blended course structure and the reason why they took blended courses. The subjects in the study were 210 graduate and undergraduate students who completed a blended course in the program. The findings of the study revealed that students decided to take a blended course mostly because it fit better into their work and family structures. It also minimizes travel time and allows enrollment in additional courses.

Pritchard's (2006) research investigated four factors, including course management, course structure, course interaction, and personal attributes in relation to students' perceptions of blended learning. The results of the study found that blended learning help students with course management because of the face-to-face interaction in a blended course. Despite an overall positive perception toward blended learning, the participants reported that blended courses were too unstructured. The researcher suggested that combining face-to-face and online learning requires more instructional considerations for instructional designers.

Students of fully online courses are often struggling with the loss of personal interaction. The findings of the Pritchard study indicated that blended course seems to

minimize those concerns because students have more opportunities to interact with the instructor and other students. Blended courses combine the best of online and face-to-face instruction, and create an environment where optimal learning can occur while meeting the needs of students who desire convenience.

Shaw (2010) conducted a study using a cross-sectional survey design and descriptive statistics to examine students' perceptions of blended learning environments. The findings of the study indicated that technological problems were not concerns for students in the blended course because they had the opportunities to ask questions during face-to-face interaction. The students reported that they had more opportunities to interact with the instructor and peers in a blended learning environment. The integration of face-to-face and online learning allowed personal interaction with the instructor and other students throughout the course.

Akkoyunlu and Soylu (2008) examined 34 students' learning styles and perceptions of blended learning. The findings of the study indicated that the face-to-face component of a blended course provided social interaction between the students and teachers. The students expected face-to-face interaction in the learning process so that they could resolve the problems that they have in the online class. Results of the research found that face-to-face interaction is a must for students. The students' reflective reports indicated that blended learning enhanced their learning experiences. Students' attitude toward blended learning was highly positive.

Usta and Ozdemir (2007) examined students' perceptions of blended learning with 36 students enrolled in a social science teacher education program. A mixed method research design was used in this study. The study results pointed out that students had

quite positive feedback about student-student, student-instructor interaction in the blended program. The students perceived the student-student interaction in the blended program as high level. They strongly agreed that they could share information with the other students in the program and that they greatly benefited from those interaction. Regarding the interaction with the instructor, students reported that the student-teacher interaction was in high level. They could interact with the instructor without difficulty during the course. The researcher concluded that students' opinions of their blended learning experiences were positive. Blended learning was effective in terms of students' satisfaction with student-student and student-instructor interaction, course structure, and blended learning experiences.

Wu, Tennyson, and Hsia (2010) examined the determinants of student learning satisfaction in a blended learning environment, using a questionnaire survey with 212 participants. The determinants of student learning satisfaction were identified, namely computer self-efficacy, performance expectations, system functionality, content feature, interaction, and learning climate. The results suggest that interaction have a significant positive influence on both performance expectations and learning climate. The researchers found that blended learning design helped students actively participate in student-student and student-instructor interaction, and foster a better learning climate and greater learning satisfaction.

The research literature supports that interaction is critical for a successful blended course, but questions exist regarding the effect of interaction on students' learning experience. Picciano (2002) found that there was a strong and positive relationship between students' perceptions of interaction and their perceptions of successful learning

experiences. However, the relationship between interaction and learning experience is a complex phenomenon in need of further study.

Types of Interaction

Interaction is a defining and critical component of education. However, it is difficult to find a precise definition of it in the literature (Anderson, 2004). Researchers use interaction to describe many different types of exchanges in teaching and learning. Wagner (1994) defined interaction as “reciprocal events that require at least two objects and two actions.” Interaction occurs when these objects and events mutually influence one another. Garrison and Shale (1998) defined all forms of education as essentially interaction between content, students, and teachers.

Interaction is a crucial element in creating effective learning experiences. In the educational philosophy of Dewey (1938), learning emerged from meaningful interactive experiences, where students interact with each other in a social context to manipulate materials and ideas. He believed that the interaction between students and teachers is a critical element in the learning process. Education needs to focus on the process of inquiry rather than the process of conveying information from teacher to students.

Researchers have built on Dewey’s theories and have proposed different types of interaction. Moore (1989) is one of the first researchers who systematically identified the three most common types of interaction in distance education, namely learner-instructor, learner-learner, and learner-content interaction. He encouraged distance educators to “organize program to ensure maximum effectiveness of each type of interaction, and ensure they provide the type of interaction most suitable for various teaching tasks of

different subject areas, and for learners at different stages of development” (Moore 1989, p. 5).

Learner-instructor interaction refers to the process where students and an expert instructor engage in dialogues and exchange ideas for purposes such as clarifying questions, gaining support, and stimulating learning motivation. The instructor seeks “to stimulate or at least maintain the student’s interest in what is to be taught, to motivate the student to learn, to enhance and maintain the learner’s interest, including self-direction and self-motivation” (Moore 1989, p. 2) Learner-instructor interaction could be synchronous such as telephone, videoconferencing and chats, or asynchronous such as email and discussion boards.

Learner-learner interaction refers to interaction among individual students or among students working in small groups. It is an “inter-learner interaction, between one learner and other learners, along or in group settings, with or without the real-time presence of an instructor” (Moore, 1989, p. 4). It could be synchronous such as video or audio conferencing or chatting, or asynchronous such as email or discussion boards.

Learner-content interaction refers “the process of intellectually interacting with the content that results in changes in the learner’s understanding, the learner’s perspective, or the cognitive structures of the learner’s mind” (Moore 1989, p. 2). Student-content interaction may include reading information, using course study guides, watching instructional videos, interacting with multimedia, participating in simulations, using cognitive support software, searching for information, completing assignments and working on projects. It occurs when the students react to the learning material during the learning process.

Anderson and Garrison (1998) expanded Moore's model and added three new types of interaction, including teacher-teacher, teacher-content and content-content interaction (as shown in Figure 1). Teacher-teacher interaction is teachers' professional development and communication with each other to enhance teaching competencies. Teacher-content interaction refers to teachers' preparation and development of learning content in teaching and learning. Teachers now have more opportunities to interact with learning content with the prevalence of Internet connectivity. In addition, intelligent programs or agents would be able to interact with each other as they continuously search the network and enlarge the database. Teachers would be able to use learning resources that continuously improve themselves through the content-content interaction.

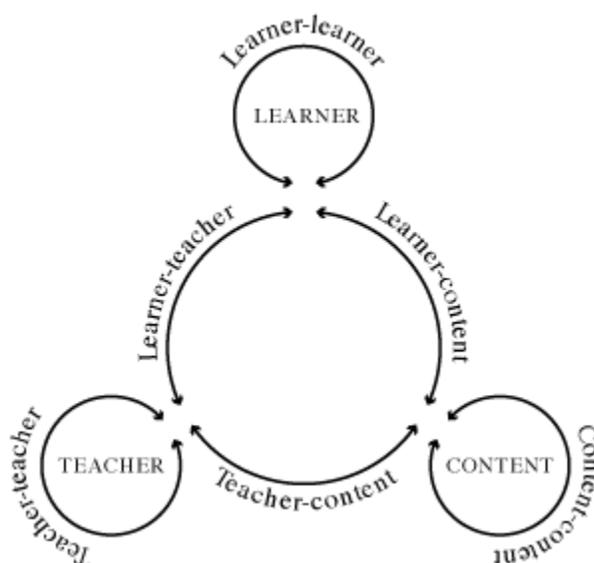


Figure 1. Educational Interaction

Interaction Equivalency Theorem

Anderson (2003) developed the Interaction Equivalency Theorem to analyze the cost and value of interaction in distance education. He proposed that one type of interaction could substitute for one another with little loss in educational effectiveness if the interaction is at the same level. Miyazoe and Anderson (2010b) indicated that different economies exist in independent and interactive oriented instructional designs. Instructional designers should take those economic factors into their consideration to meet the needs of students in an effective and efficient way. They condense the main features of the theory into two 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 (p. 2).

As shown in Figure 2, the primary focus of the first thesis deals with quality consideration of interaction. It proposes that only one of the interaction elements is necessary to assure quality learning. The second thesis refers to the quantity consideration of interaction. A course with a great deal of interaction among teachers, students, and content would provide a higher quality of learning, but it would create a course that is expensive and unsustainable.

examined students' interaction preferences in formal and informal situations. The study found that students valued the interaction with the instructor and content most highly. The values of the instructor and content elements were nearly equal, but the student element was the least valued. The study confirmed that students perceived the value of interaction elements differently. Anderson's (2003) assumption that any type of interaction could be diminished or eliminated was not supported in his study. The students in this study felt the need to have three types of interaction for a quality learning experience. Bernard et al. (2009) confirmed the importance of the three types of interaction and concluded that increased interaction treatments, whether to the teacher, the student, or the content had a positive impact on student learning.

Abrami et al. (2011) indicated that the importance of interaction in the literature is largely univocal because the interaction between students, teachers, and content play an integral role in all formal education. They found that online learning allowed some degree of interaction to occur; however, learners may not interact optimally with the given quality and quantity of interaction because of the limitation of the course design and technology. A gap exists between the designed and perceived interaction of the teacher and students. They suggested that the next generation of interactive distance education should facilitate interaction in a more targeted, intentional, and engaging way.

Miyazoe and Anderson (2012) updated the Interaction Equivalency Theorem and proposed a 64 interaction design model in a recent study. The model provided all possible patterns of interaction design based on the theory. The purpose was to identify the optimal interaction design for a given teaching and learning context. The theory tries to clarify and conceptualize the cost and time factors in the interaction design, which has

not been explicitly discussed in the educational field. The researchers provided guidelines for future study of the interaction theorem. (1) All three axes (student–content, student–teacher, and student–student) constitute the research core for the analysis. (2) Research speculates on quality and/or quantity issues in the optimal dose/balance of interaction. (3) Research speculates on the outcomes of learning experiences, such as meaningfulness, satisfaction, and cost/time issues.

