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TRANSACTIONAL DISTANCE IN MIDDLE AND HIGH SCHOOL ONLINE
LEARNING ENVIRONMENTS: AN EMPIRICAL STUDY

by

Silas Kigaita Njoroge

Dissertation

Doctor of Education

Major: Instruction and Curriculum Leadership

The University of Memphis

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Dedication

In memory of my mother, Grace Nyambura and my father, Phillip Njoroge who left the fingerprints of grace and hard work in me. You shall not be forgotten.

Acknowledgement

Thank you to my dissertation committee chairs Dr. Shepherd and Dr. Earnshaw. I would not have made it without your guidance and encouragement. I would also like to thank Dr. Szapkiw and Dr. Twafik for graciously agreeing to serve on my committee and for tirelessly providing me with valuable feedback on my research work.

Thanks to my wife Rebecca, my son Phillip, and daughter Grace for always encouraging me to keep going.

Abstract

Understanding the communication gap due to the separation of teachers-students and students-students in online learning environments can have a profound impact on improving online learning. Moore's Transactional Distance Theory (TDT) is an important pedagogical theory in distance learning that can be used to gain a better understanding of K-12 distance education practices. This study sought to empirically verify the theory by investigating the relationship of dialogue, structure, learner autonomy, and transactional distance (TD) perceived by students in a K-12 Online Learning Environments (OLE). The study also investigated the effect of environmental and demographic factors on TD. Participants were selected from online students taking one-year science courses in online high and middle school. A correlational design was used to analyze the association between transactional distance and the constructs. ANOVA was used to analyze the difference in transactional distance perceived by students in classes with different combinations of high to low structure and dialogue (+D+S, +D-S, -D+S, -D-S). ANOVA and two-sample *t*-tests were used to test hypotheses on the impact of TD on environmental and demographic factors. The results empirically showed that TD varies inversely with dialogue, structure, and learner autonomy and that environmental and demographic factors had not impact TD.

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List of Abbreviations

Abbreviation	Meaning
+D+S	High dialogue, high structure
+D-S	High dialogue, low structure
-D+S	Low dialogue, high structure
EFA	Exploratory Factor Analysis
OLE	Online Learning Environment
LMS	Learning Management System
TD	Transactional Distance
TDT	Transactional Distance Theory

CHAPTER ONE: INTRODUCTION

Introduction

According to the U.S. Department of Education (2017), online K-12 education has been on the rise and is projected to keep rising over the next ten years. Weary of underfunded schools and teacher shortages, schools have adopted technology-mediated education with the hope of increasing access to qualified teachers, lowering costs, and providing more access and collaboration opportunities for learners (Miron & Urschel, 2012). This increase in online learning, mostly in grades 7-12, has coincided with rapid advances in Online Learning Environments (OLE) and Learning Management Systems (LMS) technology. As a result, this trend has revitalized the significance of research on teaching and learning issues that can impact the quality of distance learning (Miron & Urschel, 2012). One such issue is transactional distance (TD) (Larkin & Jamieson-Proctor, 2015).

TD refers to the perceived psychological and communication gap between students and instructors due to the physical separation between learners with each other and between the teacher and learners (Benson & Samarawickrema, 2009; Huang, Chandra, DePaulo, & Simmons, 2016). This physical separation results in a space where misunderstandings between the teacher and the learners can occur (Moore, 1993). The degree to which learners perceive TD is determined by three constructs: a) structure; b) dialogue; and c) learner autonomy. Structure is the extent to which a course can be responsive to the learning needs of an individual student (Moore, 1993). Dialogue refers to the communication between and among students and teachers. Learner autonomy refers to a student's self-direction (Moore, 1991, 1993; Stein, Wanstreet, Calvin, Overtom, & Wheaton, 2005). Moore's Transactional Distance Theory (TDT) provides a

framework for analyzing the gap experienced by learners in online courses (Dron, Seidel, & Litten, 2004; Moore, 1991, 1993; Stein et al., 2005). Indeed, researchers have used TD as a psychometric construct to measure learners' perceived separation in online learning. Sub-scales have been used to differentiate between TD of students and teachers as well as students and students (Chen, 2001a; Ekwunife-Orakwue & Teng, 2014; Goel, Zhang, & Templeton, 2012). Despite the recognition of the theory as an important pedagogical framework for distance learning, few studies have empirically investigated and verified TD in modern online learning (Chen, 2001a; Huang, 2002; Huang et al., 2016). Few studies have empirically investigated and verified the relation between TD and structure, dialogue, and learner autonomy in online learning (Huang et al., 2016). There is a lack of studies on this topic in modern high and middle school OLE (Murphy & Rodriguez-Manzanares, 2008).

Having briefly mentioned TD and its constructs in the previous section, this section will now discuss the relationships among TD constructs. Researchers agree that TD varies inversely with dialogue (Benson & Samarawickrema, 2009; Kearsley & Lynch, 1996; Moore, 1991, 1993). Furthermore, researchers agree that the higher the TD the more autonomy a learner must exercise (Moore, 1993; Moore & Kearsley, 2005). The relationships between TD and structure and between structure and dialogue are less agreed upon (Chen, 2001a; Goel et al., 2012; Moore, 1993). Depending on how the distance course is designed, the perception of structure, dialogue, and TD may be high or low (Benson & Samarawickrema, 2009). Structure and dialogue are adjustable variables that change when a course is, for example, segmented into units or modules, interactive tools are used, or activities are made accessible to learners in specific ways (Fritz, 2016). Changes to structure and dialogue are dictated by the teacher and the tools and resources available in the LMS (Shea, Joaquin, & Wang, 2016). Highly structured

courses, also referred to as highly rigid, provide maximum guidance and direction to the learners (Huang, Chandra, DePaolo, Cribbs, & Simmons, 2015). On the other hand, loosely structured or flexible courses, premised on the belief that learners can create their own learning experiences, are open to negotiation between teachers and learners and are more accommodative. Thus, flexibility is believed to reduce TD (Kearsley & Lynch, 1996). However, researchers have cautioned that allowing too much flexibility in e-learning environments with high enrollment could lead to confusion and anxiety (Huang et al., 2015; Kearsley & Lynch, 1996). Indeed, the clearly defined formal components of a course (e.g., expectations, objectives, grading criteria) may not result in rigidity. Instead, the presence of individualization, such as accounting for a student's background and the provision of a variety of teaching strategies, leads to flexibility and results in low levels of structure (Kearsley & Lynch, 1996). According to Moore (1991), formality does not conflict with flexibility as the theory emphasizes the accommodation of learners' needs. Nonetheless, high dialogue provides opportunity for communication between learner-learner and teacher-learners. As teachers make course design decisions, the choices result in different amounts of structure and dialogue. This results in varying levels of TD and thus different levels of learner autonomy (Huang et al., 2016; Larkin & Jamieson-Proctor, 2015). However, there are concerns presented in the literature on the definitions of the constructs and how they relate (Dron, 2005; Garrison, 2000; Giossos, Koutsouba, Lionarakis, & Skavantzios, 2009; Gorsky & Caspi, 2005). For example, Dron (2005) suggested that the theory involves unclear definitions of the constructs. Gorsky and Caspi (2005) challenged TD theory's construct validity and suggested that the theory was a tautology (i.e., saying of the same thing twice in different words) in which only dialogue influenced TD.

In addition to structure, dialogue, and learner autonomy, environmental and demographic factors could influence a student's perceptions of TD. Environmental factors include types of communication (i.e., instructional media, class size, required courses, required participation in group discussions, number of previous online courses taken and preference for online courses, school type, grade). Demographic factors are gender and ethnicity (Moore, 1993; Moore & Kearsley, 2005; Shearer, 2003, 2009).

Besides TD, the K-12 education shift to OLE has also brought additional challenges such as learner isolation, lack of support, attrition, and poor performance (Kena et al., 2016; Miron and Urschel, 2012; U.S. Department of Education, 2017). The physical and temporal separation of the teacher-student and student-student can lead to a lack of interaction and socialization with peers as in a traditional classroom (Kena et al., 2016). In asynchronous online classes, there is a lack of immediacy as students must wait for instructor and peer responses (Lazar et al., 2004). On performance, K-12 online schools have been reported to underperform traditional brick and mortar school (Wang & Decker, 2014). For example, 27.4% of the virtual schools met Annual Year Progress, compared to 51.1% of the brick-and-mortar schools, largely due to lower assessment scores in math, reading, and lower graduation rates (Miron & Urschel, 2012).

There is a lack of studies seeking to understand TD in modern K-12 OLE (Murphy & Rodriguez-Manzanares, 2008). This study seeks to contribute to research by replicating the study "Understanding TD in Web Based Environments" by Huang et al. (2016). It aims to empirically establish the relationship between structure, dialogue, and learner autonomy with TD and to investigate the impact of environmental and demographic factors on transactional distance TD in a high and middle school Online Learning Environment (OLE). Moreover, the

grades 7-12 context is unique due to the difference in the geographical regions, educational context, students' age, and subjects, as compared to the original study. For this reason, the findings on TD from higher education may not be generalizable to K-12 education.

The study will be conducted on middle and high school students from different schools taking online courses by asking students about their perceptions of TD using the Transactional Distance Instrument (Huang et al., 2016). Results will provide a better understanding of the relationships between TD, structure, dialogue, and learner autonomy and clarify how environmental and demographic factors affect TD in middle and high school online learning.

