

The Influencing Mechanism of Student Satisfaction in Synchronous Online Classrooms: An Interaction Distance Perspective (Postprint)

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Date: 2023-10-08T00:00:00+00:00

Abstract

[Purpose / Significance] Synchronous online classrooms represent an important and widely adopted modality in online education. To improve the teaching quality of synchronous online classrooms and enhance student satisfaction, this study investigates, from the perspective of interactional distance, the influence mechanisms of dialogue, structure, and interactional distance on student satisfaction, as well as whether these mechanisms differ across various classroom types. [Method / Process] With university students as research subjects, this study integrates the Input–Process–Output model and the Theory of Interactional Distance to construct a conceptual research model, collects data through online questionnaires, and conducts empirical research via structural equation modeling. [Results / Conclusion] In synchronous online classrooms, both dialogue and structure exert significant influences on satisfaction. Specifically, interactional distance partially mediates the relationship between dialogue and satisfaction, while classroom type moderates the relationship between dialogue and interactional distance. Therefore, both online learning platform designers and instructors should recognize the importance of interaction within the dimensions of dialogue and structure. Platform designers should facilitate the use of interactive features by enhancing their convenience and flexibility; instructors should consciously strengthen interaction during classroom delivery and strategically emphasize the two types of interaction under the dialogue dimension across different online classroom types.

Full Text

Preamble

Research on the Influence Mechanism of Student Satisfaction in Synchronous Online Courses from the Perspective of Transactional Dis-

tance Theory

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Abstract:

Synchronous online courses represent a widely adopted approach in online education. To improve teaching quality and enhance student satisfaction in synchronous online classrooms, this study investigates the influence mechanism of dialogue, structure, and transactional distance on student satisfaction from the perspective of transactional distance theory, and examines whether this mechanism varies across different course types.

Methodology: Using university students as research subjects, this study integrates the Input-Process-Output (IPO) model with transactional distance theory to construct a conceptual framework. Data were collected through online questionnaires, and structural equation modeling was employed for empirical analysis.

Findings: In synchronous online courses, both dialogue and structure significantly impact satisfaction. Transactional distance partially mediates the relationship between dialogue and satisfaction, while course type moderates the relationship between dialogue and transactional distance. Therefore, online learning platform designers and instructors should recognize the importance of interaction in both dialogue and structural dimensions. Platform designers should enhance the convenience and flexibility of interactive features to promote their usage, while teachers should consciously strengthen interactions during instruction.

Keywords: synchronous online courses; transactional distance theory; IPO theory; course satisfaction

Citation Format: Wu Jiang, Yi Mengxin, Ma Yunyun. Research on the Influence Mechanism of Student Satisfaction in Synchronous Online Courses from the Perspective of Transactional Distance Theory[J/OL]. Knowledge Management Forum, 2021, 6(5): 239-251.

1. Introduction

Since the outbreak of COVID-19 in early 2020, synchronous online instruction through live streaming and video conferencing has swept across China, becoming the most prevalent teaching format nationwide in response to the Ministry of Education's call to "suspend classes without stopping learning." According to an iMedia Research report [?], 64.3% of students and parents considered live streaming an effective approach to online education during the pandemic, indicating broader acceptance of synchronous compared to asynchronous online education. The Ministry of Education stated at a press conference on May 14,

2020, that online teaching must transition from a “novelty” to a “new normal,” as online instruction integrated with “Internet+” and “Intelligent+” technologies has become a crucial development direction for higher education both domestically and internationally [?].

However, unlike traditional face-to-face classrooms, internet-based synchronous online instruction faces numerous challenges, including network lag, lack of student-teacher interaction, and insufficient student self-discipline, all of which compromise teaching quality. Consequently, research on improving synchronous online instruction quality holds significant practical importance. Previous online classroom research has widely employed student-perceived learning outcomes and satisfaction as key metrics for evaluating online education effectiveness [?], with student satisfaction frequently serving as a dependent variable. Extensive literature demonstrates that student satisfaction is closely related to cognitive learning outcomes such as performance and achievement [?, ?]. Investigating the factors influencing student satisfaction in online courses can enhance learning efficiency in synchronous online environments, inform online learning platform design, and assist instructors in improving course design.