Identifying the optimal interaction design is critical because the amount of interaction implemented in a course may incur extra cost. These costs include invisible ones, such as the teacher and students' time. Anderson's theory aims to reduce costs of educational system in terms of interaction design so that teachers, students, and institutions can make better use of educational resources and time in a more productive way.

Interaction in Blended Learning

The interaction among teachers, students, and content could occur in face-to-face and/or online learning modes of instruction in a blended learning environment. The combination of synchronous (face-to-face) and asynchronous (online learning) methods is likely to increase the quantity and quality of interaction in blended learning. Blended learning presents an opportunity to redesign an integrated interaction mode that creates a holistic and seamless learning experience across different time and space.

Wagner (2006) discussed the next wave of blended learning and indicated that the integration of mobile technology, personal devices, and wireless networks is critical for the development of fully interactive digital learning experiences. Educational application could take advantage of digital media and provide rich learning content on a variety of

digital devices. The interaction in blended learning represent an evolution that leverages the portability of handheld devices to create rich multimedia learning experiences in a variety of forms. Wagner (2006) suggests that the next generation blended learning experiences should effectively combine face-to-face instruction, online instruction, and arrays of content objects of all form factors. In addition, the prevalence of wireless networks makes knowledge and information always accessible by using mobile devices. Students could check on facts in the middle of a classroom lecture and interact with students and content in a way that was previously unimaginable.

While the idea of combining face-to-face and online components sounds simplistic, even experienced instructors may struggle with the question of creating balance and harmony between these two modes of learning (Tabor, 2007). Blended learning involves interaction both in the online and face-to-face learning environments. Some research studies examined the integration and balance of the two components.

Lee and Dashew (2011) conducted research on designing effective student interaction with the instructor, students, and learning content in college settings. They found that blended learning provided an opportunity to redesign and bridge different modes of interaction. Faculty should create a more robust model that takes full advantage of distance tools, and develop a blended course that make the best use of face-to-face and online learning interaction.

Blended learning may cause confusion for students because it requires frequent switches from the face-to-face to the online mode of learning. Simply turning a classroom lecture into an online format does not necessarily provide rich interaction for students to make the learning experience meaningful. The correspondence between face-to-face and

online components is critical (Donnelly, 2010b; So & Bonk, 2010). Donnelly (2010a) used “harmonization” to describe the situation that brings the face-to-face and online environments together in a seamless way.

To provide a meaningful way to integrate face-to-face and online learning environments, Picciano (2009) proposed a multimodal model of blended course design that allows students to learn in their most comfortable learning environment while also challenging them to experience and learn in other ways. His “blending with purpose model” was derived from the literature of blended learning technology, student generations, and learning styles. He suggested that instructional designers should develop a flexible learning environment utilizing face-to-face and online learning approaches. His model incorporated the teacher, student, and content interaction. It presented six basic pedagogical objectives, which include learning content, face-to-face social and emotional supports, dialectic and questioning discussion boards, reflection blog, collaborative learning, and learning evaluations. He recommended the design of a multimodal blended course should integrate the six components as seamlessly as possible.

Conclusion

The widespread use of learning technologies has led to the integration of face-to-face and online learning environments and the trend toward blended learning is evident. Anderson’s Interaction Equivalency Theorem provides researchers a theoretical background to examine the interaction phenomenon in a blended learning environment. Compared to the research on Anderson’s theorem in distance learning, little research has been done on the interaction in blended learning through the students’ perspective. In an attempt to add to the body of knowledge of blended learning and interaction theorem, this

study investigated students' perceptions of interaction in a multimodal blended course while utilizing Anderson's (2003) assumption of the Interaction Equivalency Theorem. The findings provided guidelines for the design and development of blended courses and contributed to the body of research of the theory.

Chapter III

Methodology

The purpose of this study was to examine students' perceptions of interaction and their learning experience in a multimodal blended course. The researcher investigated how students perceive the quality and amount of interaction in face-to-face, blended, and online learning modes, and how interaction affect their learning experiences. Anderson's (2003) Interaction Equivalency Theorem implies that if providing extensive interaction brings little effect on students' learning, it would be more effective to focus on the interaction that students value the most when designing a blended course. The researcher used Anderson's theory as a guideline for the analysis of teacher, student, and content interaction in this study.

Research Questions

The main goal of this study was to shed light on getting the right mix of interaction in blended learning environments. This study focused on the following questions.

1. How do students perceive the quality and amount of interaction in a multimodal blended course?
2. From students' point of view, how does interaction affect students' learning experiences in a multimodal blended course?

Research Design

Mixed-methods research involves the use of both quantitative and qualitative approaches and provides a more thorough understanding of complex systems like teaching and learning than using a quantitative or qualitative method alone. Researchers

can gain broader perspectives as a result of using mixed methods (Creswell, 2009). It helps to clarify and explain relationships between variables and allows us to explore those relationships in depth (Fraenkel & Wallen, 2008).

A concurrent embedded strategy of mixed methods can be defined as “use of one data collection phase during which both quantitative and qualitative data are collected simultaneously” (Creswell, 2009, p. 214). A concurrent embedded approach has a primary method (quantitative or qualitative) that guides the research and a secondary data (qualitative or quantitative) that provides a supporting role in the procedure. The mixing of the data from the quantitative and qualitative is often useful to integrate and compare the information in a discussion section. Those data can also be analyzed side by side as two different pictures that provide an overall composite assessment of the problem.

This mixed-methods research used a concurrent embedded strategy to collect both qualitative and quantitative data. This study primarily employed a descriptive quantitative approach that used a survey to elicit students’ perceptions of interaction and their learning experience in a multimodal blended course. In order to gain broader perspectives on the students’ subjective experiences, qualitative data were collected by individual interviews of four students during the same phase of survey data collection.

Participants

The Jack J. Valanti School of Communication at the University of Houston has offered the Information and Communication Technologies course to a large group of undergraduate students for several years. In order to better meet the needs of students, the teachers of this course decided to teach collaboratively. They combined different course sections into a multimodal blended course and offered the course simultaneously in face-

to-face, online, and blended modes. The teachers used identical course content in these three learning modes. Each student chose a designated mode for his or her main course delivery system but was encouraged to make use of the other modes, if desired.

The COMM 3353 Information and Communication Technologies course contained 14 modules and two exams. Each learning module included a variety of features, such as course lectures, PowerPoint presentations, podcasts, readings, assignments, and quizzes. Online and blended students must pass a quiz in order to have an access to the next module. An online discussion board was used for students to ask questions. Three instructors taught this course collaboratively, and an effort was made to ensure that course content and requirements of each section were identical. The multimodal design provided students with a learning environment that best fits their needs, and it gives students opportunities for learning in other possible ways as well.

The students of the course COMM 3353 Information and Communication Technologies of Spring 2013 were the participants of this study with the consent of the course instructors. Letters of cooperation were received from the course instructors. The study sample combined all students enrolled in the three different learning modes, which included 22 students in the face-to-face section, 23 students in the blended section, and 84 students in the online section. A total of 129 students were eligible to participate in this study.

Instrumentation

Instrumentation for this study consisted of a survey and an interview. The researcher used an online survey (see Appendix A) to elicit students' perceptions and experiences of the course. The survey questions were developed based on Picciano's

(2002) perception of interaction instrument. The survey contained scales and open-ended items. The survey collected participants' demographic information, their perceptions of interaction, the importance of types of interaction, the value of course elements, the priority of the interaction elements, and the students' learning experiences. The interview questions (see Appendix B) were adopted from Rhode's (2009) study to investigate students' perceptions of interaction and their opinion about Anderson's Interaction Equivalence Theorem (2003).

Data Collection

The survey data were collected through an online survey. A link to the online survey was sent to the students in face-to-face, blended, and online sections before the course was completed. Informed consent to participate was displayed at the beginning of the survey. This page also explained each student's right not to participate and to drop out of the survey if they chose. The survey was available for approximately one month and approximately 20 minutes were required for each subject to complete the survey. The study sample combined all students enrolled in the three different learning modes, which included 129 students (22 face-to-face, 23 blended, and 84 online), and a total of 107 students (21 face-to-face, 10 blended, and 76 online) completed the online survey. Eighty-three percent of the students in this course participated in the survey.

An invitation letter was sent to the students to seek their participation for individual interviews. Four of the survey participants (two face-to-face, one online, one blended) agreed to participate and completed the interview. The interview was individual in-person interview and was voice recorded. The recordings were password protected and accessible to the researcher and his designated experimenters. None of the questions were

sensitive and code names were used to maintain confidentiality for the participants.

The total time commitment of each subject was approximately 30 to 40 minutes for each interview.

Data Analysis

This study employed both quantitative and qualitative data analysis techniques. The researcher used a descriptive approach for the analysis of quantitative data. Frequency, rating, and percentage were used to describe students' demographic data, students' preference of interaction element, and value of course elements. The qualitative data were analyzed by using Carspecken's (1996) coding method. Materials analyzed were transcriptions of tapes of four interviews and written comments on the open-ended questions from the online survey. The coding procedure involved 6 steps. Step 1: Open up the first word processing files containing a portion of record. Step 2: Open up a new, blank file and split the screen so that one can see both the data file and the blank file. Step 3: Begin reading through the data file on the screen and type the code in the blank file. Step 4: Use sub-codes when important distinctions occurring within an already established code. A coding scheme begins to develop a hierarchical structure of categories. Step 5: Continue reading through the record, generating new codes and sub-codes where appropriate. Step 6: Formulate possible high-level codes and find instances of these codes in the record.

As coding proceeded, the codes resulted in a hierarchical scheme. Once the coding procedure was completed, the researcher pulled those codes together and compared them across the data, reorganized, and grouped into emerging themes. Themes and reorganization of the codes helped the researcher decided how to focus the data

analysis. Then the researcher chose emphases for the final analysis and research discussion.