Problem of Practice Statement

Alternative education programs such as those offered in OLEs present options for students who would otherwise not have access to courses or are at risk of dropping out of school due to various reasons (Allen, Seaman, Poulin, & Straut, 2016). For the past ten years, there has been a rapid increase in K-12 students enrolled in OLEs (Kena et al., 2016). With this high growth rate, online learning could be the dominant form of education soon, implying that more students will be learning without face-to-face interaction with their teachers and peers (Allen et al., 2016). The lack of face-to-face interaction in online learning creates a separation that challenges learning, collaboration, interaction, and knowledge sharing between students and teachers and students and students (Allen et al., 2016; Pourreau, 2015). In K-12 OLE settings, this lack of face-to-face interaction can present larger challenges for young learners who have not yet developed skills to learn and study independently (Allen et al., 2016; Pourreau, 2015). Moore's transactional distance theory (1991, 1993) is an essential pedagogical concept that can be used to understand the separation of teachers and learners in OLEs. Most formal studies into how structure, dialogue, and learner autonomy correlate with TD perceived in online learning

have been concentrated in higher education settings (Chen, 2001a; Ekwunife-Orakwue & Teng, 2014; Goel et al., 2012; Pourreau, 2015). Less is known about how TD manifests itself in grades K-12 (Rice, 2006). Thus, understanding the relationship between TD, structure, dialogue, learner autonomy, and how learners perceive TD can have significant implications for OLE based courses. Reducing TD could lead to increased student engagement and satisfaction, a result that could have positive effects on other issues such as learner isolation, poor performance, and high dropout and attrition rates in OLEs (De la Varre, Keane, & Irvin, 2011).

Research Questions

This quantitative study will be guided by three research questions:

1. How do structure, dialogue, and learner autonomy impact student's perceptions of TD (Huang et al., 2016)?

2. How do environmental factors (i.e., instructional media, class size, required courses, required participation in group discussions, number of previous online courses taken and preference for online courses, school type, grade) impact student-perceptions of TD (Huang et al., 2016)?

3. How do demographic factors (i.e., gender and ethnicity) impact student perceptions of TD (Huang et al., 2016)?

This study aims to first empirically verify the relationships among the TD constructs and then empirically verify the impact of environmental factors and learner demographics on perceptions of TD during instruction in grades 7-12 online courses. The Transactional Distance Instrument (see Appendix A) will be used to find students perception of TD and will be administered to the students through a survey (Huang et al., 2016). Data on student demographics and environmental factors will be obtained via a pre-survey questionnaire at the

top of the survey. The sample for this study will be comprised of about 150 students from different schools taking online courses (grades 7-12). There are more than 5,500 middle and high school students taking online courses in various subjects in the metro area with a population of over a million.

Purpose Statement

This study is a replication of the study “Understanding TD in Web-based learning environments” (Huang et al., 2016) that was conducted in a higher education setting. The purpose of this correlational and causal-comparative study is to empirically verify the association between TD and its constructs and to investigate the impact of environmental and demographic factors on TD in courses offered at an online school (Grade 7-12) in Memphis, Tennessee. To verify the association among the variables of interest (i.e., TD, structure, dialogue, and learner autonomy), a correlational analysis will be performed using Pearson correlation. To verify the difference in TD perceived between groups of high/low structure and dialogue, a causal comparative will be performed using one-way ANOVA. To investigate the impact of environmental factors (i.e., instructional media, class size, required courses, required participation in group discussions, number of previous online courses taken and preference for online courses, school type, grade) and demographic factors (i.e., gender and ethnicity), ANOVA and Two-Sample *t*-tests will be used. The TD data will be obtained for the students via the Transactional Distance Instrument, a validated Likert-type scale instrument that measures a student’s perception of TD, course structure, dialogue, and learner autonomy. Environmental and demographic data will be obtained through a pre-survey questionnaire.

Null Hypotheses

The following null hypotheses will be tested in this study:

Hypothesis 1. Association between student perception of TD and structure, dialogue, and learner autonomy.

- $H_{1.1}$: There is no statistically significant correlation between dialogue and perceived TD (Huang et al., 2016).
- $H_{1.2}$: There is no statistically significant correlation between structure and perceived TD (Huang et al., 2016).
- $H_{1.3}$: There is no statistically significant correlation between learner autonomy and perceived TD (Huang et al., 2016).
- $H_{1.4}$: There is statistically no significant effect of high dialogue and high structure (+D+S) on student perception of TD (Huang et al., 2016).
- $H_{1.5}$: There is statistically no significant effect of low dialogue and low structure (-D-S) on student perception of TD (Huang et al., 2016).
- $H_{1.6}$: Low dialogue-high structure (-D+S) and high dialogue-low structure (+D-S) do not lead to a TD between high dialogue-high structure (+D+S) and TD perceived in low dialogue-low structure (-D-S) (Huang et al., 2016).

Hypothesis 2. Impact of environmental factors on the student's perceptions of TD.

- $H_{2.1}$: TD is not perceived in the order below, from least to most, live audio/video communication media (least TD), live audio communication, live text communication, broadcast audio/video, traditional email and/or discussion forums (Most TD) (Huang et al., 2016).
- $H_{2.2}$: There is no statistically significant difference in TD perceived by students who have used synchronous communication (live text communication + live audio communication

+ live audio/video communication) and students who have only used traditional asynchronous communication (email + discussion forums) (Huang et al., 2016).

- H_{2.3}: There is no statistically significant difference in TD perceived by students who use audio/video communication (broadcast audio + broadcast audio/video + live audio communication + live audio/video communication) and students who have used only traditional text-based communication (email + discussion forums) (Huang et al., 2016).
- H_{2.4}: There is no statistically significant difference in TD perceived by students who use Web2.0 tools (blogs, wikis, Twitter) and those who used text-based communication (email + discussion forums) (Huang et al., 2016).
- H_{2.5}: There is no statistically significant difference in TD perceived by students in smaller size classes and students in larger classes (Huang et al., 2016).
- H_{2.6}: There is no statistically significant difference in TD perceived by students who volunteered to take online classes than those who did not volunteer (Huang et al., 2016).
- H_{2.7}: There is no statistically significant difference in TD perceived by students who are required to participate in group or class discussion those who are not required (Huang et al., 2016).
- H_{2.8}: There is no statistically significant difference in TD perceived by students who prefer online classes than those who prefer face-to-face (Huang et al., 2016).
- H_{2.9}: There is no statistically significant difference in TD perceived by students who have previous online experience than those that do not (Huang et al., 2016).
- H_{2.10}: There is no statistically significant difference in TD perceived by students in middle and high schools (Huang et al., 2016).

- $H_{2.11}$: There is no statistically significant difference in TD perceived by students in public and private schools (Huang et al., 2016).

Hypothesis 3. Impact of demographic factors on the student's perceptions of TD.

- $H_{3.1}$: There is no statistically significant difference in TD perceived by male and female students (Huang et al., 2016).
- $H_{3.2}$: There is no statistically significant difference in TD perceived students from different ethnicities (Huang et al., 2016).

Definitions

The following definitions will be used in this study:

Attrition. The process of gradual reduction of persistence in distance learning due to reasons such as isolation and lack of support. Attrition leads to students dropping out (U.S. Department of Education, 2017).

Blended learning. An approach to instruction that combines online learning and face-to-face instruction (Pulham & Graham, 2018)

Dialogue. A construct of the TD theory referring to communication between teachers/students and students/students (Moore, 1993). In this study, dialogue will refer to a variable measuring the student's perception of communication between teachers and students and between students and students (Benson and Samarawickrema, 2009)

Distance education. Distance education refers to the various forms of study where the teachers are not present with their students in the same room, building, or premise (Osguthorpe & Graham, 2003).

Face-to-face instruction. Face-to-face instruction is a format where the teachers and students are in the same physical space (Osguthorpe & Graham, 2003).

Isolation. Isolation is the feeling of alienation that a student feels because much of the social interactions that would be present in traditional learning environments is not present in online learning environments (U.S. Department of Education, 2017).

Learner autonomy. Learner autonomy is the ability of the learner to share responsibility for learning (Moore, 1993). In this study, learner autonomy will refer to a variable that measures the students' perception of their self-direction.

Learning Management System (LMS). A software application for delivery and administration of learning content (Stockless, 2018).

One-to-one computing. Every student and teacher have 24/7 access to an individual, portable computing device and ubiquitous Internet access while on campus and at home (Ryan, Kaufman, Greenhouse, She, & Shi, 2016).

Online Learning Environment (OLE). The term refers to different forms of online learning where delivery of content happens in an online platform. Some terms that have been used to refer to OLE are digital learning, distributed learning, open learning, networked learning, Web-based education, online learning, cyber education, net education, computer-based learning, distance learning, and other similar terms. OLEs offer learning opportunities in ways that transcends the traditional brick and mortar learning model, limited in time and space (Greene & Hale, 2017; Pulham & Graham, 2018).

School choice. The term refers to options available to students in public K-12 education. School choice is intended to offer alternatives to families generally tied to only schools in the family's location of residence (Simonson, Schlosser, & Orellana, 2011).

Structure. Structure is the extent to which a course adapts to the learning needs of individual students. In this study, structure refers to the ability of the learning environment and instructional activities to be customized and tailored to the individual learner (Moore, 1991).

Transactional Distance Theory. Transactional distance (TD) has been defined as the perception of psychological distance between student and teachers, between students and students, and between students and the learning content. TD may also be perceived in face-to-face learning. It may be increased with physical distance, for example, in online learning instruction. TD is influenced by three constructs: structure, dialogue, and learner autonomy (Moore, 1990).

CHAPTER TWO: REVIEW OF THE LITERATURE

Introduction

Due to advancements and innovations in education technology, education agencies and schools are offering educators and students new opportunities for teaching and learning in K-12 education (Allen et al., 2016). The rise in the number of K-12 schools implementing Online Learning Environments (OLEs) is one example. This trend has resulted in a rapid increase in the number of students enrolled in online courses (U.S. Department of Education, 2017). Learning management systems (LMSs) have been used as the primary means for delivering courses to learners in online environments. Using technology affordances available in LMSs, such as tools for communication, collaboration, evaluation and assessment, teachers design courses based on their preferences and pedagogy (Fritz, 2016; Kena et al., 2016; U.S. Department of Education, 2017). However, when students take online courses, they experience issues such as separation, isolation, and lack of support (Kena et al., 2016).