Nevertheless, existing research on online course satisfaction often lacks clear theoretical framework support [?]. Meanwhile, transactional distance theory, a crucial theoretical foundation for online classroom research, has not fully elucidated the influence mechanisms of its dialogue and structure dimensions, nor the role of transactional distance itself, on student satisfaction [?]. Addressing this gap, this study adopts a transactional distance perspective, employing survey questionnaires and structural equation modeling to examine how dialogue, structure, and transactional distance affect student satisfaction in synchronous online courses, and investigates the moderating role of course type.

2. Theoretical Foundation

2.1 Research on Online Course Student Satisfaction

Current research on online course student satisfaction primarily examines three dimensions: student, instructor, and design. From the learner perspective, studies have identified several influencing factors [?, ?, ?]. M. Igbaria [?] found that students' computer anxiety negatively impacts learning satisfaction. A. Y. Wang and M. H. Newlin [?] discovered that students with high self-efficacy achieve better academic performance and report higher course satisfaction. S. B. Eom and H. J. Ashill [?] found that learning styles significantly affect students' perceived satisfaction. From the instructor perspective, researchers have found that instructors' positive attitudes toward online learning, timely feedback, and high levels of instructor-student interaction positively influence student satisfaction [?, ?]. Yang Jiumin [?] demonstrated that the proportion of time instructors appear in video conferences affects student satisfaction differently depending on the nature of the knowledge being taught. C. Stone [?] found that strong

instructor presence, effective online classroom design, and effective interaction directly increase students' willingness to participate and improve course completion rates.

From the technical dimension of online learning platforms, Jiang Zhihui et al. [?] found that live streaming courses result in lower student satisfaction compared to recorded courses due to issues like lag and delay. Qian Aiping [?] confirmed through two quasi-experimental studies that sending guided bullet comments improves student satisfaction with online courses. A. T. Baharin et al. [?] found that online course effectiveness has a greater impact on satisfaction than efficiency. However, due to a lack of consensus on online education theories, particularly in early online education research, many studies were not theoretically grounded [?]. S. M. K. Tallent-Runnel et al. [?] identified inconsistent terminology and lack of theoretical frameworks as problems in online education research, including studies on student satisfaction. Some literature based on transactional distance theory focuses on interaction construction in online education environments, treating online classroom interaction as a direct external factor affecting satisfaction while overlooking transactional distance as a potential mediating variable. This study therefore investigates whether transactional distance mediates the relationship between dialogue, structure, and satisfaction.

2.2 Theoretical Framework

2.2.1 Input-Process-Output (IPO) Model The IPO model, proposed in 1964, describes the process of data input and output in a system and its information exchange with the external environment, comprising antecedent variables (input), mediating variables (process), and outcome variables (output) [?]. In the IPO model, "I" represents the antecedents of a behavior structure, "P" represents the internal structure of the behavior, and "O" represents the outcomes or impacts of that behavior.

2.2.2 Transactional Distance Theory Transactional Distance Theory (TDT), first proposed by M. G. Moore in 1972, provides a comprehensive framework for distance education that allows integration with other theories and represents a core theory of modern distance education. Moore described online education as "the separation of teacher and learner in time and space, where the essence of distance is transactional" [?]. Through continuous refinement by Moore and other scholars, the mature TDT analyzes online education through two dimensions: transactional distance and learner autonomy, with dialogue and structure used to measure transactional distance. Dialogue refers to the communication and interaction between teachers and students, while structure refers to the flexibility of instructional plans and classroom design to meet individual learner needs [?, ?, ?, ?].

Moore's transactional distance model has long been considered a critical structure determining the quality of online classrooms. X. Huang et al. [?] developed and validated a measurement tool for transactional distance in web-based learn-

ing environments, providing preliminary empirical evidence for the validity of the structure dimension. This study therefore combines the IPO model and TDT to propose a measurement framework that treats dialogue and structure as antecedents of transactional distance and student satisfaction as the outcome variable, investigating the mechanisms through which dialogue, structure, and transactional distance influence satisfaction.