In addition, a peer reviewer reviewed and confirmed the data to adjust for the researcher's personal bias. The peer reviewer was a post-doctoral researcher in language education. The reviewer was experienced with qualitative research and was qualified, knowledgeable, and comfortable with reviewing the interview data. The written discussion was organized by themes derived from the Carspecken process, with quotations from students to support each theme.

Summary

This research used a concurrent embedded strategy of mixed methods research as described by Creswell (2009). The researcher used a survey and interviews to investigate students' perceptions of interaction and learning experiences in a multimodal blended course. The quantitative data was analyzed by using a descriptive approach and the qualitative data were coded using Carspecken's (2009) coding method. The researcher used rich, thick descriptions in an effort to convey enough information to increase the external validity of the mixed data so that educators can determine how closely their situations match these data and determine whether the findings can be transferred to their situation.

Chapter IV

Data Analysis And Results

This chapter presents the data analysis and results of the research questions in this study. This mixed-methods research was conducted in one phase, collecting both quantitative and qualitative data. The quantitative data were collected through a survey using both scales and open-ended questions. The qualitative data were collected using open-ended questions through a survey and individual interviews. An invitation letter of participation was sent to each student before the end of the course. One hundred and seven students participated in the survey, and four of the survey participants (two face-to-face, one online, one blended) completed the interview.

Descriptive Characteristics of Respondents

Demographic data were collected as part of the online survey (Appendix A), which was administered before the end of the course. The study sample combined all students enrolled in three different learning modes, which included 22 students in the face-to-face section, 23 students in the blended section, and 84 students in the online section. A total of 129 students were eligible to participate in this study. As shown in Table 2, altogether 107 students (21 face-to-face, 76 online, 10 blended) participated in the survey. The participation rate of the survey was 83%. Twenty-eight percent ($n = 30$) of the students were male and 72% ($n = 77$) were female. About 90% ($n = 96$) of the participants in this study were between 20 to 29 years old, and more than 70% of the participants ($n = 76$) rated their computer expertise as intermediate or expert. In terms of geographic distribution, 78% ($n = 84$) of the participants lived within 30 miles of the UH main campus.

Table 2

Demographic Characteristics of Participants

Characteristic	n	%
Gender		
Male	30	28
Female	77	72
Course format		
Face-to-face	21	20
Online	76	71
Blended	10	9
Age		
Under 20	4	4
20-29	96	90
30-39	4	4
40-49	3	3
Computer expertise		
Novice	31	29
Intermediate	67	63
Expert	9	8
Distance		
0-10 miles	34	32
11-20 miles	25	23
21-30 miles	25	23
31-40 miles	18	17
More than 40 miles	5	5

For the reason why students chose a designated mode for his or her main course delivery method, six categories were found from the analysis of student's comments in the open-ended question. As shown in Table 3, accommodating class or work schedule was the main reason that online (60%) and blended (60%) students chose this course format. Some students in the online (13%) and blended (30%) sections mentioned the convenience of the delivery format. Since the online section provided more seats than the face-to-face and blended formats did, 22% of the online participants indicated that course availability was the reason of their choice. Personal preference (67%) and in-person interaction (24%) were the two main reasons for students to select the face-to-face section.

Table 3

The Reason of Choosing Course Delivery Format

	Face-to-face		Online		Blended	
	n	%	n	%	n	%
Schedule	0	0	45	60	6	60
Course availability	0	0	17	22	0	0
Convenience	0	0	10	13	3	30
Personal preference	14	67	3	4	0	0
In-person interaction	5	24	0	0	0	0
Major requirement	2	9	1	1	1	10

The Reason for Choosing Online Format

Fitting into one's schedule seems to outweigh any other factor even when students

understand that online learning is more difficult. Online learning provides a more flexible learning schedule for students compared to face-to-face and blended learning. Some students indicated that they live far away from campus, while others have to study and work at the same time. Therefore, the convenience and flexibility that online learning can provide were very valuable to them. Some responses from online students stated, “My schedule for the semester didn’t allow me to take this course in face-to-face and the online format turned out to work well for me;” “I chose online because it was the best option for my school and work schedule;” “I chose online because I have a full time career and the option to take this class online was very valuable for me;” “I enjoy working on my own time and this class allowed me to take five classes this semester with no scheduling conflict” (survey, April 30, 2013).

Some students expressed their reason for choosing online format in the open-ended question and stated,

Honestly, I heard the online version was the most difficult of the course. The course was not easy if you had no prior knowledge of HTML like I did, but it was the only class to fit both my schedule and my course needs (survey, April 30, 2013).

I chose the online course because I am already spending 15 hours taking other courses on campus and therefore taking an online course gives me the flexibility that I need (survey, April 30, 2013).

I love the flexibility that online courses offer students. For example, if I have a heavy workload from another class, I will be able to do the required work for my other class first. When I have time I am capable of doing my online work (survey,

April 30, 2013).

The Reason for Choosing Blended Format

Participants chose a blended format primarily because they perceived that blended learning was convenient and flexible while it also provided an active learning experience. The blended class met once a week in the evening to meet the needs of students who worked full time during the day. They voted that blended learning combined the best of online learning and face-to-face instruction. One student stated, “I live far from campus, and work full time. The hybrid format helped me manage my other obligations while still actively participate in the course work” (survey, April 30, 2013). Other participants commented,

I personally prefer face-to-face at all times. I feel like I’m learning a lot more with more direction. However, hybrid works out because you have the best of both in one. You learn in face-to-face and submit everything electronically (survey, April 30, 2013).

I originally signed up for the online course. When I first logged on to see the class, I knew I was going to need extra help because I felt the content provided wasn't enough. I felt everything was outdated or simply slapped together: syllabus and whatever documents were posted. So I decided to go for hybrid. (survey, April 30, 2013).

The Reason for Choosing Face-to-Face Format

Personal preference and in-person interaction were the two most common reasons for students to choose the face-to-face format. Most students chose face-to-face simply

because they preferred to study in a classroom setting, while others emphasized the importance of instant feedback and in-person interaction. One student stated,

Because I find it easier to interact with the instructor and have the availability to ask specific questions and concerns as opposed to the online section. The content of the class is hard, and it is harder if you do not have someone to answer your questions face-to-face. Discussions are sometimes confusing and not always reliable. I prefer to rely on someone who tells me exactly what I need to know and how to learn it rather than figuring it out myself (survey, April 30, 2013).

Other students also commented, “Because I hate online classes, the professors never respond and they don't care to help you;” “I feel that I learn better in the face-to-face classes;” “I prefer learning in a face-to-face environment;” “I choose face-to-face so I could ask the teacher about any questions I may have;” “For me face-to-face is much more effective. I don't like to communicate through email because sometimes your questions cannot be addressed effectively” (survey, April 30, 2013).

Analysis of Research Question One

Research question one: How do students perceive the quality and amount of interaction in a multimodal blended course?

Because of the inequality of numbers in the types of course delivery and the resultant small and zero cell sizes in the cross-tabulation, inferential statistics such as Chi Square were not possible. The quantitative data were analyzed using percentages and frequencies in this study.

Analysis of Survey Data

Student-teacher interaction. When asked how important the interaction with the teacher was, as presented in Table 4, the percentage of each importance rating by groups suggests that student-teacher interaction is very important for participants in this course. The majority of the students (95%) in the face-to-face group indicated that student-teacher interaction was important. In particular, 71% thought it was very important. Ninety-seven percent of students in the online and 100% in the blended format reported that student-teacher interaction was important. The results were consistent across different learning groups.

Table 4

Importance of Student-Teacher Interaction

Level of importance	Face-to-face		Online		Blended	
	n	%	n	%	n	%
Not important	1	5	2	3	0	0
Important	4	19	21	28	3	30
Somewhat important	1	5	18	24	2	20
Very important	15	71	35	46	5	50

The participants were asked to rate the quality and amount of student-teacher interaction that they had experienced in this multimodal blended course. As shown in Table 5, the percentage of each student-teacher interaction rating by groups suggests that students in face-to-face and blended formats experience a better quality and amount of student-teacher interaction than online learning students do. The majority of the students

in face-to-face (71%) and blended (70%) formats indicated that the quality of interaction with their teacher was increased compared to their previous course experience. In the online format, only 49% of the students indicated the interaction with their teacher was increased while 22% chose no change and 29% reported decreased.

In terms of the amount of interaction with the teacher, the majority of the students in face-to-face (62%) and blended (60%) formats felt that it was higher compared to their previous course experience. A higher percentage of participants across all three learning formats selected no change for the amount of student-teacher interaction. In addition, 31% in the online section suggested a decreased amount of interaction with their teacher.

Table 5

Interaction with the Teacher

Scale	Face-to-face		Online		Blended	
	n	%	n	%	n	%
<i>Quality</i>						
Decreased	1	5	9	12	0	0
Somewhat decreased	2	10	13	17	0	0
No change	3	14	17	22	3	30
Somewhat increased	8	38	24	32	3	30
Increased	7	33	13	17	4	40
<i>Amount</i>						
Decreased	1	5	8	11	0	0
Somewhat decreased	0	0	15	20	0	0
No change	7	33	24	32	4	40
Somewhat increased	7	33	17	22	4	40
Increased	6	29	12	16	2	20

Student-student interaction. When asked how important interaction between students was, as presented in Table 6, the percentage of each importance rating by groups suggests that student-student interaction is less important than student-teacher interaction. In the face-to-face format, 76% of the students indicated that the interaction with other students was important. Only 68% of students in the online section and 70% in the blended section indicated that it was important. In other words, more than 30% of students in the online and blended formats felt that the student-student interaction was not important.

Table 6

Importance of Student-Student Interaction

Level of importance	Face-to-face		Online		Blended	
	n	%	n	%	n	%
Not important	5	24	24	32	3	30
Important	4	19	15	20	2	20
Somewhat important	5	24	28	37	3	30
Very important	7	33	9	12	2	20

As shown in Table 7, the percentage of each student-student interaction rating by groups suggests that students experience an average quality and amount of student-student interaction in this course. Only 38% of students in the face-to-face section indicated that the quality was increased compared to their previous course experience, while most participants (57%) chose no change. In the online format, 19% indicated the interaction with other students was increased while 33% chose no change and half of the

participants (50%) chose decreased. In the blended format, 50% of the participants felt the quality of student-student interaction was increased.