TD has long been a prominent issue in distance learning research (Dron, 2005; Garrison, 2000; Giossos, Koutsouba, Lionarakis, & Skavantzoz, 2009; Gorsky & Caspi, 2005). Moore's original definition of TD focused on the perceived distance between teachers and learner (Moore, 1991). This definition has been expanded to include learner-learner and learner-content. According to this conceptualization, which will be used throughout this paper, TD is defined as the perception of psychological distance between student and teachers, between students and students, and between students and the learning content (Benson & Samarawickrema, 2009; Gorsky & Caspi, 2005; Wikeley & Muschamp, 2004). Indeed, TD has been considered as a multidimensional construct that includes both social and cognitive aspects of learning, where interpersonal closeness, shared understanding and perceived learning are

major components. Perceived closeness relates to the social component, while shared understanding and perceived learning relates to cognitive aspects (Bischoff et al., 1996; Gorsky & Caspi, 2005; Huang et al., 2015). Caspi and Gorsky (2005) agreed that the understanding or misunderstanding component of TD should be a more important aspect to consider, as in Moore's original definition (1991, 1993). The TD perceived by students depends on the course structure, dialogue between the teachers/students and student/student, and learner autonomy (Moore, 1991; Moore, 1993). Technology affordances such as interactive two-way communication tools offer a high potential for reducing the TD experienced by students (Huang et al., 2016)

This chapter examines what literature says about Transactional Distance Theory, how the theory has evolved and how the theory has been used as a framework for evaluating communication and psychological gaps that students experience in OLEs. This literature review will begin by describing the current state of K-12 online education. The review will then shift focus to the growth of distance programs in grades 7-12, OLEs and their delivery using modern LMSs, and the advantages and challenges of grades 7-12 OLEs. Transactional Distance Theory will then be explained, associations between its constructs discussed, and the evolution of its research summarized. Finally, the review concludes by looking at what the research says about TD in the context of an OLE and what the literature says about the impact of environmental and demographic factors on TD.

Current State of K-12 Education

According to the National Center for Educational Statistics (Hussar et al., 2017), an estimated 50.7 million students attended public K-12 schools in 2016. The same report projected the attendance to rise by 3% in the year 2017. In another report, the National Center

for Education Statistics predicted that the enrollment rate will continue to increase to 56.8 million students by 2026, indicating the increasing demand for education in the United States (Kena et al., 2016). The increase in enrollment has increased the teacher-student ratio, exacerbating the loss of effective teachers to districts with better working conditions. Mostly affected by this mobility are low performing schools where teacher shortages are already common (Kena et al., 2016). This shortage has created a situation where schools must fill positions with inexperienced or ineffective teachers, or even having no teachers in subjects such as math and science, thus lowering of the quality of education and lowering student's achievement (Molnar et al., 2017). Across the U.S, state education agencies, local education agencies and individual schools are making efforts to transform schools by reforming school leadership, teacher quality, standards, testing, and funding by leveraging technology. This trend is demonstrated by the rise of online schools (Allen et al., 2016; Kena et al., 2016; Molnar et al., 2017). For example, in 2016-17, there were 528 full-time virtual schools in the USA enrolling 278,511 students and 140 blended schools enrolling 36,605 students. Thirty-four states had full-time virtual schools (Molnar et al., 2017; Kena et al., 2016). This increase is due to multiple variables of OLE that appeal to K-12 education such as the prospect of access to highly effective teachers and the lower costs resulting from not building and maintaining brick and mortar schools (Miron & Gulosino, 2016). There is also a belief that OLEs can expand student choices, improve the efficiency of public education, and allow customization of courses to fit individual student needs more effectively than in traditional face-to-face learning environments (Ingram, 2016). For example, OLEs have increased of non-traditional and underserved students' access to college curricula by offering a variety of opportunities such as embedding dual-enrollment programs in low performing and understaffed schools. Other examples are advanced

placement course and International Baccalaureate programs that provide college-level curricula and examinations to high school students (Ingram, 2016).

However, there is little evidence that the rapid expansion of education to online learning has been effective in terms of student achievement. Molnar et al. (2017), in a National Educational Policy Center (NEPC) report, argues that the movement toward OLEs is often supported by limited data. For example, a study done by Stanford University researchers using matched pair sampling found that students in virtual schools made fewer gains than students in traditional schools (Miron & Urschel, 2016). In another study, 44% of online schools in eighteen states were reported to have failed to meet their Annual Yearly Progress (AYP) benchmarks, compared to only 21% of brick and mortar schools over the same period (Ingram, 2016). In contrast, supporters of virtual schools claim that advantages of offering online courses in K-12 education outweigh the disadvantages by providing a means of mitigating funding issues, bypassing teacher shortages, and broadening access to courses unavailable in schools (Borup, Graham, & Drysdale, 2014; Miron & Urschel, 2016). Other benefits include offering a high-quality education, achieving better student outcomes and skills, and allowing for school choice (Barbour & Reeves, 2009).

Distance Programs in K-12 Education

Secondary school distance education programs are not new. Evolving from an adult, text-based and correspondence-based distance education programs, current distance programs have gradually shifted to relying more on technology for delivery and communication (Greene & Hale, 2017). In the U.S., the evolution of K-12 distance learning has paralleled with technological advances used over the last two centuries—from print to media and communications technologies to the Internet revolution (Greene & Hale, 2017). The aim of

distance programs has included increasing opportunity through school choice. School choice advocates posit that allowing parents to have increased choices forces schools to improve in order to recruit and retain students (Greene & Hale, 2017; Miron & Urschel, 2012). School choice also broadens access to supplemental services for students in non-traditional environments such as remote areas, home schools, isolation due to health reasons, full-time athletics, jail, and students with unique needs such as flexible schedules due to employment, needing to improve the quality of their education, early graduation, credit recovery, or finding a curriculum in a learning style that fits them (Simonson et al., 2011).

Having briefly described distance learning in K-12 distance education, this section will look at what the literature says about its effectiveness compared to learning in bricks and mortar schools. Studies have researched why students struggle in an online setting as compared to face-to-face learning. For example, Dixson (2011) and King (2014) concluded that consistent interaction between teacher-student and between student-students in online classes is the key to setting high academic expectations for students. The lack of consistent interaction leads to low expectations and poor performance. Martin and Bollinger (2018) suggested that online learning requires more discipline for students to progress through classes than face-to-face learning. Porter (2015) suggested that the Bloom taxonomy (1956) holds much significance in the success of online learning. Some of the barriers to OLE, such as isolation and less interaction are in direct conflict with aspects of Bloom's affective domain of learning such as valuing, reception, response, and internalization (Porter, 2015).

In a comprehensive literature review on the current state of K-12 distance programs, Rice (2006) noted that there is a lack of quality studies focused on student online experiences. Additionally, Rice (2006) stated there is an abundance of current research on Web-based

technologies and delivery systems, the properties of such systems, and impact on student learning outcomes. According to Rice (2006), most studies comparatively examine student performance in online schools and traditional face-to-face instruction. Online distance programs have been evaluated and validated in two meta-analysis studies. The two studies, comparing K-12 distance learning with traditional K-12 schooling, are seminal because they provided empirical evidence that modern OLEs could be as effective as traditional face-to-face methods (Cavanaugh, 2001; Cavanaugh, Gillan, Kromrey, Hess, & Blomeyer, 2004). In the first study, Cavanaugh (2001) concluded that the use of interactive distance learning to complement, enhance, and expand educational options resulted in achievement that is comparable to traditional face-to-face instruction. In the second study, Cavanaugh, Gillan, Kromrey, Hess, and Blomeyer (2004) found that distance education can have the same effect on measures of student academic achievement scores that were comparable to traditional education. In a study involving school administrators' perception of online learning, Allen et al., (2016) found that over 66 % of school administrators perceived online learning to as good or better than face-to-face schooling.

Few studies provide validation for the use of OLE in K-12 education, and little is known about the conditions that foster K-12 student success or failure in OLEs (Barbour & Reeves, 2009; National Education Policy Center, 2017; Pourreau, 2015). In contrast, Rice (2006) published a comprehensive literature review on K-12 distance education that addressed the comparisons in the two studies mentioned in the previous paragraph but added learner characteristics, learner supports and the affective domain in his comparison. Rice (2006) concluded that the most important factor in student success is access to highly qualified teachers. In addition, Rice (2006) suggested that the effectiveness of K-12 distance education

depends on the quality of teachers, quality of instruction and students but not on the medium of delivery. A similar conclusion was made in a study of teaching habits of high school online teachers (Borup, et al., 2014). Borup et al. (2014) concluded that online teachers were most effective in improving student outcomes when they designed learning and facilitated activities, provided one-on-one instruction, motivated students, and closely monitored student learning. According to the International Association for Online K-12 Learning, one important element of effective online teaching is monitoring student's time management and progress towards mastery of objectives. However, monitoring learning activity can be difficult in online settings (Powell, 2015). LMSs can eliminate this problem by providing detailed information on student access to learning content and activity. However, online schools have not been utilizing LMS features that can aid the monitoring of students because data are hard to analyze and interpret (Powell, 2015).

K-12 online learning. The term “K-12 online learning” is generally used to refer to the practice of using technology to deliver online learning to elementary and secondary schools. The term “virtual school” is generally used to refer to supplemental programs that offer online courses to students who attend brick-and-mortar schools and who want to or need to supplement their course options (Pulham & Graham, 2018). On the other hand, “blended learning” was recently defined as an education program in which a student learns “in part at a supervised brick-and-mortar location away from home and at least in part through online delivery with some element of student control over time, place, path, and/or pace” (Waters, Barbour, & Menchaca, 2014, p. 380). For this study, “K-12 online learning” is defined as a program in a public or private school where 80% or more of learning and teaching is done online. In public schools,

online learning is governed by the local or state education agencies in which they operate while private schools operate their online learning more independently (Osguthorpe & Graham, 2003).