3. Research Model and Hypotheses

3.1 Construct Definition and Hypothesis Development

3.1.1 Dialogue Based on the measurement framework proposed by X. Huang et al. [?], the dialogue dimension in TDT includes student-teacher and student-student interactions, which are essential for most learners. Student-teacher interaction involves immediate feedback and professional guidance from instructors, while student-student interaction refers to information and idea exchanges among students about course content [?]. In online classrooms, high levels of dialogue typically lead to lower transactional distance [?]. For example, under high-dialogue conditions, teachers can adjust classroom structure based on each learner's responses, thereby reducing the psychological distance between students and teachers and resulting in relatively closer transactional distance [?]. Numerous studies have shown that student-teacher and student-student interactions in online classrooms directly affect satisfaction. K. Swan [?] found that students with higher levels of interaction with teachers in online courses demonstrated higher satisfaction and learning achievement. C. N. Gunawardena et al. [?] found that active participation in online discussions improved student satisfaction with online courses and discussion forums. J. B. Arbaugh [?] found that interactive teaching styles and high levels of teacher-student interaction were closely related to high user satisfaction and learning outcomes. Therefore, this study proposes:

H1a: Higher levels of student-teacher interaction lead to closer perceived transactional distance.

H1b: Higher levels of student-student interaction lead to closer perceived transactional distance.

H2a: Higher levels of student-teacher interaction lead to higher student satisfaction with the course.

H2b: Higher levels of student-student interaction lead to higher student satisfaction with the course.

3.1.2 Structure Structure conveys the rigidity or flexibility of design elements such as learning objectives, instructional strategies, and assessment methods [?]. X. Huang et al. [?] argue that both content and interface are essential in defining the rigidity or flexibility of classroom design elements. Therefore, the structure dimension includes student-content interaction and student-interface

interaction. V. A. Thurmond and K. Wambach [?] define learner-interface interaction as the process by which students operate relevant tools to complete tasks, while student-content interaction refers to students examining or learning course content and participating in classroom activities. According to TDT, classroom structure is negatively correlated with perceived transactional distance. J. Weidlich and T. J. Bastiaens [?] surveyed 141 students at a distance university in Germany and found that student-content interaction directly affects student satisfaction with courses. Therefore, this study proposes:

H1c: Higher levels of student-content interaction lead to closer perceived transactional distance.

H1d: Higher levels of student-interface interaction lead to closer perceived transactional distance.

H2c: Higher levels of student-content interaction lead to higher student satisfaction with the course.

H2d: Higher levels of student-interface interaction lead to higher student satisfaction with the course.

3.1.3 Transactional Distance According to M. G. Moore's theory, distance does not refer to physical geographical distance but rather psychological distance. In the teaching process, perceived distance between students and teachers may lead to communication gaps and misunderstandings. While many studies have focused on interaction design in virtual learning environments, few have examined transactional distance [?, ?]. Research indicates that transactional distance significantly affects student satisfaction. For example, J. K. Mbweza [?] surveyed 168 Bachelor of Education students at the University of Nairobi and found that learner-learner transactional distance and learner-teacher transactional distance were primary predictors of student satisfaction in online courses. Therefore, this study proposes:

H3a: Closer perceived transactional distance leads to higher student satisfaction with the course.

3.1.4 Moderating Role of Course Type Classifying online courses makes course positioning more specific and clarifies teaching purposes and methods, thereby improving teaching scientificity and targeting. This study posits that for different types of online courses, the influence mechanisms of course attributes on student transactional distance differ, requiring different teaching methods. This research divides online courses into theoretical and non-theoretical (experimental and discussion) types. Theoretical courses involve instructors lecturing online, while non-theoretical courses include experimental courses combining instructor demonstration with hands-on practice and discussion courses dominated by student discussion with instructor commentary. Due to different emphases, student needs vary across these two course types, and the factors influencing transactional distance may also differ. Therefore, this study proposes:

H4a: The effect of student-teacher interaction on perceived transactional dis-

tance is moderated by course type.

H4b: The effect of student-student interaction on perceived transactional distance is moderated by course type.

H4c: The effect of student-content interaction on perceived transactional distance is moderated by course type.