In terms of the amount of interaction with other students, 29% of students in face-to-face classes indicated that it was increased compared to their previous course experience, and 62% chose no change. In the online format, only 11% indicated that the interaction was increased while 41% chose decreased. In the blended format, 50% of the participants thought the amount of interaction with other students was increased.

Table 7

Interaction with other Students

Scale	Face-to-face		Online		Blended	
	n	%	n	%	n	%
<i>Quality</i>						
Decreased	0	0	22	30	2	20
Somewhat decreased	1	5	15	20	1	10
No change	12	57	25	33	2	20
Somewhat increased	3	14	12	16	2	20
Increased	5	24	2	3	3	30
<i>Amount</i>						
Decreased	0	0	26	34	1	10
Somewhat decreased	2	10	15	20	1	10
No change	13	62	24	32	3	30
Somewhat increased	0	0	10	13	2	20
Increased	6	29	1	1	3	30

Student-content interaction. When asked how important the interaction with the content was, as shown in Table 8, all of the participants (100%) in the face-to-face and blended formats agreed that the interaction with learning content was important. In the online format, 97 % of the participants indicated that it was important. Inspection of the percentage of each importance rating by groups suggests that student-content interaction was as important as student-teacher interaction for the participants in this study.

Table 8

Importance of Student-Content Interaction

Level of importance	Face-to-face		Online		Blended	
	n	%	n	%	n	%
Not important	0	0	2	3	0	0
Important	1	5	13	17	4	40
Somewhat important	3	14	10	13	0	0
Very important	17	81	51	68	6	60

For the quality and amount of interaction with the course content, as shown in Table 9, 72% of students in face-to-face and 70% in blended sections thought that the quality was increased compared to their previous course experience while only 49% in the online section did. For the amount of content interaction, 77% in the face-to-face and 70% in the blended section indicated that it was increased. Inspection of the percentages suggests that online students do not experience the increase of content interaction as much as the students in face-to-face and blended students do in this course.

Table 9

Interaction with Course Content

Scale	Face-to-face		Online		Blended	
	n	%	n	%	n	%
Quality						
Decreased	1	5	3	4	0	0
Somewhat decreased	2	10	7	9	0	0
No change	3	14	29	38	3	30
Somewhat increased	10	48	26	34	3	30
Increased	5	24	11	15	4	40
Amount						
Decreased	0	0	3	4	0	0
Somewhat decreased	1	5	6	8	0	0
No change	4	19	22	29	3	30
Somewhat increased	10	48	33	43	3	30
Increased	6	29	12	16	4	40

Ranking of interaction elements. Participants were asked to rank the importance of the three interaction elements, namely teacher, students, and content. As shown in Table 10, most participants ranked the teacher element over the other two across all three learning formats. The ranking results suggest that students perceived the interaction with teachers to be the most important in this study.

Table 10

Ranking of Teacher Element

Rank	Face-to-face		Online		Blended	
	n	%	n	%	n	%
Rank 1	12	57	45	60	6	60
Rank 2	7	33	23	30	4	40
Rank 3	2	10	8	10	0	0

As shown in Table 11, the majority of the students in face-to-face (67%), online (74%), and blended (70%) sections ranked the student element No. 3 as important. The ranking result suggests that the student element is of least concern to the participants in this study.

Table 11

Ranking of Student Element

Rank	Face-to-face		Online		Blended	
	n	%	n	%	n	%
Rank 1	6	29	7	9	2	20
Rank 2	1	5	13	17	1	10
Rank 3	14	67	56	74	7	70

As shown in Table 12, the majority of participants ranked the content element second in importance across the three delivery formats. Inspection of the rankings of all three interaction elements suggests that teacher is the most important element across

different delivery formats. The content element ranked number two, and the student element is the least important of the three.

Table 12

Ranking of Content Element

Rank	Face-to-face		Online		Blended	
	n	%	n	%	n	%
Rank 1	3	14	24	32	2	20
Rank 2	13	62	40	53	5	50
Rank 3	5	24	12	16	3	30

Analysis of Interview Data

In-person interaction preferred. Participants emphasized the opportunity to interact with their teacher in the face-to-face environment when asked how they would perceive the student-teacher interaction in this course experience. Online learning provides a more flexible and convenient learning environment; however, in-person student-teacher interaction is one of the reasons that students prefer face-to-face instruction. Alex, the first interviewee from face-to-face section, expressed “I prefer face-to-face because you are able to talk to the professor, you are able to ask for help and get it right away!” He mentioned,

In the beginning I was actually taking the online course, then I read the instruction and everything. They are really confusing. It helps me if I can actually feel the teacher and go to the class so I was thinking; I have to get out of here (online course)!

I took online class before. If you didn't talk to someone, it will be very difficult. It's just you and yourself. Sometimes you asked your professor and your professor didn't answer your question. I had a professor who didn't answer my question in 6 days. It takes a while for them to email you back because online course is so much bigger. In this class, it's like only 30 people in the classroom. The professor can remember your name and I can get right away feedback (Alex, personal communication, May 9, 2013).

Jenny, the second interviewee from the face-to-face section, talked about her online learning experience and explained the reason why she selected face-to-face over online learning. She stated,

Online learning is really time consuming and I really need help. I don't like to email the professor and wait for that answer, so I go face-to-face. I can actually see what's going on. If I have questions I can just raise my hand and get answered. In face-to-face the teacher would be able to look at my codes and help me figure out what's wrong with it right in the classroom (Jenny, personal communication, May 9, 2013).

Lisa, the interviewee from the online section, indicated that the opportunity to interact with the instructor in-person was the most beneficial. She stated, "I think it is very beneficial to have teacher available even if it is an online course. It is very important for online teachers to provide in-person interaction for students in an online learning environment." She valued the interaction with her teacher very much and it is a "must" for her. "The professor should be available on discussion board at least so they can answer questions from the students. The interaction with the teacher is a must for me.

The hybrid format would be a better choice.” She further explained,

I prefer to meet the teacher in person instead of just email them online. I had three online courses before and the professor in this course is the best. She is available anytime and I go to her office to talk to her. Even if in some face-to-face class, teachers are not that available. She can physically show me what’s going on in a face-to-face meeting. Even though I was in online section, I still need in person interaction with the teacher (Lisa, personal communication, May 10, 2013).

When asked how would you perceive your interaction with other students in this course, Alex preferred to interact with peers in a face-to-face classroom. He stated,

I had 4 or 5 friends in the class and we would stay after class to help each other. We practiced together, but I didn’t contact any other students in online section. Sometimes students from online section would post to seek students to meet up. I tried to email them back but it didn’t work. I just stay with my friends in the face-to-face class because it’s easier (Alex, personal communication, May 9, 2013).

A closer student-teacher interaction. The face-to-face environment has the potential to support a closer student-teacher interaction. Alex stated that “If I was in the online class I wouldn’t be able to do that much because in online class you rarely know the professor.” Jenny expressed her concerns for the lack of in-person interaction with the teacher in online courses,

I feel intimidated if I go up to her and say can you help me. It just like (meeting) my boss. Like my teacher (in this course), he is younger. He doesn’t have like a suit. He dresses like us. It makes me see him more like us, and we understand each other (Jenny, personal communication, May 9, 2013).

Although the multimodal design of this course provided an extensive student-teacher interaction, Alex explained the close personal connection in the face-to-face environment was the reason why he didn't contact the other two instructors in this course. He stated,

I just stick to my professor because I really understand him and we have a good personal connection. That's not going to happen online. I feel more confident what I was doing. If I have a problem he was there (Alex, personal communication, May 9, 2013).

Jenny mentioned the daily email communication brought the student-teacher interaction even closer. "The teacher and I get to know each other pretty good in this class because we emailed each other like almost every day!" In addition,

He (the teacher) would stay after class and we can talk to each other. He said that if you have any questions I would stay after or before class. One time we talked after class like 2 or 3 hours, he is really great. He also calms me down when I was nervous (Jenny, personal communication, May 9, 2013).

Dual-channel interaction. Blended learning combines the best of face-to-face and online learning. It has the potential to provide extra time and channels for extensive student-teacher interaction. Karen was a student in the blended format. She originally selected the online format but transferred to the blended section. She felt that blended learning was better compared to online or face-to-face alone because it combined both face-to-face and online interaction. Although she didn't meet the professor as much as her classes before, but the professor was available in both online and face-to-face environments. She stated,

On the first day of my class, I looked at the syllabus and everything and I had a very difficult time understanding what is going on! I felt like this (online learning) is not going to be very helpful and I decided to change from online to hybrid section. I felt hybrid (blended) is better because it combines online and face-to-face instructions.

Although we met once a week and the meeting was three hours long. He also offered hours after the class. Other than that he had office hours that you can come into his office outside the classroom time. I asked him to look over my coding after the class. That's very convenient because I don't have to wait for his email. Also he was very quick with his email. That was great. If I don't have him in person he is still available through emails (Karen, personal communication, May 10, 2013).

Lack of student-student interaction. Karen felt that the student-student interaction did not exist in the blended format. She stated, "Everyone is kind of by themselves. I felt like that. We didn't do group assignments. I feel like we never really talked" (Karen, personal communication, May 10, 2013).

Jenny agreed that the interaction with other students was scarce because most of the assignments and tests were individual. The interaction with other students was not required in this course. However, she felt that students in the face-to-face section could take advantage of meeting time in the classroom. She stated, "I talked to other students and we help each other out. We met before class or after class. Sometimes we met in a computer lab and we worked on it together" (Jenny, personal communication, May 9, 2013).