Implementation of OLEs

The section below defines LMSs, elaborates their use as the most common technology for OLE delivery, and describes some of their basic functionalities. The section ends with an outline of the advantages and limitations of OLEs.

Learning Management Systems

A Learning Management System (LMS) refers to one of the most used approaches to delivering content and monitoring student learning in online education (Sistek-Chandler, Tolbert, & Amber, 2012). Indeed, the growth of K-12 online learning has been attributed to the advancement of LMS technology (U.S. Department of Education, 2017). Some of the functions of LMSs include delivery and management instructional content, tracking student performance, collecting and presenting data for analytics, personalizing instruction, course registration and administration, and integrating other technology systems into learning. When implemented fully, LMSs can function as tools that handle all aspects of the OLE learning process (i.e., course design, instructor pedagogy, student learning, and assessment and evaluation (Sistek-Chandler et al., 2012). A basic LMS set up should enable access to content, development of content, integration of content with third-party software and adherence to standards such as Sharable Content Object Reference Model , better known as SCORM (Carliner, 2005). While the above description of features are a minimum that can help in understanding functionality, LMSs are also considered as systemic applications that provide the structure of the entire learning process within a school or an organization (Fathema, Shannon, & Ross, 2015).

From a user perspective, an LMS is comprised of three types of features that facilitate learning. The first type of feature is the tools that engage learners in learning activities such as quizzes, online presentation tools and assignments (Firat & Yüzer, 2016). The second type of feature is the communication tools that enable interaction between teachers-learners and students-students. Communication tools are a very important factor in improving the quality of dialogue between teachers and students (Kasim & Khalid, 2016; Moore & Kearsley, 2005). Communication media such Web-conferencing applications allow for richer two-way synchronous communication while tools such as email, discussion boards, calendars and gradebooks are more asynchronous offering delayed interaction (Huang et al., 2016). The third feature is the productivity tools that teachers use to design and manage courses and how courses will be conducted. The list of functionalities includes (but is not limited to) creating, modifying course pacing, uploading course media and content, and, on the student side, uploading and downloading resources (Fritz, 2016; Khalid, 2016; U.S. Department of Education, 2017).

LMSs have been used as a means of collecting data to understand and optimize OLEs (Siemens & Baker, 2012). The use of LMSs allows for collection and analysis of students' online actions without the time-consuming process of manual data-collection. Instead, data collection in LMSs takes place through learner interaction with the content and captures the input of their action sequence to solve problems (Fritz, 2016). LMSs aggregate the data collected and present it in graphs, tables and visual formats (Khalid, 2016).

Experts are divided on the best method data analysis, and the analysis of student data involves ethical concerns regarding legal and privacy issues (Avella, Kebritchi, Nunn, & Kanai, 2016). Regarding data analysis, Educational Data Mining, Learning Analytics, and Visual Analytics are three types of analyses commonly used to analyze LMS data (Siemens & Baker,

2012; U.S. Department of Education, 2017). EDM involves using student data to develop predictive models using data mining techniques. LA seeks to understand entire learning systems by combining data on student learning with other data. VA involves visualizing larger data sets for patterns, trends, and exceptions (Siemens & Baker, 2012). There is no consensus on the best way of using LMS data to monitor learner progress due to the different interpretations of results from the different analysis methods (Firat & Yüzer, 2016; Siemens & Baker, 2012). Concerning ethical issues, there have been concerns that student data has been mined without their consent and that their privacy can be compromised in the process (Siemens & Baker, 2012). Despite the concerns, Siemens and Baker (2012) argue that LMS data can provide a powerful way of monitoring and gaining up to date insights on student learning (see also Kasim & Khalid, 2016).

Advantages of OLEs

Technology-mediated systems such as OLE offers advantages. In the following section, the advantages of OLEs are explained and include access to high-quality teachers, access to high-quality programs, improved student outcomes, and school choice.

Access to high-quality teachers. Online learning addresses the issue of access to high-quality teachers and instruction caused by socioeconomic and geographic differences (Ingram, 2016). In the U.S., a child's chances of attending a school with high-quality teachers depends on their address which is largely determined by the parents' socioeconomic status (Cavanaugh, 2001). K-12 online learning can equalize this discrepancy by providing distance access to quality teachers in schools already experiencing shortages (U.S. Department of Education, 2017). In a meta-analysis of literature, Cavanaugh (2001) concluded that online learning enables schools to offer courses that would otherwise be unobtainable due to shortages in highly qualified teachers,

especially in math and sciences. This benefit leads to the next benefit of providing high-quality learning opportunities.

Providing access to high-quality learning opportunities. With access to high-quality teachers, schools can offer high-quality learning opportunities such as Advanced Placement (AP) and dual credit courses (Baker, Bouras, Hartwig, & McNair, 2005; Cavanaugh, 2001). In dual enrollment programs, students access college curricula and instructors to earn college credit. Although dual credit programs have existed for over thirty years, their enrollments have increased rapidly in recent years (Kilgore & Wagner, 2017). The programs are administered by colleges and students gain access to the course content and instructors through distance learning models involving an LMS (Cassidy, Keating, & Young, 2010). Dual enrollment has been found to provide students with a wide variety of potential benefits (Barnett & Kim, 2014) such as providing college experience to traditionally underserved communities. Proponents of dual enrollment believe that the programs have potential to facilitate the high school-to-college transition for students (Cassidy et al., 2010; Kena et al., 2016; Kilgore & Wagner, 2017; Marken, Gray, & Lewis, 2013).

Increased school choice and flexibility. The availability of online schools has allowed parents and students to have more choices in addition to the brick and mortar schools in their zones (Ingram, 2016). K-12 online schools offer students greater flexibility and therefore provide parents and students with better options for their education (Cavanaugh, 2001). Closely tied to school choice is the convenience and flexibility of OLEs regarding time, the pace of learning, and location of learning. This aspect of K-12 has been cited as a major advantage of online learning (Baker et al., 2005; Hassell & Terrell, n.d.). Due to this advantage, online learning can be a benefit to students who have challenges that prevent them from attending

school during the day or students with full-day schedules that prevent them from taking extra courses. This convenience that has been cited as the reason for the rapid growth in adoption of OLEs (Borup, 2016; U.S. Department of Education, 2017).

Student motivation and improved outcomes. According to a literature review of virtual schooling (Barbour & Reeves, 2009), students enrolled in OLEs tend to have a higher motivation than those in traditional brick and mortar schools and could lead to improved performance. Indeed, the high student motivation has been attributed to such factors as the convenience of offering courses at the learner's schedule, providing additional time for assignments, and providing shelter for students who fear bullying (Cavanaugh, 2001). According to Cavanaugh (2001), learning in a safer environment can help students to acquire skills that they need to succeed in higher education. However, empirical research in K-12 virtual learning to support the high motivation of online learners is limited (Barbour & Reeves, 2009).

Limitations of OLE

While there is a belief among educational policymakers and administrators on the benefits of OLEs, there are also limitations to its implementation. In the section below, a summary of the limitations of OLEs are described. They include learner isolation, lack of support leading to high drop-out rates, and poor performance.

Learner isolation. According to Kena et al. (2016), the physical and temporal separation of the teacher/student and student/student can lead to a lack of interaction in OLEs. Students in distance learning programs and courses have reported a lack of socialization and interaction with peers, in comparison to a traditional classroom (Kena et al., 2016). This is more of an issue for students taking full-time online schooling as opposed to students in part-time online programs (Watson et al., 2009). Isolation has been cited in literature as being a barrier to

distance learning by decreasing student motivation (Hawkins et al., 2012). Barbour & Reeves observed a direct relation between isolation and dropout rates and concluded that designing online courses with accommodations that allow for more teacher-learner interaction support boosted retention in online learning (Barbour & Reeves, 2009). In a study by De La Varre et al. (2011) in a small rural online school, isolation was found to be a factor contributing to high drop-out rates and an increase in student frustration. In online learning contexts, students have been reported to experience a range of negative emotions such as confusion, anxiety, and frustration due to perceived lack of prompt responses (Lazar et al., 2004). Frustration occurs when a student must deal with an obstacle to their achievement of a task or goal (Lazar et al., 2004). Frustration has been identified as one of the most significant factors in the high dropout and attrition rates in OLE (De la Varre et al., 2011). Although other reasons have been cited as causing frustration in online learning, such as the absence of non-verbal cues during instruction, feelings of isolation can increase the negative emotions associated with frustration (De la Varre et al., 2011). Learners who are geographically separated may also feel frustrated due to the lack of immediate teacher support (referred to as immediacy) or the psychological closeness between teacher and learner (De la Varre et al., 2011).

According to Barbour & Reeves (2009), OLE teachers are expected to maintain control of content, method of delivery and to provide guidance. However, in online learning, the lack of face-to-face interaction with the teacher decreases the main source of guidance during learning. Additionally, most students are not ready to handle the degree of autonomy required to compensate for the lack of proximity. Thus, additional structures to support the learner may serve to replace for the lack of proximity (Moore, 1973).

Lack of support and attrition. Lack of support can be exacerbated by the lack of immediacy when students' desire help. In online learning, lack of immediacy happens when students must wait for instructor responses or in asynchronous online discussion when students must wait for other students' responses (Lazar et al., 2004). In K-12 online courses, teachers and facilitators are available to help students only at specific and limited times. The lack of support or immediate response, when students are in most need, may lead to a student experiencing negative emotions such as frustration (Hawkins & Barbour, 2010). Studies by Hawkins and Barbour (2010) and Rice (2006) reported that attrition rates are higher in K-12 OLEs than in typical face-to-face environments. One reason given for higher attrition rates is frustration due to lack of feedback (Watson, Gemin, Ryan, & Wicks, 2009).