H4d: The effect of student-interface interaction on perceived transactional distance is moderated by course type.

3.2 Theoretical Model

Based on the IPO model and transactional distance theory, this study proposes a model of student satisfaction in synchronous online courses. As shown in [Figure 1: see original paper], if we view students as a special “system,” the interaction factors in the dialogue and structure dimensions represent external inputs to the system. The intensity of these interaction inputs affects students’ internal perception of transactional distance, which serves as a mediating process affecting satisfaction—the transformation of external inputs within the system. This internal perception leads students to output their satisfaction level with the course, representing the system’s output result.

4. Empirical Study

4.1 Data Collection and Statistical Analysis

Data were collected through an online questionnaire distributed primarily to students at Wuhan University and other institutions. The questionnaire consisted of three parts: (1) demographic questions including gender and age; (2) questions about respondents’ online learning experiences; and (3) measurement of the main variables in the model, requiring respondents to answer based on their actual experience in a specific course. The model included six variables measured using items from established scales in international literature [?, ?], all rated on a 5-point Likert scale with 24 items total. To ensure scientific validity, a pilot study was conducted and domain experts were invited to evaluate the questionnaire, with revisions made based on feedback. During formal distribution, 515 questionnaires were received. After removing invalid responses, 492 valid questionnaires remained, yielding a 95.5% validity rate.

4.2 Sample Descriptive Statistics

A total of 492 valid questionnaires were collected. Since 46 respondents completed the questionnaire multiple times based on experiences in different courses, the descriptive statistics only analyze respondents’ first submissions. Among participants, females accounted for 72.6% and males 27.4%. Most respondents were undergraduates, with only 80 (17.9%) at the master’s level or above. Respondents’ internet usage experience mostly ranged from 5-12 years, with fewer

having less than 4 years or more than 13 years of experience (see).

4.3 Analysis of Online Course Implementation

This study investigated the status of online course implementation in China, collecting statistics on instructors' chosen platforms, platform features, and difficulties encountered during online learning, as shown in [Figure 2: see original paper]-[Figure 5: see original paper].

[Figure 2: see original paper] shows the distribution of online teaching platforms used by respondents' instructors. Tencent Meeting was the most widely used platform, with 70% of respondents' instructors adopting it, followed by instructor-created social media groups. [Figure 3: see original paper] indicates that "network congestion" and "inability to achieve effective interaction" were common problems encountered by respondents during online learning, each affecting over 50% of respondents. [Figure 4: see original paper] and [Figure 5: see original paper] present statistics on effective online interaction methods and helpful platform features. Recording functionality was considered helpful by the vast majority of respondents, while assignment assessment and evaluation were also widely regarded as beneficial. Among various interaction methods, 57.6% of respondents considered classroom dialogue effective, followed by group discussion.

4.4 Reliability and Validity Testing

SmartPLS 3.0 was used to test the reliability and validity of the survey data. Reliability refers to the consistency between measured data and conclusions. This study employed Cronbach' s Alpha and Composite Reliability (C.R.) to analyze construct reliability. All variables in the scale achieved Cronbach' s Alpha coefficients above 0.8 and C.R. values above 0.9, indicating good reliability. Validity refers to the effectiveness of the measurement model—whether the measurement instrument accurately measures the intended constructs. Factor analysis results showed that all measurement variables had factor loadings above 0.7, AVE values above 0.5, and the square roots of each construct' s AVE were significantly greater than their correlations with other constructs, demonstrating good convergent and discriminant validity (see and).

4.5 Structural Equation Model Testing

SmartPLS 3.0 was used to test the hypotheses, with Bootstrapping employed to verify mediating effects. The results consist of two parts: (1) Without introducing the mediating variable, all independent variables in the dialogue and structure dimensions had significant positive effects on student satisfaction, supporting hypotheses H2a-H2d (see). (2) The Variance Accounted For (VAF) value was used to test mediating effects. Analysis showed that after introducing perceived transactional distance, the VAF values for student-student and student-teacher interactions fell between 20%-80%, indicating that perceived

transactional distance partially mediates the relationship between these two independent variables and satisfaction, supporting H1a and H1b. However, for student-content and student-interface interactions, VAF values were below 20%, indicating no mediating effect of transactional distance, thus rejecting H1c and H1d (see).