Lisa also indicated that student-student interaction is not necessary because of the extensive interaction with her teacher. Her student-student interaction experience was limited in this course. However, she thought that the student-student interaction was helpful. Sometimes students could meet and study as a group. She stated,

You might talk to other students on the discussion board. Students can be just as helpful as professors sometime. I actually met some students in this course and they explained something to me and that's helpful. We had a study group and we gave out our numbers and contacted each other. So I think that student interaction was very helpful (Lisa, personal communication, May 10, 2013).

A variety of student-content interaction. Participants had an opportunity to discuss their interaction with the various types of content in this multimodal blended course. The extensive online content provided in this course was helpful especially for the face-to-face and blended format students. The Blackboard and discussion board extended students' content interaction in the face-to-face and blended sections. The extra website resources and online tutorial videos were the most beneficial. Other than the course lectures and learning materials in the classroom, face-to-face and blended students could have extra help from the online section in this multimodal blended course.

Alex mentioned how he took advantage from the online section and he stated, The online teacher explains each assignment in the discussion board if they have questions. Even though I was in face-to-face section, I was reading them because it really helped me a lot. We had modules online but I never went through these modules. It's extra work and more complicated. I just wanted to do my assignments and get it over with (Alex, personal communication, May 9, 2013).

Jenny mentioned that the tutorial videos and the website were the most beneficial course elements, especially the step-by-step tutorial videos. She stated, “you are not going to know every code. You can check the code on the website and you will understand what it is for. Then you use that code and you can know what it does. At the same time, I have a tutorial video to help me go step-by-step” (Jenny, personal communication, May 9, 2013).

Lisa felt that the learning content of this course was sufficient. She stated, “I think the content was enough for me to learn. The textbook, assignments, and the professor also provided tutorial videos for the assignments. And also the other professors had notes online. It was awesome because that helped me understand better (Lisa, personal communication, May 10, 2013).

Perceived Interaction Equivalency

Participants were asked which type of interaction was more important than other types. Consistent with the survey results, participants viewed student-teacher and student-content interaction as equally important in most contexts and they felt that student-student interaction was less important.

Participants were asked if student-teacher interaction were to be either diminished or eliminated from the course, whether other types of interaction could fill that void. Jenny gave an example to illustrate how student-student and student-content interaction compensated for the loss of her interaction with the teacher. She stated,

Our teacher was missing for a week because his wife was having a baby. We had an assignment due but not many people understood it. So we emailed each other (student-student interaction) trying to figure things out. We watched the videos

online (student-content interaction) and the teacher also gave us extra websites to help us. It was like tutorial videos. If I didn't understand the online video, I would go to the website (Jenny, personal communication, May 9, 2013).

From the students' perspective, increasing the level of student-student and student-content interaction could compensate for the reduction of student-teacher interaction. Lisa felt that good quality of student-content could substitute for the loss of student-teacher interaction. However, Alex felt that student-teacher was so important and it cannot be completely replaced. He felt that the interaction with other students could compensate for the loss of teacher interaction in some cases. He stated, "sometime your friends will help and both of you can look at the content and will understand it better."

Participants were asked whether the interaction with other students could be diminished or eliminated from the course by increasing other types of interaction. Among all three types of interaction, the student-student interaction was the most dispensable in this study. Students perceived that was the weakest of the three types of interaction. Jenny stated, "You don't really need to talk to other students. I mean, it would be beneficial to talk to them but I personally don't feel the need." Alex expressed a similar point of view, "It will work without interacting with other students. If you have questions, you can ask more questions to the teachers." Karen felt her interaction with other students were also limited. She stated, "I think that's what I have experienced I don't have much interaction with peers. I still came up okay. I don't need it."

When asked if student-content interaction could be diminished or eliminated from the course by increasing other types of interaction, participants generally felt the interaction with learning content could be substituted. Alex stated, "As long as you have

a good professor, you will be fine without much interaction with learning content.”

Karen also expressed, “If you don’t have much interaction with learning content, you might need to talk to the teacher and students.” Lisa also stated, “in online learning, I think the most important interaction is learning content. I can read the book, the power points, and the notes. If I don’t understand it, I can go for the professor. Most of the time I can learn by myself. The content is very easy to read (Lisa, personal communication, May 10, 2013).

Summary

The analysis of the survey and interview data regarding research question one leads to the conclusion that participants overwhelmingly perceive student-teacher and student-content interaction to be very important. The interaction with other students trails behind. When comparing different learning formats, the participants in the face-to-face and blended formats possessed a more positive perspective for the increased quality and amount of interaction. Most participants in the online section expressed a neutral or negative perception about the quality and amount of interaction in this course.

Participants expressed their preference for in-person interaction with the teacher and other students in the interviews. The face-to-face communication between students and teachers could foster a closer interaction and relationship. The multimodal blended design provided a dual-channel interaction environment, including face-to-face and online modes. Students and teachers could interact with each other both in the real world and in cyberspace. In addition, the multimodal course design provided a variety of student-content interaction that allowed students to take advantage of different learning modes. However, the course design lacked student-student interaction because the tests

and assignments were mostly individual-based and had to be accomplished independently.

Participants viewed student-teacher and student-content interaction as equally important in most contexts, and felt that student-student interaction was less important. The three types of interaction were mostly equal and compensable. Participants generally agreed that an increase of one type of interaction could compensate for the loss of other types.

Analysis of Research Question Two

Research question two: From the students' point of view, how does interaction affect students' learning experiences in a multimodal blended course?

Analysis of Survey Data

The instructional design of the multimodal blended course in this study provided an extensive level of student-teacher, student-student, and student-content interaction. In addition to rating on a five-points scale, participants were asked if they considered their learning experience successful or unsuccessful. They also had the opportunity to point out the best and the weakest parts of the course in an open-ended question. The participants' comments on the open-ended questions were analyzed using qualitative research methods in this study.

Learning experience. As presented in Table 13, 83% of the participants rated their learning experience successful.

Table 13

Successful vs. Unsuccessful Learning Experience

	n	%
Successful	89	83
Unsuccessful	18	17

When comparing different learning formats, as shown in Table 14, 90% of the participants in the face-to-face and blended formats reported that their overall learning experience increased compared to their previous course experience. In the online section, 72% indicated their overall learning experience was increased while 22% selected no change. Inspection of the percentages suggests that online students do not feel their learning experience increased as much as the face-to-face and blended students do in this course.

Table 14

Overall Learning Experience

Scale	Face-to-face		Online		Blended	
	n	%	n	%	n	%
Decreased	1	5	4	5	0	0
Somewhat decreased	1	5	1	1	0	0
No change	0	0	17	22	1	10
Somewhat increased	11	52	34	45	5	50
Increased	8	38	20	27	4	40

The best and weakest aspect of the course. When asked in an open-ended question which aspect of the course most contributed to its success and what the best aspect of the course was, participants felt the extensive student-teacher and student-content interaction played a very important role of their successful learning experience. Particularly, the tutorial videos provided in the online section were created for the purpose of course assignments. Therefore, many participants indicated that online tutorial videos were the most beneficial learning content. Some students mentioned the accessibility of the course, supplementary websites, discussion boards, digital syllabus, and PowerPoint slides were also very advantageous.

When asked what were the weakest aspects of the course and the reasons for finding the learning experience unsuccessful, participants primarily mentioned the outdated online content, including the lecture videos, textbook and podcasts. Some students criticized the unorganized and inconsistent information saying it was too hard to follow while others felt that insufficient student-student interaction and overwhelming amount of course information were frustrating elements of the course. The lack of communication of instructors caused a “mix up on due dates” for the assignments. Some students felt that the course would be more successful if the professors had provided the face-to-face, blended, and online sections separately.

Students commented about their successful experience and the best part of the course, “Being in constant communication with my professor, which is very rare, but very grateful;” “I would say my interaction with my professor. Her videos and help were very useful. She is the reason I passed this course;” “The most successful was the tutorial videos on how to complete assignments;” “The instructional videos helped

TREMENDOUSLY;” “The tutorial videos were very helpful if there was something I did not understand. It was step-by-step assistance and very helpful for every assignment;” “The syllabus really helped for understanding what I had to study;” “The discussion board and all of the resources provided contributed the most to my success in this course;” “The reference sites were most helpful. Most of the traffic at the w3schools website is probably from the students of this class, myself included;” “I liked that students are welcome to go to different versions of the course, hybrid online and in class depending if there’s space;” “The best aspects of the course was the amount of help given through interaction on the discussion board and from the instructor.” Some students commented,

I found that the professor was VERY helpful and responsive to any and all of the questions I had concerning the course content and assignments. My professor responded quickly to all of my questions and the final review session that she held was also very helpful (survey, April 30, 2013).

The instructor’s tutorial videos in the assignment tab showed us what to do step-by-step. She showed us how to complete the assignment and allowed us to design our website using the way we wanted to do it. Also it helped us by refreshing the learned content in our heads before moving forward with what needed to be completed (survey, April 30, 2013).

The online tutorials: they were step-by-step and very well explained. Also the discussion boards: the instructor always made sure to answer any and all questions so there were no confusions about assignments (survey, April 30, 2013).

I think that having the option to learn in three different ways is beneficial for

everyone, but I think that each class should be run separately to maintain order.

I think too much information is given and one may be overwhelmed. I think that we should stick to that. Everything else just seems to make it harder and over worked (survey, April 30, 2013).

Students commented about their unsuccessful experience and the weakest part of the course, “OUTDATED! Seriously;” “Factual and historical information;” “The boring podcasts;” “Probably the podcast, sometime they were really hard to get through;” “Antiquated textbook;” “The lectures videos need to be updated. The Internet changes too quickly to use lectures that are nearly 10 years old;” “Computer and Internet applications change so quickly that lectures and textbooks should be updated every two years to keep up with pertinent information;” “UPDATE the lecture videos because a lot of things are different now;” “There's a lot of documents on the Blackboard and it's not really organized. There are two syllabi with different dates on them which confused me;” “The most unsuccessful were all the lectures videos because it was too hard to follow.”