Poor performance. In a study by the U.S. Department of Education (2017) involving a meta-analysis of studies comparing OLEs with face-to-face instruction, analysts reviewed and summarized studies contrasting different versions of online learning. For example, Beck & LaFrance (2017) compared 100% online learning with classes that combined online and face-to-face interactions. The study concluded that combining online and face-to-face elements achieved significantly better outcomes than those of purely face-to-face instruction and purely online instruction (Beck & LaFrance, 2017). However, studies using performance data have found that full-time K-12 online schools underperformed when compared to traditional face-to-face schools, even though there has been an argument that virtual schools cannot be evaluated on test scores only (Wang & Decker, 2014). Indeed, Beck & LaFrance (2017) concluded there currently does not exist a framework for evaluating online schools. According to the National Education Policy Center (Miron & Urschel, 2012), the Annual Yearly Progress measures for K-12 virtual schools were substantially lower than the ratings for the brick-and-mortar schools. Only 27.4%

of the virtual schools met Annual Yearly Progress, compared to 51.1% of the brick-and-mortar schools. Math and reading assessment scores data across grades 5-11 showed that virtual schools were behind traditional schools by 5-12%. Concerning graduation rates, K-12 online schools had an average rate of 50% as compared to 74% for traditional schools (Miron & Urschel, 2012).

Summary

Based on the literature, the current problem facing K-12 education is increasing enrollments but fewer financial resources and teaching personnel. In efforts to bridge the gap, K-12 schools are resorting to technology as a means of delivering learning, with the promise of lowering cost, providing access to students who are at risk of dropping out, and access to highly qualified teachers. However, K-12 online learning has the disadvantages of learner isolation, lack of support, high attrition rates, and poor student performance. As noted, there is a lack of empirical studies focused on student online experiences in K-12 OLEs. It is important to understand student perception of their online learning context for K-12 OLEs to be effective (US Department of Education, 2017). Such information can be important to teachers in designing and delivering courses in such a way as to minimize the negatives effects. Understanding a student's perception of TD in the context of K-12 OLE can have significant implications on the design of online courses to bridge the separation between teachers and learners.

Transactional Distance Theory

TD is defined as the perception of psychological distance between teachers-students, between students-students, and between students-learning content (Moore, 1993). The theory seeks to define the elements of educational transaction that influence the perception of separation in distance education. These elements are not only influenced by geography but by methods of interaction used between teachers, learners, and the learning environment (Moore,1993; Moore

& Kearsley, 2005). According to the theory, TD exists in all kinds of educational settings including face-to-face learning where the teacher and learner are in the same space (Moore & Kearsley, 2005). The distance is not entirely dependent on geographical proximity but by the instructional pedagogy and methods of interactions between instructors, learners, learning content, learning interface, learning environment and the extent to which the interaction occurs (Huang et al., 2016; Moore, 1993).

Evolution of the Theory

The concept of TD was first defined by John Dewey (Dewey & Bentley, 1949) and further developed by Boyd and Apps (as cited in Moore, 1980, p. 6). They described the TD constructs as being dependent on the environment, the learners, and the pattern of behavior in a given context. Moore expanded on the theory by defining transaction as distance education (Moore, 1993). He stated that the separation between the teachers and learners creates a unique environment with special teaching and learning behaviors (Moore, 1993). Several studies, which will be subsequently described, have since been carried out to verify the empirical status of the transactional distance theory. Saba and Shearer (1994) aimed at empirically verifying TD and its constructs in distance learning. Participants for the study were selected from graduate students who worked one-on-one with an instructor. Data were collected by videotaping and recording interactions between the students and the instructor. Using discourse analysis (i.e., comparing spoken and written communication) between the instructor and the learners, they developed a way of measuring the variables of interest and the raw data for simulating the interrelationships between the variables. Their results strongly suggested that TD varies dynamically on dialogue and structure. As Saba and Shearer (1994) concluded, “An increase in the level of learner control increased the rate of dialogue, which in turn decreased the level of TD; an increase in the level of

instructor control increased the rate of structure, which in turn increased the level of transactional distance” (p. 54). Bischoff, Bisconer, Kooker, and Woods (1996) assessed students’ perception of TD on 221 postgraduate students using an investigator-developed tool that measured elements of dialogue, structure, and TD within traditional and distance courses. Analyses of the principal components, internal consistency and reliability verified the presence of three factors: structure, dialogue, and TD. Dialogue was found to be greater in the distance courses than in traditional face-to-face courses. Distance courses did not differ from traditional courses on the amount of structure or TD (Bischoff et al., 1996).

Chen and Willits (1998) attempted to verify the earlier finding by Saba and Shearer (1994). The study involved 121 learners’ experiences with videoconferencing and used path analysis to examine the postulates of Moore’s Theory of Transactional Distance. They concluded that high TD led to low student outcomes. Also, when they factored in the learning environment involving in-class discussions, they found that dialogue contributed positively to learning outcomes, but structure and learner autonomy had no significant effect. Furthermore, the data suggested that, when the learner outcomes were evaluated only in terms of student’s perception, the relationships among the constructs were only partially supported. Chen (2001a) extended the Chen and Willits (1998) study of TD to Web-based learning environments. Investigating 71 students in adult education at four Taiwanese University, students answered a questionnaire on their perception of TD. Exploratory Factor Analysis of the data found four dimensions of TD: instructor-learner, learner-learner, learner-content, and learner-interface TD. Chen (2001b) investigated the effects of four factors (i.e., learner skill level with the Internet, previous experience in taking distance education courses, the extent of interactions and types of learner support) on TD. The study found that both the student’s skill level and the

extent of interactions between instructor and learner had significant effects on TD. However, the study found that previous experience did not have an impact on TD.

Zhang (2003) extended on Chen's study (2001a) by investigating the four dimensions of TD [i.e., TD between student and student (TDSS), TD between student and teacher (TDST), TD between student and content (TDSC), and TD between student and interface or LMS (TDSI)]. One hundred college students answered a 200-item questionnaire on their perception of TD in Web-based learning environments. Results of EFA concluded that the four dimensions model of TD was acceptable. Furthermore, the study found that the strongest factor in determining perceived TD was TDSS, followed by TDST, and then by TDSC. Gorsky and Caspi (2005) reviewed empirical studies that attempted to validate TD theory (Moore, 1993). The study found that existing empirical data did not support or validate the basic tenets of the transactional distance theory. Furthermore, the study proposed the reduction of the theory into a single tautology that states, "As dialogue increases, TD decreases".

Using a different approach, Chen, Kinshuk, Hsieh, and Yang (2006) applied a hybrid model to evaluate TD in online learning. Employing mathematical algorithms, they developed a model that takes input parameters in classrooms such as seating arrangements, student-teacher and student-student proximity. The model then calculates the amount of TD in a traditional face-to-face setting. Using the same algorithm for online learning, the model took inputs based on online activities such as student/teacher, student/content, and student/student interactions. To empirically verify the relations, the study used a validated instrument to elicit student perception towards TD. The study results validated the mathematical model on that level student-student interaction and student-teacher interaction have effects on TD and its constructs. Goel, Zhang, and Templeton (2012) attempted to bridge the gap between the TD theory's tenets and its

empirical validity. One-hundred and twenty college students answered a questionnaire on the perception of TD and on their intentions to return for another e-learning experience. The study found strong evidence that TD positively impacted an individual's intentions to return for another e-learning course.

The studies above mainly focused on verifying the TD theory based on the student's perception of TD. Chen, Kinshuk, Hsieh, and Yang (2006) deviated from this approach and used a hybrid approach that involved both an algorithm that calculated the TD directly and an empirical component that relied on student's perception. In both approaches, there was strong evidence verifying the theory's constructs and the inverse relationship between TD and dialogue. There is no convergence on relationships between TD and structure or TD and learner autonomy. Even where there was evidence, it was not strongly supported. This lack of agreement on the relations between TD and the constructs is further validated by Gorsky and Caspi's (2005) examination of published works on TD. Gorsky and Caspi (2005) concluded that most studies have found an inverse relation between TD and dialogue. Few studies, except for Chen (2001b) and Goel, Zhang, and Templeton (2012), have investigated and validated the impact of other factors of TD. Moreover, the interpretations of TD deviated from the original definition because there was no direct way of measuring understanding/misunderstanding between the teacher/student and student/student (Goel et al., 2012). Most of these studies failed to include all the constructs in the full theoretical model. The inconsistencies stemming from a lack of definitional clarity from the studies above have failed to yield consistent support for the theory (Goel et al., 2012).

To harmonize the different approaches, Huang et al. (2016) developed the Transactional Distance Instrument (TDI). The TDI measures each construct using Moore's original TD definition but uses the measurement in using modern OLE. This instrument would be relevant for this study by empirically verifying the relationship between the constructs and investigating the effect of the use of modern communication technologies in a K-12 education OLE.

How TD is constructed in this study

Moore (1991) defined TD as a psychological distance that needs to be crossed by teachers and learners for learning to take place. He suggested that TD was influenced by three constructs: dialogue, structure, and learner autonomy. Moore further suggested that the distance is not spatial or temporal but relates to the understanding between teachers and learner. Thus, Moore's original theory applies to both synchronous and asynchronous learning environments. However, communications technology advances have improved the quality of synchronous and asynchronous communications and thus most studies comparing face-to-face learning with online learning have found no significant difference in TD (Gorsky & Caspi, 2005). In addition, previous studies on the theory have lacked a direct measuring understanding or misunderstanding between the instructor and learners (Chen, 2001a, 2001b; Chen & Willits, 1998; Saba & Shearer, 1994). More recently, researchers have sought to measure the understanding aspect by considering transaction distance as multi-dimensional construct that includes both teacher-learner and learner-learner understanding (Caspi & Gorsky, 2005; Chen, 2001b, Huang et al., 2015)

This study takes the position of Caspi and Gorsky (2005) by arguing that the understanding or misunderstanding aspect of TD is a separate construct that is very important to

consider and should be measured directly. This position agrees with Moore’s original definition that suggested that the distance is transactional and not temporal or spatial (1991, 1993).