4.6 Moderating Effect Testing

Since the moderating variable (course type) in this study is categorical, we divided the overall sample into two independent subsamples based on respondents' selected course types (theoretical and non-theoretical courses) and established separate regression models for the four independent variables on the dependent variable. Table A presents the regression coefficients β and significance results for theoretical and non-theoretical courses, while Table B uses Fisher's r -to- z transformation to calculate Z-values and one-tailed P-values for the significance of differences between correlation coefficients in the two independent samples (see).

The analysis shows that in both theoretical and non-theoretical courses, the difference in the effects of student-student and student-teacher interactions on transactional distance is significant ($p < 0.1$), indicating that course type moderates the influence of these interactions on transactional distance, supporting H4a and H4b. However, course type does not significantly moderate the effects of student-content or student-interface interactions on transactional distance, thus not supporting H4c and H4d.

5. Discussion

5.1 Dialogue Dimension

The model validation results indicate that both student-student and student-teacher interactions in the dialogue dimension can directly and positively affect satisfaction, and can also positively influence satisfaction by reducing transactional distance. This suggests two key mechanisms. First, in synchronous online courses, higher levels of student-student interaction lead to closer perceived transactional distance, creating a sense of reduced spatial-temporal barriers and thereby increasing satisfaction. Additionally, interaction with peers enhances students' sense of classroom participation and improves the overall classroom atmosphere, further boosting satisfaction.

Second, higher levels of student-teacher interaction lead to closer perceived transactional distance, reducing the difference from face-to-face classrooms and increasing satisfaction. Moreover, student-teacher interaction can stimulate student engagement and improve focus, leading to better classroom experiences and higher satisfaction.

5.2 Moderating Role of Course Type

The moderating effect hypotheses for course type were only partially supported. Course type moderates the relationships between student-student interaction, student-teacher interaction, and transactional distance, while the other two moderating hypotheses were not significant. Regardless of course type, student-student interaction positively affects perceived transactional distance, with a stronger effect in theoretical courses. This suggests that in theoretical courses, instructors should emphasize student-student communication to create a closer sense of transactional distance. Conversely, student-teacher interaction only affects transactional distance in non-theoretical courses, indicating that compared to instructor-led theoretical courses, the interaction between instructors and students in hands-on experimental courses and discussion courses that require student thinking and exchange can better create a sense of “being there.”

6. Conclusion

This study holds both theoretical and practical significance. Theoretically, it combines TDT and the IPO model to empirically determine the mechanisms through which dialogue, structure, and transactional distance affect student satisfaction in online courses: dialogue influences satisfaction both directly and through the mediation of transactional distance, while structure only directly affects satisfaction. Additionally, the study finds that course type moderates the effect of dialogue on transactional distance. In theoretical courses, only student-student interaction significantly affects perceived transactional distance, while in non-theoretical courses, student-teacher interaction has a stronger impact on transactional distance.

Practically, the study verifies that both dialogue and structure in synchronous online courses affect student satisfaction. Therefore, platform designers should enhance the convenience and flexibility of interactive features to promote their use, while instructors should increase the frequency of interactions in both dimensions. Furthermore, since different course types moderate the effect of dialogue on transactional distance, teaching methods should be adapted accordingly. In theoretical courses, instructors should provide more opportunities for student-student discussion, while in non-theoretical courses, designers should increase the frequency and depth of instructor-student interaction.

This study has several limitations. First, the research subjects were limited to university students; future research could explore the influence mechanisms of satisfaction among primary and secondary school students in synchronous online courses and compare differences. Second, this study did not further divide transactional distance into sub-dimensions. J. K. Mbweza [?] subdivided transactional distance into student-student and student-teacher distances in his research; future studies could adopt such dimensionalization to explore underlying mechanisms.

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Author Contributions

Wu Jiang: Primarily responsible for topic selection, research design, and paper revision.

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Ma Yunyun: Primarily responsible for data collection, processing, analysis, and paper writing.

Note: Figure translations are in progress. See original paper for figures.

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