Some students indicated that:

A lot of the information presented is out of date. I currently work for an Internet company, and most of these lectures are irrelevant because web based technology has just evolved so much (survey, April 30, 2013).

The online lecture videos need to be updated, and much clearer with the information we need to learn to do well in this course. Without the help of the professor, this course would have been unbearable (survey, April 30, 2013).

“The first introduction to the course is a little confusing. I was unsure of who my instructor was.”

Time devoted in this course. When asked about the time devoted in this course, as shown in Table 15, the majority of participants in the face-to-face (91%) and blended (80%) format felt the time they spent on this course was increased compared to other courses. Sixty-four percent of the participants in the online format thought they spent more time, but some students (26%) felt that there was no difference.

Table 15

Time Devoted in This Course

Scale	Face-to-face		Online		Blended	
	n	%	n	%	n	%
Decreased	0	0	3	4	1	10
Somewhat decreased	2	10	4	5	1	10
No change	0	0	20	26	0	0
Somewhat increased	5	24	29	38	4	40
Increased	14	67	20	26	4	40

Value of course elements. Participants were asked to rate different course elements on a scale of 1-4 with 4 being very valuable and 1 being not used. These elements varied from technology tools used to pedagogical components and interaction experience in this course. Of the 14 course elements that participants rated, Table 16 presents how the respondents ranked each of the course elements of this multimodal blended course. Rankings were computed by adding the percentage of responses at somewhat valuable and very valuable.

Table 16

Rating of Course Elements

Course Element	Not used		Not valuable		Somewhat valuable		Very valuable		Rank
	n	%	n	%	n	%	n	%	
Assignment instructions	0	0	1	1	23	22	83	78	1
Digital course syllabi	1	1	6	6	27	25	73	68	2
PowerPoint	4	4	5	5	34	32	64	60	3
Videos	2	2	7	7	22	21	76	71	3
Weekly course schedules and modules	7	7	7	7	32	30	61	57	5
Application downloads	4	4	10	9	25	23	68	64	5
Digital textbook	7	7	12	11	43	40	45	42	7
Providing multiple delivery formats	13	12	9	8	37	35	48	45	8
Podcast	14	13	13	12	38	35	42	39	9
The flexibility to change learning modes	16	15	14	13	36	35	41	38	10
Communications with other students NOT currently enrolled in your section	34	32	30	28	28	26	15	14	11
Reading the course discussion board	20	19	12	11	39	36	36	34	12
Posting questions or comments to the course discussion board	23	22	14	13	31	29	39	36	13
Communications with instructors from other sections	22	21	20	19	35	33	30	28	14

Analysis of Interview Data

Multiple formats enrich students' learning experience. When asked about the value of the multiple formats feature of the course, participants felt the feature was valuable because it provided freedom of learning for students. With the flexibility of multiple formats, students could be able to change the mode of learning when they needed or wanted it. The instructional design of the course has the potential to meet every student's need.

Alex felt this course provided a blended learning experience for him as a student in the face-to-face section. Alex stated,

I was in the face-to-face class but I also looked at the videos in the online section, the Blackboard, and some of the multiple choice questions to practice and they really help. I really like the videos in the online section. Sometimes I got confused from the instruction of my professor in the classroom, so I went into the online section ask for help from the videos. I could combine those two different opinions to help me understand. The online professor would post tutorial videos. When my professor didn't really explain something or I missed a class, I would go online for those tutorial videos and go step by step. I like that. I did take advantage from there. If I need extra help, tutorial video was always there (Alex, personal communication, May 9, 2013).

Jenny felt that the multiple format of this course is valuable because she could check course materials online when she missed a class. She also mentioned some students in the face-to-face section were actually taking the course in a totally online or blended mode. She stated, "some people I know they never went to the class and just did

everything online; maybe they should take the online course instead of face-to-face. They did everything online and they were doing fine” (Jenny, personal communication, May 9, 2013). The course content were provided online and students were only required to take the midterm and final exams. The face-to-face students had the freedom to change mode of learning when needed. Lisa also commented,

I think it (multiple format) helps. Because it is different for everybody, I personally like hybrid. But my friend would prefer online because of fulltime jobs. Hybrid combines the best of both worlds. I was very busy this semester so I chose online. But I needed face-to-face interaction with the teacher so hybrid class would be the best for me. I think hybrid would be the best for many other students because you get the interaction in face-to-face, and you can learn by yourself (Lisa, personal communication, May 9, 2013).

Inconsistency and outdated course content are confusing. Participants expressed concerns about the inconsistency across different learning formats when asked how the interaction in this course affected their learning experiences. The inconsistency of course information could cause confusion and sabotage students’ learning experience. Having multiple instructors has the potential to increase student-teacher interaction, but it also presents challenges for instructors in this course. Alex stated,

Sometimes it’s really confusing to have different instructors in this course. In the Blackboard we have different menus, and different links to different sections. That is confusing. The due dates of assignments are different from different sections. Sometimes one professor would change the due date of the assignment and that would look too confused. We have different duties of assignments and

we don't know which one is which one. I received many emails from online section students. When I answer to them they would say that's not how my professor taught it but thanks for answering (Alex, personal communication, May 9, 2013).

Jenny mentioned a similar experience when she went online watching the tutorial videos, she stated,

I did come to a tutorial section by the online professor. I came to her online section, and what she covered was different from my professor. So I thought my professor taught it in a simpler way. And then I came to her review section but I ask him (my professor) do you think this is going to be beneficial. He said they grade in different ways so I felt like, if I came to her online section it wouldn't be beneficial because they teach and grade in different ways. They [teachers] weren't consistent with each other (Jenny, personal communication, May 9, 2013).

Karen felt that the multiple-format design was great, but the course content had to be consistent. She mentioned that the lecture video in this course "didn't reflect what my professor said in the class." She stated,

I feel that's (multiple format) good because I have a great experience at the online tutorial section. I remember one person who took online course and came to our class because she has trouble. I think that's important for students, but they (teachers) are not consistent with each other such as teaching and grading. Face-to-face section uses textbook but we do not use it at all.

Those videos were outdated; it would be nice if it can reflect what the professor says in the classroom. I saw some videos and I stop watching them

because I felt like they are not helpful. If they provide with up to date lecture video, like lecture recordings in the f2f section and that would be very very helpful (Karen, personal communication, May 9, 2013).

Alex also expressed the same concern about the outdated lecture video and online content. He stated,

Those [lecture] videos were also outdated. What he said in the video didn't reflect what my professor said in the class. It's different style and content. I saw some videos and I stop watching them because I felt like they are not helpful (Alex, personal communication, May 9, 2013).

Besides the website and tutorial video, Jenny mentioned that the free textbook was useless, and the podcast and other videos were old-fashioned. She stated, "The textbook is free. It's long. I didn't read it because I prefer paper book;" "The power points on the website were really old. Some of the power points said that the Internet is new;" "Those content really need to be updated." For the podcast, she said,

I tried to use the podcast but my computer won't allow me to download them.

And those podcasts were also very old. I am a visual learner so the podcast didn't help me too much. For some other people it might help. It's still valuable because there are so many different types of learners. They (teachers) probably just need to update it (Jenny, personal communication, May 9, 2013).

Lisa expressed the same concern about the podcast and outdated learning content. She mentioned,

Podcast is hard for me to keep your attention on it, because you can't physically see anything, you just listen. That's why people love TV because they can see

what's going on. It's like listen to the radio. It's easier to think about other things. You really have to pay attention, so for me the podcasts is the least beneficial part. Besides, the video and podcast were really outdated (Lisa, personal communication, May 10, 2013).

Karen mentioned the problem of the textbook and podcast as well. She stated, "The textbook is completely useless! A decent or up to date textbook might be more useful;" "I had a hard time loading the podcast. I try to go through iTunes, and I think it's not accessible to me so I just not using it. Podcast is not really necessary" (Karen, personal communication, May 10, 2013).

Summary

The majority of the participants in this study regarded their overall learning experience in this multimodal blended course as successful. The participants indicated that the extensive student-teacher interaction and various learning content types contributed the most to the success of their learning. Students mentioned that online tutorial videos, discussion boards, learning interaction, and learning outcomes were some of the best aspects of this course. In addition, students valued the convenience and flexibility of the multimodal course design.

While some students thought that the multimodal design, which warranted convenience and flexibility, made the class successful, others found the course experience unsuccessful for the very same reason. The lack of communication of instructors caused inconsistent instruction among the three learning formats. Students who rated the learning experience unsuccessful mostly criticized the outdated online content and inconsistency of information in this course.

The multimodal design of this course provided a changeable learning experience for students. Students could take advantage of the course design and change their mode of learning when desired. However, the inconsistency of course information may cause confusion and sabotage students' learning experience. Having multiple instructors in a multimodal blended course has the potential to increase course interaction, while it also presents challenges for instructors.

Chapter V

Discussion

This study used a mixed methods approach to investigate students' perceptions of interactions in a multimodal blended learning environment. The purpose was to explore how students perceived the types of interactions as well as what effect such interaction had on their overall learning experience. The researcher used the Interaction Equivalency Theorem espoused by Anderson (2003) as a guideline for the analysis of interaction in this study. This chapter presents discussions of the research questions and conclusions of this study.

Discussion of Research Question and Findings

Research Question One

How do students perceive the quality and amount of interaction in a multimodal blended course?

Combining the analysis of survey and interview data, students prioritized the interaction with the instructor and with the content over the interaction with other students in this study. Inspection of the percentage of each learning format suggests that the perceived growth of quality and amount of interaction in the face-to-face and blended formats is more evident than the growth in the online format. For face-to-face and blended students, the multimodal design provided students not only in-person interaction but also extended their interaction to online learning environments. On the other hand, face-to-face meetings were optional for online students, and most online students did not take advantage of this opportunity. This might be the reason why online students reported a neutral or negative perception of the quality and amount of interaction in this course.