The Constructs

TD is influenced by three interrelated constructs: (a) the structure of the course, (b) the dialogue between the teacher and learner and (c) learner autonomy (Moore, 1993). Figure 1 shows TD and the constructs. Each construct will be described in detail.

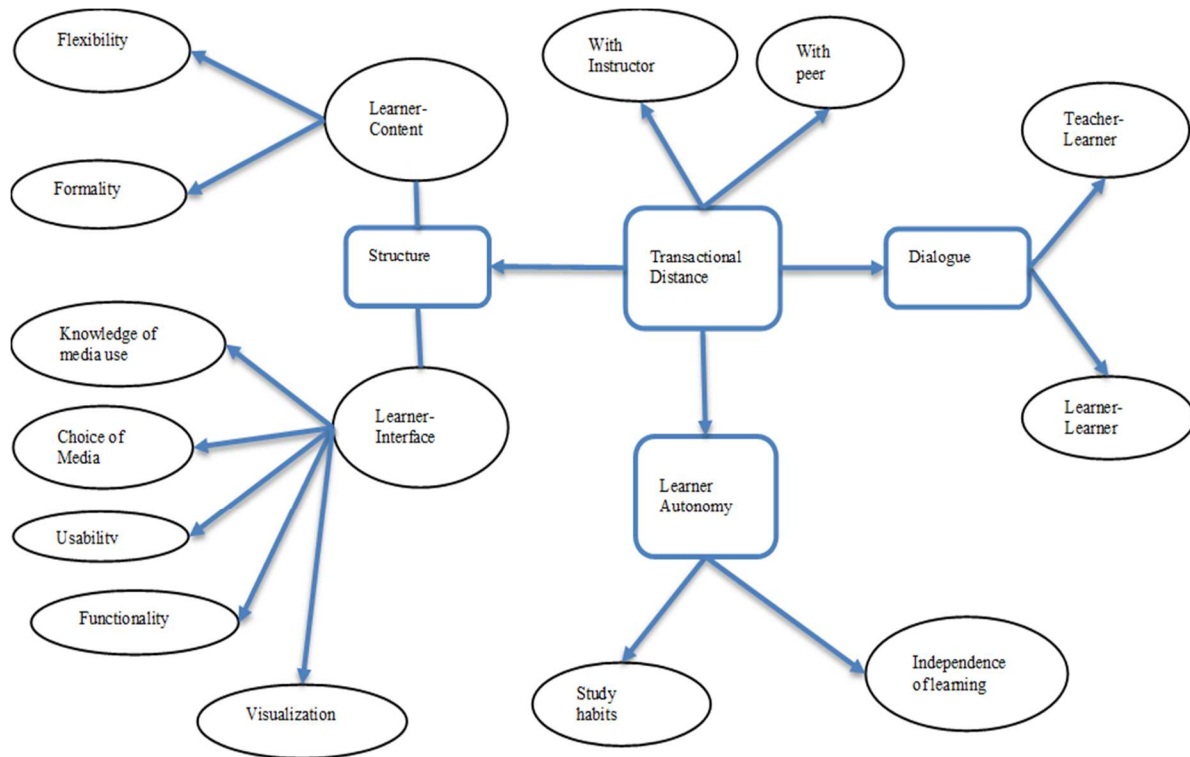


Figure 1. Overview of the relations among the transactional distance constructs (Adapted from Huang et al., 2016).

Structure. Structure is the extent to which a course can be responsive to the learning needs of individual students (Moore, 1993). Course structure can refer to course design elements such as course layout, the conceptual framework that ensures consistency across units, or the extent of rigidity and flexibility in course organization and delivery (Kearsley & Lynch, 1996; Moore, 1991, 1993; Stein et al., 2005). Course layout refers to how course materials are divided into units or modules and how accessible course resources and tools are available. Decisions on course layout can be dictated through the LMS which can provide course design templates. These templates define how and when communication (dialogue) takes place, or they can identify how many times and ways the course tools and resources are assessed by the learners (Huang et al., 2016). With advances in technology, LMSs are providing more flexibility for course designers and increasing the potential for more customization of structure for learners. Course menus or page organizers can show the course layout. Depending on the course layout, course elements can be easy or intuitive to navigate for the learner, thus necessitating a course structure that is flexible for the learner and accommodative of them (Stein et al., 2005; U.S. Department of Education, 2017; Wikeley & Muschamp, 2004). The ability of students to navigate units and modules in a course has been used to measure how well a course is designed (Stein et al., 2005). Indeed, a high student satisfaction has been equated with good designs and good structure (Stein et al., 2005). From the above conceptualization, structure can also be thought of as the extent of rigidity or flexibility. Rigidity and flexibility are present in both the course layout and the conceptual frameworks used to design the course (Kearsley & Lynch, 1996). Rigidity and flexibility address such questions as to how students can move ahead in the

course or if sections of the course are selectively released (i.e., granting access to materials after successful completion of previous assignments; Wikeley & Muschamp, 2004). Highly rigid courses provide maximum possible guidance and leave no room for the learners to creativity interact with content (Moore, 1993). In contrast to the above conceptualizations, Chen and Willits (1999) used environmental factors such as class sizes, activities and seating arrangement to measure structure.

Benson and Samarawickrema (2009) considered structure as having two sub-constructs: (a) learner-content interaction and (b) learner-interface interaction (see figure 1 above). Huang et al. (2016) further identified five elements of learner-interface interaction: a) usability, b) visualization, c) functionality, d) media use, and e) cognitive load required to learn the technology. Usability relates to the intuitiveness of the navigational components of the course. Visualization refers to the cosmetic aspects of the interface's look and the coherence of the interface's visual organization. Functionality refers to how useful the interface is in engaging the learner with course content during learning. Media use relates to the overall role of OLE as an information delivery system and as a platform for student interaction with content, instructor, and other learners (Benson & Samarawickrema (2009). For this study, we focus on the element of cognitive load referred to as mental effort (i.e., the amount of effort required to learn the technology) (Paas, van Merriënboer, & Adam, 1994). According to Shea et al. (2016), the less intuitive an interface is, the higher the level of mental effort and vice-versa. The structure of the program is an adjustable variable that can be changed with modifications in the course design within the OLE (Shea et al., 2016). According to Moore (1991), high structure leads to high rigidity which leads to high student perception of TD.

Dialogue. Dialogue has been defined as the degree of communication between the teacher and student and between student and student (Benson & Samarawickrema, 2009). Moore (1993) stated that a dialogue is

purposeful, constructive and valued by each party. Each party in a dialogue is a respectful and active listener; each is a contributor and builds on the contributions of the other party or parties. The direction of a dialogue in an educational relationship is towards the improved understanding of the student (p. 24).

The theoretical construct of dialogue can be broken down further into elements of learner/learner, learner/teacher, and learner/content interaction (Ekwunife-Orakwue & Teng, 2014). With advances in technology that provide multiple channels of interaction, researchers have proposed the broadening of Moore's (1993) definition of dialogue to include learner-learner and learner-content interactions that occur during instruction (Benson & Samarawickrema, 2009; Chen & Willits, 1999). Ekwunife-Orakwue and Teng (2014) and Mbvesa (2014) investigated learner-instructor, learner-learner, and learner-content interactions. Mbvesa (2014), using a sample of 168 online students at the University of Nairobi, Kenya, explored the effect of perceived TD on student satisfaction. Mbvesa (2014) concluded that learner-instructor, learner- learner, and learner content dialogic interactions were strong predictors of student satisfaction. Ekwunife-Orakwue and Teng (2014) included both student satisfaction and student outcomes in their study involving 342 online students. They concluded that learner-content interaction had a higher effect on student satisfaction than learner- learner, learner-instructor, but that dialog, in general, did not influence students' final grades.

The conclusions by Ekwunife-Orakwue and Teng (2014) and Mbvesa (2014) seem to agree with Chen and Willits (1999), who had earlier suggested that dialogue effects on TD

depended on different types of dialogue. For example, asynchronous interactions were found to be less significantly correlated to TD, perhaps because of less frequency of interaction and time delay. The learner-content aspect of dialogue may also be influenced by the learner's computer literacy (Chen, 2001b) while the learner-learner interaction may be influenced by the presence of modern communication tools that offer richer and more interactive channels (Huang et al., 2016). Furthermore, the availability of multiple communication channels provides for a variety of ways that the learner can interact, resulting in more dialogue (Huang et al., 2016).

Dialogue also depends on the student's and instructor's responsiveness to the type of communication, subject, teacher personality, learner ability, linguistic differences, and on the level of structure (Bischoff, Bisconer, Kooker, & Woods, 1996). Previous research by Chen & Willits (1999) concluded that, when measuring dialogue based on the quantity and frequency of interactions, dialogue includes both learner-instructor and learner-learner interaction. However, according to Huang et al. (2015), measuring dialogue this way may seem counterintuitive to Moore's original definition. Moore's original definition of dialogue focused on the quality of interaction (e.g., "purposeful," "constructive," "positive," and "valued by each party") (1993, p. 24). According to Moore (1991), increasing dialogue also increases flexibility and correspondingly reduces structure and the student perception of TD.

Learner autonomy. Moore (1993) defined learner autonomy as the ability of students to share responsibility for their learning processes. Moore stated that learners being self-directed indicates the level of learner control during the learning process (Moore, 1991, 1993). Learner autonomy has been described as the degree to which learners make choices on their learning and the degree to which they construct their own knowledge based on their experiences (Moore and Kearsley, 1996). Learner autonomy is not open to direct manipulation by the instructor as

structure and dialogue (Moore, 1991, 1993). Moore (1993) described learner autonomy as self-directedness and not emotionally dependent on the teachers. Less self-directed learners need more help from the teacher and require a tighter structure (Moore, 1991, 1993). Thus, according to Moore, TD and learner autonomy are directly proportional; the greater the TD the more learner autonomy a student must exercise. Moore asserted that programs with more structure and less dialogue will necessitate the learner exercise more autonomy; and, thus the program's TD will increase (Moore, 1993).