Abrami et al. (2011) indicated that online learners may not interact optimally with the given quality and quantity of interactions because of limitation in the course design and technology. A gap may exist between the course designer's intentions and students' perceptions (Miyazoe & Anderson, 2012). The results of this study further strengthen the literature. The research findings of this study suggest purposeful interaction design is recommended because students may not necessarily use all the interactions provided in a course. Every interaction activity must have a purpose and it should meet students' learning needs.

Picciano's (2009) multimodal blended course design used face-to-face learning environments for the purpose of social and emotional support. Akkoyunlu and Soylu (2008) also found that the face-to-face component of a blended course provided social interaction between students and teachers. In this study, the researcher found that participants preferred in-person interaction because students and teachers could develop a closer relationship in a face-to-face environment. The findings suggest that the interaction in a face-to-face environment should not be discounted when designing a multimodal blended course.

The results of this study echoed the findings of Rhode's (2009) study concerning students' preferences of interaction elements. Participants reported their experiences regarding the various types of interactions in this multimodal blended course. The results pointed out the importance of student-teacher and student-content interaction, while the interaction with other students was deemed less influential. One of the reasons could be that most of the course assignments and tests were individual and had to be finished independently. In other courses that emphasize group discussion and collaboration, the

interaction with other students could be equally important as student-teacher and student-content interaction.

The results indicated that the extensive teacher, student, and content interaction provided in this course were valuable especially for the face-to-face and blended format students. Face-to-face and blended students could gain extra help from the online content other than the course lectures and learning materials in the classroom. The face-to-face meeting was not required for online students, which might be the reason why online students did not benefit as much as the students in the face-to-face and blended sections.

Research Question Two

From the students' point of view, how do interactions affect students' learning experiences in a multimodal blended course?

Students who rated the learning experience unsuccessful mostly criticized some outdated online content and inconsistency of information. Most students mentioned that the course lecture videos, textbook, and podcasts needed to be updated. The course lecture videos did not reflect what the teacher said in the classroom because those videos were not recorded in the face-to-face instruction. The lecture videos would be more beneficial if they were recorded and updated frequently. The ideal scenario would be providing the teacher's face-to-face lecture videos for students in the blended and online sections. Students in the face-to-face section could review the lecture videos as well, when needed.

From the analysis of survey and interview data, participants expressed the interaction with the teacher and with the course content as being most crucial factors contributing to their overall success in a multimodal blended course. For interaction with

learning content, students perceived online tutorial videos one of the best aspects of this course from the analysis of ranking of course elements and the interview data.

Although students criticized some outdated online content, participants regarded online tutorial videos as the most beneficial because the videos were created for the purpose of explaining course assignments. Those videos compensated for the loss of student-teacher interaction for online students while also providing supplementary learning content for students in the face-to-face and blended sections. Providing tutorial videos in the online section strengthened the student-teacher and student-content interactions simultaneously in this multimodal blended course, and most importantly they were updated frequently. With the fast development of high-speed Internet, real-time video broadcasting is possible for the purpose of teaching and learning. With live stream capability, teachers could broadcast their instruction in the classroom to provide a real-time and online student-teacher interaction, which students value the most based on the results of this study.

The results of this study support Paulsen's (1993) Theory of Cooperative Freedom, which suggests that students search for the freedom of time and place constraints, the freedom to choose media and content, the freedom of course access, and the freedom of the pace of their learning. The multimodal design provided a customizable learning experience where students could change their mode of learning when desired. The freedom to select learning modes provided convenience and flexibility for students in this multimodal blended course. Some participants indicated that the multiple format feature of the course was a critical factor that enriched their learning experience. A

multimodal blended course design could provide the freedom of learning that meets students' needs.

Anderson and Garrison (1998) expanded Moore's (1989) interaction model and added three types of interactions, including teacher-teacher, teacher-content and content-content interactions. Teacher-teacher interaction is teachers' professional development and communication with each other to enhance teaching competencies. Teacher-content interaction refers to teachers' preparation and development of learning content in teaching and learning. Teachers now have more opportunities to interact with learning content with the prevalence of Internet connectivity. In addition, intelligent programs or agents would be able to interact with each other as they continuously search the network and enlarge the database. Teachers would be able to use learning resources that continuously improve themselves through the content-content interaction.

The findings of this research suggest that instructional designers should take teacher-teacher and teacher-content interaction into consideration when designing a multimodal blended course. The inconsistency of course information provided by different instructor may cause confusion and sabotage students' learning experience. The lack of communication of instructors could cause inconsistent instruction among three learning formats. Having multiple instructors in a multimodal blended course has the potential to increase course interaction, while it also presents challenges for instructors. More research is needed to investigate the challenges for instructors when designing a multimodal blended course.

Interaction Equivalency

The participants in this study viewed student-teacher and student-content interaction as equally important in most contexts, while they felt that student-student interaction was less important. Most of the course assignments and tests were individual and had to be finished independently, which might be the reason why students perceived the interaction with other students as less important. In other courses that emphasize group discussion and collaboration, the student-student interaction could be equally important as student-teacher and student-content interaction.

The findings of this study support Anderson's (2003) assumption of thesis one: An increase of one interaction type could compensate for the loss of other types. One interaction type could be minimized or maximized in some extreme cases. For quality consideration, one extensive interaction could be sufficient for a quality learning experience, and the other types could be minimized.

Anderson's (2003) assumption of thesis two is also supported in this study: More than one extensive interaction will likely provide a more satisfying educational experience, although it would be more costly and time-consuming compared to a less interactive learning experience. The majority of the participants indicated that their learning experience was successful and increased. Most participants also felt that they spent more time on this course compared to other courses. The results suggest that an extensive interaction design may provide a higher quality learning experience for students, but the course may be more time-consuming than a less interactive course. However, costs include visible and invisible ones, such as money and time. More

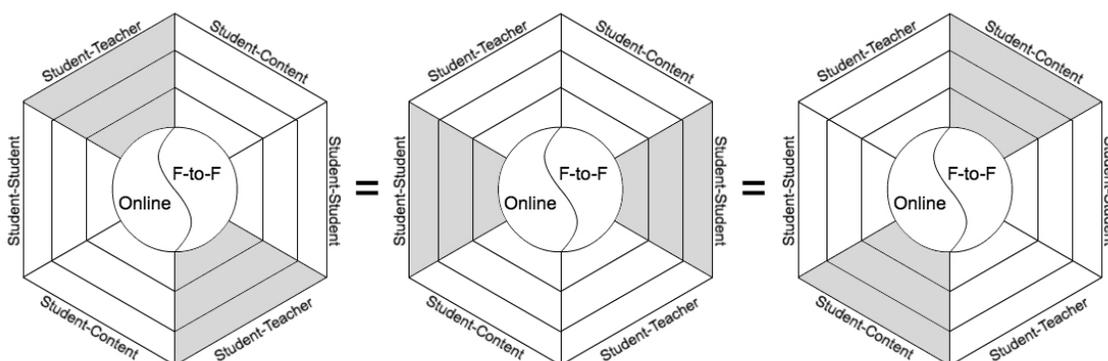
research is needed to further investigate how extensive interaction affect students' learning experience in terms of the costs of learning experiences.

Participants indicated that the dual-channel design, including face-to-face and online dimensions, provided an extensive level of interaction in this course. The student-teacher, student-student, and student-content interactions could occur in face-to-face and/or online learning environments in a blended course design, which allows students to interact with the teacher and the learning content in the real world and cyberspace. However, blended learning may cause confusion for students because it requires frequent switches between face-to-face and online modes of learning. In addition, inconsistent information provided in the face-to-face and online learning could cause confusion and frustration. The findings of this study suggest that the integration of face-to-face and online learning components is critical when designing a blended course. Donnelly (2010a) emphasized a seamless harmonization between face-to-face and online environments in blended learning. So and Bonk (2010) also found the correspondence between face-to-face and online components is critical. More research is needed to investigate how to integrate face-to-face and online learning environments seamlessly and effectively.

Anderson (2003) developed the Interaction Equivalency Theorem to analyze the cost and value of the interactions in distance education. Miyazoe and Anderson (2010b) condensed the main features of the theory into two theses, namely quality and amount considerations of interaction. Based on the findings of this study, the researcher modified the visual representation of the Interaction Equivalency Theorem (as shown in Figure 2) illustrated by Miyazoe and Anderson (2010b). The researcher combined face-to-face and online dimensions, as shown in Figure 3, to provide a dual-channel perspective of the

interaction design in blended learning environments. The design was derived from the concept of yin and yang, a Chinese cosmological term to describe how forces are interrelated (Wikipedia, 2013). At the center of the figure, the divided circle represents face-to-face and online learning environments. The worlds of face-to-face and online learning are two complementary forces interacting to form a dynamic blended learning system in which the whole is greater than the parts. The hexagon represents six dimensions of the interaction in a blended learning environment. Interaction design of a blended course should integrate the six dimensions as harmoniously as possible.

Thesis 1: Is one extensive interaction enough for a quality learning experience?



Thesis 2: Does increased interaction render higher satisfaction?

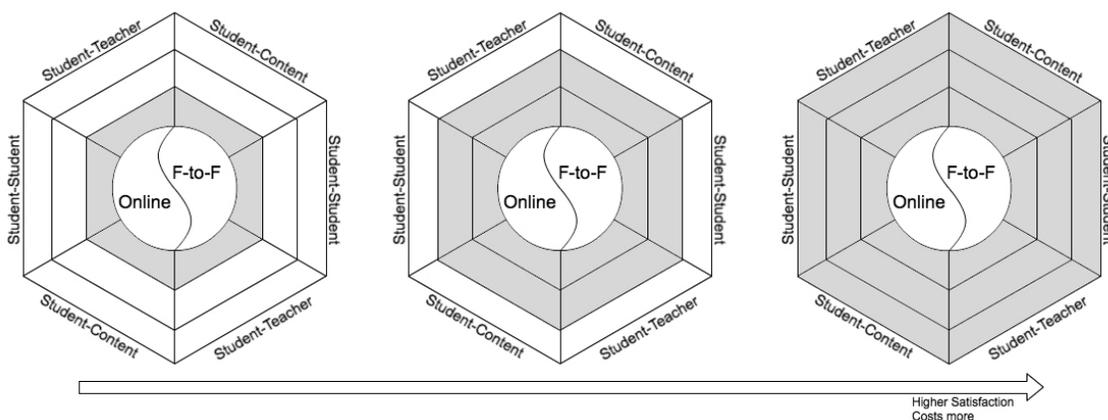


Figure 3. The Interaction Equivalency Theorem in Blended Learning Environments

Recommendations

This study focused on students' perceptions of interactions but did not simultaneously investigate teachers' perceptions about the instructional design in a multimodal blended learning environment. Successive studies could explore the teachers' challenges in course design and their perceptions of interactions, including teacher-teacher, teacher-content, and content-content interactions. In addition, future studies could also investigate a larger number of students or different learner populations to measure the effects that different types of interactions may have on students' overall learning experiences. Interactions in graduate level courses should be examined to find out how student maturity affects the quality and amount of learning interactions.

This study found that students prefer in-person interactions compared to asynchronous online communication approaches, such as email and discussion boards. Future research is needed to explore whether the emergent computer-mediated synchronous communication, such as videoconference and live stream video broadcast, could compensate for the loss of face-to-face interaction in an online or blended learning environment.

While students prefer the interactions with the teacher and the content to the interaction with other students, the finding may vary in different learning conditions and environments. With the fast development of massive open online courses (MOOCs), in-person human interaction become even more difficult when thousands of students are enrolled in one course. Massive online courses maximize student-content online interaction while in-person interaction between teachers and students are literally minimized or diminished. The research of Anderson's Interaction Equivalency Theorem

remains promising while learning technology continues to change the landscape of education.

Limitations of the Study

The Jack J. Vanlanti School of Communication at the University of Houston has offered the Information and Communication Technologies course to a large group of undergraduate students for several years. In order to increase the amount of interaction between students and teacher and to provide students with efficient support, the teachers of this course combined different course sections into a multimodal blended course and offered the course in face-to-face, online, and blended mode of learning simultaneously. The teachers used identical course content in these three learning modes. Each student chose a designated mode for his or her main course delivery system but was encouraged to make use of the other modes, as desired.

A typical blended course usually combines face-to-face instruction with computer-mediated instruction in a single course section. The integration of face-to-face, online, and blended formats as part of a multimodal blended course is somewhat unique because it included a combination of all three delivery formats. This study examined the specific group of undergraduate students enrolled in this atypical blended format of a course on the subject of communication technology. While the findings from this research may raise an awareness of students' perceptions of interaction, the small sample size, specific selection of participants, and the distinctive format of the blended course examined in this study may limit the findings to be generalized to a larger population. The information shared by the participants was specific to the current study and the generalizability of the findings may be limited. This study aimed to provide an initial

understanding of the students' perceptions of interaction in this course, and the findings may serve as the foundation of future studies.

Conclusions

The findings of this study suggest that students perceive interaction with the teacher and with the content as more valuable than the interaction with other students in a multimodal blended course. In-person interaction between teachers and other students could lead to a closer interaction and relationship. Frequently updated online content would be very beneficial for a successful blended learning experience. The multimodal blended design provides a great dual-channel interaction solution for the development of an interactive blended learning environment.

Anderson's Interaction Equivalency Theorem is supported in this study. Although the participants in this study viewed student-teacher and student-content interaction as equally important in most contexts, while they felt that student-student interaction was less important. In other courses that emphasize group discussion and collaboration, the student-student interaction could be equally important as student-teacher and student-content interaction. An increase of one interaction could substitute for the loss of other types of interactions. Instructors and instructional designers should combine and balance the interaction in face-to-face and online learning environments as seamlessly as possible when designing a blended course.

The results of this study provide guidelines for the development of blended learning where multiple learning modes and extensive learning interactions are emphasized. As illustrated in the visual representation of Anderson's Interaction Equivalency Theorem, the interaction design in blended learning should include 1) face-

to-face and online dimensions, and 2) all three types of interactions. Because the optimal blend of face-to-face and online interactions may vary in different subjects and courses, course development should be an iterative process where instructors and instructional designers periodically refine the interaction design to meet the needs of students.

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Appendix A

Student Survey

Dear students:

We are conducting a research study about the multiple delivery modes being used in this course. As you know this course was offered in face-to-face, hybrid, and online formats at the same time and provided multiple types of interaction. We would like to know how well this course met your learning needs. The following questionnaire was designed to get feedback on your overall satisfaction with your learning experience with an emphasis on your perceptions of the quality and quantity of interaction with the instructors, peers, and learning content in this course. This data will be used for a doctoral dissertation in education. Thank you for your assistance.

1. Gender
 - 1) Male
 - 2) Female
2. In which course format did you enroll?
 - 1) Face-to-face
 - 2) Online
 - 3) Hybrid
3. Age
 - 1) Under 20
 - 2) 20-29
 - 3) 30-39
 - 4) 40-49
 - 5) Over 50
4. I would rate my level of computer expertise as:
 - 1) Novice
 - 2) Intermediate

- 3) Expert
5. How far do you live from the main campus of UH?
- 1) 0-10 miles
 - 2) 11-20 miles
 - 3) 21-30 miles
 - 4) 31-40 miles
 - 5) More than 40 miles

Please compare this course with your other course experiences.

	Decreased	Somewhat Decreased	No change	Somewhat Increased	Increased
6. The quality of interaction with the instructor	<input type="checkbox"/>				
7. The amount of interaction with the instructor	<input type="checkbox"/>				
8. The quality of interaction with other students	<input type="checkbox"/>				
9. The amount of interaction with other students	<input type="checkbox"/>				
10. The quality of interaction with course content	<input type="checkbox"/>				
11. The amount of interaction with course content	<input type="checkbox"/>				
12. The time I devoted	<input type="checkbox"/>				
13. Overall learning experience	<input type="checkbox"/>				

In general, how important are the interaction with instructors, students, and course content for your learning experience?

	Not Important	Important	Somewhat important	Very important
14. Your interaction with the instructor	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
15. Your interaction with other students	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
16. Your interaction with the course content	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Value of course elements

Please rate the value of the elements of the course.

	1 Not used	2 Not valuable	3 Somewhat valuable	4 Very valuable
17. Providing multiple delivery formats (f2f, hybrid, online)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
18. The flexibility to change learning modes (f2f, hybrid, online) during the semester	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
19. Communications with instructors from other sections	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
20. Communications with other students NOT currently enrolled in your section	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
21. Reading the course discussion board	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

22. Posting questions or comments to the course discussion board	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
23. Digital textbook	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
24. Videos	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
25. Podcast	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
26. Digital course syllabi	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
27. Powerpoints	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
28. Weekly course schedules and modules	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
29. Application downloads	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
30. Assignment instructions	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Learning experience

31. How would you rank the importance of the three interaction elements? 1 means the most important. 3 means the least important.

Instructor

Student

Content

32. Why did you choose this course delivery format (f2f, hybrid, or online)?

33. Would you rate your experiences with this course as

Successful

If successful, what aspect of the course most contributed to your success?

Not successful

If not successful, what aspect of the course was most problematic for you?

34. What were the best aspects of the course?

35. What were the weakest aspects of the course?

36. What can be done to improve this course?

~End of Survey~

Appendix B

Interview Protocol

Leadoff question:

This course was delivered in three different learning formats: face-to-face, online, and hybrid.

Tell me about a typical week of your course. Start from the beginning and then take me through all your activities, one by one. Do not be afraid of giving too much detail. I am interested in everything.

Follow-up questions:

Course formats

1. Did you ever switch to a different mode of learning during the course? If no, why? If yes, did you find it helpful to your overall learning experience?
2. What value did the multiple-format feature of the course have on your overall learning experience?

Student-teacher interaction

1. How did you perceive the student-instructor interaction in this course? (Face-to-face and online modes)
2. Did you ever communicate with the instructors from other sections? If no, why? If yes, did you find it helpful to your overall learning experience?
3. How involved was the instructor in your overall learning experience?
4. How important was his/her feedback?
5. How did you interact with the instructor? Which kind of interaction with the instructor is most beneficial in this course?

Student-student interaction

1. How did you perceive the student-student interaction in this course? (Face-to-face and online modes)
2. Did you ever communicate with students from other sections? If no, why? If yes, did you find it helpful to your overall learning experience?
3. Did you respond to any of the other students' postings in Blackboard? If yes, what prompted you to do so? If no, what prevented you from doing so?
4. How valuable were the interaction with other students to your overall learning experience?

Student-content interaction

1. How did you perceive the student-content interaction in this course? (Face-to-face and online modes)
2. Thinking of all the different types of learning content in the course, what kinds of course content were helpful to your overall learning experience?

Learner Preferences of Interaction / Equivalency Theorem

1. Thinking of the three types of interaction, including student-teacher, student-student, and student-content, which type do you think is most important to a successful and quality learning experience? Why?
2. Thinking of all interaction that you had with the instructor. If they were to be diminished or even eliminated from the course, do you feel that an increase in other types of interaction would fill that void? If yes, what other types of interaction would compensate? If no, why?
3. Thinking of all interaction that you had with the students, if they were to be diminished or even eliminated from the course, do you feel that an increase in other types of

interaction would fill that void? If yes, what other types of interaction would compensate? If no, why?

4. Thinking of all interaction that you had with the course content, if they were to be diminished or even eliminated from the course, do you feel that an increase in other types of interaction would fill that void? If yes, what other types of interaction would compensate? If no, why?
5. In what way does the quantity and quality of the interaction in a multiple formats course like the one you have just recently completed impact the quality of the learning experience?
6. Do you think this course cost you more or less (e.g. time, money, effort, etc.) to complete than other courses you have take