From the definitions above, the theory suggests that there exist physical and temporal barriers between teachers and learners in distance learning. These barriers result in pedagogical issues that can be overcome by the structure of a course and dialogue between a teacher and learner.

Relationship Between Transactional Distance and the Constructs

There is no consensus, theoretical or empirical, on the relationship among dialogue, structure, learner autonomy, and TD (Huang et al., 2016). There has been a general agreement that there exists an inverse relationship between dialogue and TD (i.e., as dialogue increases, TD decreases) (Benson & Samarawickrema, 2009; Kearsley & Lynch, 1996; Moore, 1991, 1993; Saba & Shearer, 1994).

The relationship between TD and structure is the least defined and least agreed on in literature. The few studies that have empirically investigated the relationship have found different results. The reason for this lack of agreement is based on the question of how the level of structure affects the level of dialogue and consequently affects the level of TD (Benson & Samarawickrema, 2009; Kearsley & Lynch, 1996; Moore, 1991, 1993; Saba & Shearer, 1994). Similarly, the relationship between TD and learner autonomy has been defined based on the

inverse relationship between structure and dialogue. Moore (1993) stated the program with more structure and less dialogue necessitates the learner exercise more autonomy and therefore experience more TD (Moore, 1993).

Moore (1993) proposed that structure and dialogue vary inversely in a context where video and audio are used for one-way lectures. Similarly, Saba and Shearer's study (1994) concluded that an inverse relationship exists between dialogue and structure. However, the students in the study had one-on-one communication with their teachers over the phone; thus, doubts were raised about the validity of the findings. No studies on OLE have found a direct relation between dialogue and structure (Kearsley & Lynch, 1996; Wikeley & Muschamp, 2004).

Researchers have proposed paired models of structure and dialogue. Four interactive effects of dialogue (high or low) and structure (high or low) have been proposed to explain the theoretical model. There is a consensus that high dialogue, high structure (+D+S) and high dialogue, low structure (+D-S) formats are the most effective in reducing TD, but low dialogue, low structure (-D-S) is the least effective and leads to the most TD. High dialogue, low structure (+D-S) and low dialogue, high structure (-D+S) leads to moderate TD (Benson & Samarawickrema, 2009; Moore, 1991, 1993; Moore & Kearsley, 2005).

From the studies above, there exists a dynamic relationship between dialogue, structure, learner autonomy, and TD. Understanding the relationships is vital to understanding the theoretical model in the context of OLE. The relationship between TD and structure, dialogue, and learner autonomy needs to be further examined empirically due to the different contexts and interpretations, limited number of studies, and the progress made in modern OLEs (Chen, 2001a, 2001b).

Criticism of Transactional Distance Theory

TD theory has also been criticized as having ambiguous definitions and measurements. Most of the studies on TD have been criticized for their lack of construct validity or for providing limited empirical data to support the theory (Gorsky & Caspi, 2005). Advances in Web technologies that offer more interactive and flexible means for dialogue and structure in the context of online distance education have not been included in the studies (Huang et al., 2016). To date, few studies have explored the theoretical model in current online learning distance courses (Huang et al., 2016). The literature has expressed concerns on the lack of agreement on the operational definitions of the constructs and how they are related (Dron, 2005; Garrison, 2000; Giossos et al., 2009; Gorsky & Caspi, 2005). Dron (2005) claimed that the theory's unclear definitions of the constructs have resulted in different interpretations of the theory. This position is further supported by Garrison who stated, "that the definitions of structure and dialogue made it unclear whether they are variables, clusters or dimensions" (2000, p. 5). However, despite criticism of the theories inability to consistently explain and/or predict relationships between constructs in e-learning, researchers have advanced the concept of TD and continued to explore its implications and usefulness as a framework for analyzing distance learning (Huang et al., 2016; Kassandrinou et al., 2014).

Effect of Environment and Demographic Factors on Transactional Distance

Moore (1993) proposed that other factors, in addition to structure and dialogue, could affect the TD perceived by learners in distance learning. Moore (1993) argued that environmental and demographic factors affect TD indirectly due to their effect on structure and dialogue. For example, the type of communication media used can affect the quality of dialogue. In some instances, online classes using one-way communication such as recorded videos for

communication might offer less interaction between the teacher and learner than classes using two-way communication such as Web conferencing (Moore, 1993; Moore & Kearsley, 2005). Additional factors such as class size, previous online experience, and students learning preference could affect the TD perceived (Moore & Kearsley, 2005). In addition to environmental factors, Shearer (2009) proposed that demographic factors such as age, gender, and ethnicity could have an impact on perceived TD. However, few studies have empirically investigated the effect of environmental and demographic factors on the TD perceived by a learner in OLEs.

Transactional Distance in Modern OLE

According to Moore's original definition of TD (1993), perceived TD depends on dialogue, course structure, and learner autonomy. This definition of transactional distance has been well established and is accepted as the pedagogical theory of distance learning. However, the relationship between the constructs has not been backed with empirical verification in the context of a current OLE (Huang et al., 2016). Newer and more advanced technologies, such as Web 2.0 and LMSs do have an impact on TD. More empirical evidence is needed to verify the effects on TD in modern e-learning environments (Benson & Samarawickrema, 2009).

Benson and Samarawickrema (2009) used the TD theory to analyze the broad characteristics of OLEs to identify any implications for modern e-learning designs. They concluded that structure and dialogue are inversely related. At the same time, high levels of structure combined with low levels of dialogue results in large TD. Thus, increasing dialogue has major implications for online courses, although TD is also influenced by learner autonomy.

Garrison (2000) noted that learner autonomy is not easily explained as it may refer to personal learner autonomy or autonomy associated with the learning materials and may also depend on the characteristics of individual learners. Since TD is high in online contexts, a course with high dialogue and high structure (+D+S) is imperative to bridge the distance (Benson & Samarawickrema, 2009).

Huang, Chandra, DePaolo, Cribbs, and Simmons (2015) developed the Transactional Distance Instrument by considering each construct as multidimensional and composed of sub-scales as shown in Table 1.

Table 1
Transactional Distance Constructs and Sub-scales

Construct	Sub-scale
TD	TD with teachers TD with peer
Dialogue	Teacher-student dialogue Student-student dialogue
Structure	Learner-content Learner-interface
Learner Autonomy	Independence of learning Study habits

Using Likert-type scale questions, the tool was developed by focusing on students' responses to their perception of the subscales in an OLE (Huang et al., 2015). The Transactional

Distance Instrument was used to collect data from a higher education e-learning setting and sought to understand how modern environmental factors such as communication impacted students' perception of TD. Using nine hypotheses, the study sought to empirically verify the theory and determine how TD was impacted by instructional media, class size, participation in group discussion, previous online courses taken, and preference for online courses. The studies found a similarity in the perceived TD among the students in classes using live audio communication media as opposed to those using live text communication and one-way broadcast audio/video (Huang et al., 2015). However, post hoc tests revealed that students in classes using only email and/or discussion forums perceived significantly higher TD. Also, the study found that students in online classes that used Web 2.0 tools - such as blogs, wikis, and Twitter - reported significantly lower TD than students in classes using asynchronous text-based communications (Huang et al., 2015). These observations suggest that modern technology tools could be used to reduce TD (Huang et al., 2016).

Huang et al. (2016) verified an inverse relationship between high structure and high learner autonomy classes (+D+S) and the degree of TD perceived by students. This relation supported the findings that +D+S results in the least TD, -D-S results in the highest TD, and -D+S and +D-S leads to TD between the two extremes (Benson & Samarawickrema, 2009; Moore, 1991, 1993; Moore & Kearsley, 2005). These finding converged with previous research that concluded the inverse relation between TD and learner autonomy and asserted that autonomous learners are more comfortable with high TD (Moore, 1991). Also, the findings negated the assertion that the relationship between structure and dialogue are inverse (Saba & Shearer, 1994). Huang et al.'s (2016) findings have significant implications for instructional design of online distance courses. Teachers and instructional designers must consider designing

online courses with high structure and high dialogue (+D+S) to achieve low TD especially for the less autonomous learners.

According to the literature reviewed in this section, the TD theory offers a framework for understanding distance learning. Theoretically, researchers have described the TD theory as being a function of structure, dialogue, and learner autonomy. Researchers have proposed paired models of dialogue (high or low) and structure (high or low) to explain the theoretical model (Benson & Samarawickrema, 2009; Moore, 1993). Research on empirical verification of the theory and models have evolved over the years and resulted in different interpretations with no consensus on the relationship among the constructs. To date, few studies have investigated TD in online learning. Huang et al. (2015) considered each construct as a multidimensional entity composed of sub-scales (Table 1) and developed an instrument that measures the student's perception of each construct based on those sub-scales. Huang et al.'s (2016) study adds a better and comprehensive understanding of the relationships among structure, dialogue, learner autonomy, and TD in modern OLE.

Summary

Based on the research reviewed, online distance programs offer schools in K-12 education a solution to addressing the problems of increasing enrollment, reduced financial resources, and a decrease in access to highly qualified teachers. Despite this promise, a physical and temporal barrier exists between teachers and learners in distance learning. This barrier must be overcome for effective learning to occur. The TD theory offers an important framework that can be used to evaluate and understand teacher-learner separation in online learning. Despite its wide recognition as an important pedagogical theory in distance education, gaps in the literature persist due to lack of agreement on the definitions of the constructs and how they relate. The

studies reviewed in this chapter offer several approaches to measuring and understanding both TD and its related constructs of structure, dialogue, and learner autonomy. Because there is no agreement on the relationships among the constructs, it is important to empirically verify the relationships due to the different interpretations. Furthermore, there is a lack of studies that have empirically investigated and verified the TD in K-12 online learning (Huang et al., 2016).

Huang et al. (2016) adds a more comprehensive understanding of the relationships among structure, dialogue, learner autonomy, and TD in modern OLE. Although the study was contextualized in e-learning for higher education, the findings can be very useful in understanding TD in K-12 education OLE. The sample from grades 7-12 online learners is unique due to the difference in geographical locations, age, and level of interaction between teachers and learners; these differences imply findings from higher education cannot be assumed to generalize in the K-12 OLE. Thus, a replication of the study in K-12 online would be necessary to empirically verify the theory and determine its generalizability across different age groups by collecting data using the same instrument and applying the same methods (Huang et al., 2015; Huang et al., 2016).

Furthermore, considering the advances in LMS technology and the evolution of computer-mediated communications, it is important to investigate how environmental and demographic factors influence the perception of TD in online learning. Studies reviewed suggest that the use of modern technology, as availed by modern LMS affordances in communication and interaction, could have an impact on increasing dialogue and thus reversing TD. For example, students who use modern synchronous two-way channels could perceive less TD than those who use asynchronous communication. In addition, there are no studies that have investigated the effect of demographic factors in grades 7-12 OLE. Thus, there exists a gap in the

knowledge of how modern learning environments and demographic factors impacts TD. This knowledge can have great implications on the design and delivery of K-12 online courses.

Thus, this study seeks to add to research on TD by focusing on three areas:

1. Empirically verifying the relationships among dialogue, structure, learner autonomy, and perceived TD in grades 7-12.
2. Empirically investigate the effect of environmental factors on TD perceived in grades 7-12 OLE.
3. Empirically investigate the effect of demographic factors on TD perceived in grades 7-12 OLE.

The answers to these three focus areas could have significant implications for the instructional design of OLE-based distance courses and may add to the knowledge on the most effective and efficient ways of implementing learning in modern OLEs to both minimize TD and potentially increase student success in K-12 distance learning.

CHAPTER THREE: METHODOLOGY

Introduction

The purpose of this quantitative study was to empirically verify the relationship between TD and its constructs and to investigate the impact of environmental and demographic factors on TD perceived in online courses taken by middle and high school students in grades 7-12. This study sought to contribute to research on TD in grades 7-12 in an OLE by replicating the study by Huang et al., (2016) guided by the same research questions:

1. How do structure, dialogue, and learner autonomy interact and impact student perceptions of TD (Huang et al., 2016)?
2. How do environmental factors (i.e., instructional media, class size, required courses, required participation in group discussions, number of previous online courses taken, preference for online courses, school type, and grade) impact student-perceptions of TD (Huang et al., 2016)?
3. How do demographic factors (i.e., gender and ethnicity) impact student perceptions of TD (Huang et al., 2016)?

Research Design

The design for this study was quantitative, using both correlational and causal-comparative designs (see Table 2). This chapter includes a description of the participants and learner characteristics, instrumentation, the consent process, and data collection procedures and analysis. The chapter ends with a brief mention of the limitations and delimitations.

Table 2
RQs, hypotheses, variables, and design

RQ	<i>H</i>₀	Null Hypothesis	Variables	Design
1	1.1	No significant correlation between dialogue and perceived TD.	Dialogue (IV) Transactional distance (TD) (DV)	Correlational design.
	1.2	No significant correlation between structure and perceived TD.	Structure (IV) TD (DV)	
	1.3	No significant correlation between learner autonomy and perceived TD.	Learner autonomy (IV) TD (DV)	
	1.4	High dialogue and high structure (+D+S) have no significant effect on student perception of TD.	+D+S (IV) -D-S (IV) -D+S (IV) +D-S (IV) TD (DV)	Causal comparative design.
	1.5	Low dialogue and low structure (-D-S) have no significant effect student perception of TD.		
	1.6	Low dialogue-high structure (-D+S) and high dialogue-low structure (+D-S) leads to a TD between high dialogue-high structure (+D+S) and TD perceived		

Table 2 (continued)
RQs, hypotheses, variables, and design

RQ	H_0	Null Hypothesis	Variables	Design
2	2.1	No significant difference in TD perceived when different presentation media are used.	Students who used: <ul style="list-style-type: none"> • Live audio/video communication (IV) • Live audio communication (IV) • Live text (IV) Communication • Broadcast audio/video (IV) • Email and/or discussion forums (IV). • TD (DV) 	Causal comparative design.
	2.2	No significant difference in TD perceived when synchronous and asynchronous communications are used.	Students who used: <ul style="list-style-type: none"> • Live text- communication + live audio communication + live audio/video communication (IV) • Email + discussion forums (IV). • TD (DV) 	
	2.3	No significant difference in TD perceived when audio/video communication and traditional text-based communication are used.	Students who used: <ul style="list-style-type: none"> • Broadcast audio + broadcast audio/video + live audio communication + live audio/video communication (IV). • Email + discussion forums (IV). • TD (DV) 	
	2.4	No statistically difference in TD perceived when Web 2.0 and text-based communications are used.	Students who used: <ul style="list-style-type: none"> • Web2.0 tools (blogs, wikis, Twitter) (IV) • Email + discussion forums (IV) • TD (DV) 	

2.5	No significant difference in TD perceived by students in smaller size classes and students in larger classes.	Students in: <ul style="list-style-type: none"> • Small classes (IV) • Large classes (IV) • TD (DV) 	
2.6	No significant difference in TD perceived by students who volunteered to take online classes and those who did not volunteer.	Students who: <ul style="list-style-type: none"> • Volunteered (IV) • Did not volunteer (IV) • TD (DV) 	Causal comparative design.
2.7	No significant difference in TD perceived by students who participate in group or class discussions and those who are not required to participate	Students who: <ul style="list-style-type: none"> • Participated in group discussion (IV) • Did not participate in group discussion (IV) • TD (DV) 	
2.8	No significant difference in TD perceived by students who prefer online classes and those who prefer face-to face classes	Students who: <ul style="list-style-type: none"> • Prefer online (IV) • Do not prefer online (IV) • TD (DV) 	
2.9	No significant difference in TD perceived by students who have previous online experience and those that do not.	Students who have: <ul style="list-style-type: none"> • Previous experience (IV) • No have previous experience (IV) • TD (DV) 	
2.10	No significant difference in TD perceived by students in middle schools and high schools	Grade: <ul style="list-style-type: none"> • Middle school students (IV) • High school students (IV) • TD (DV) 	

Table 2 (continued)
RQs, hypotheses, variables, and design

RQ	H_0	Null Hypothesis	Variables	Design
2.11		No significant difference in TD perceived by students in public schools and private schools.	School attended: <ul style="list-style-type: none"> • Public school students (IV) • Private school students (IV) • TD (DV) 	
3	3.1	No significant difference in TD perceived by male and female students.	Gender: <ul style="list-style-type: none"> • Male students (IV) • Female students (IV) • TD (DV) 	Causal comparative design.
	3.2	No significant difference in TD perceived by students from different ethnicities	Ethnicity: <ul style="list-style-type: none"> • White students (IV) • Non-white students (IV) • TD (DV) 	

Participants

The sampling design was convenience sampling because participants were conveniently available to potentially facilitate a short data collection time (Creswell & Creswell, 2017). The participants were selected from students taking year-long online science courses offered in both the public and private school settings. At the public online school, approximately 5,500 students from different schools throughout the school district take one or more online courses and approximately 250 students are full-time online students. The school offers students in grades 7-12 expanded academic options through online courses. Students may take up to two additional courses per semester while enrolled in their home school or enroll on a full-time basis and complete all courses in a 100% virtual environment. At the private school, about 75 students take online courses. This study focused on students who were enrolled full-time in online courses.

They focused on their year-long science course, which they were about 50% through at the time of the study. The science course was chosen to prevent students from selecting and rating their most or least favorite online courses during the study. Table 3 shows a summary of learner characteristics of students taking online courses at the schools

Table 3
Learner Characteristics

Characteristic	Public Online School	Private School
Age	12-19	14-19
Grades	7-12	9-12
Gender	Male and female	Male
Ethnicity	88% Black, 6% White, 4% Hispanic, 2% Other	94% White, 3% Black, 2% Hispanic, 1% Other
Social economic background	Low income/Middle class/High income families	High-income families
Comfort level using technology	Good ability with computers, electronics, mobile devices, Learning Management Systems (LMS)*.	Very good ability with computers, electronics, mobile devices, Learning Management Systems (LMS)**.

*Hilliard, M. (2020, January 14th). Personal communication.

**Scully, P. (2019, November 20th). Personal communication.

Power Analysis

To ensure a statistical test will have adequate power, an a priori power analysis was conducted to find the minimum sample size. The effect size (ES) $d = 0.5$ is large using Cohen's (1988) criteria.

An a priori power analysis was conducted using G*Power3 to test the correlation between two variables, with a large effect size ($d = .50$), and an alpha of .05. Result showed that a total sample of 64 participants are required to achieve a power of .95.

An a priori power analysis was conducted using G*Power3 to test the difference between independent 5 independent groups using ANOVA, with a large effect size ($d = .50$), and an alpha of .05. Result showed that a total sample of 80 participants are required to achieve a power of .95.

An a priori power analysis was conducted using G*Power3 to test the difference between two independent group means using a two-tailed test, with a large effect size ($d = .50$), and an alpha of .05. The result showed that a total sample of 74 participants with two equal sized groups of $n = 37$ are required to achieve a power of .95.

Thus, a proposed sample size of 150 will be more than adequate for the main objective of this study and should also allow for expected non-participation in the target sample (Cohen, 1988; Johnson & Christensen, 2008).

Consent Process

Parental consent (Appendix A) and participant assent (Appendix B) documents were sent electronically prior to data collection. The survey was set up so that potential participants clicked a checkbox and signed a signature field indicating they read the consent/assent information and

agreed to participate voluntarily. Once checked, the participant was automatically redirected to the questionnaire. At the same time, the investigator was notified by email automatically.

Setting

This study was conducted on middle and high school students taking online science courses at a private school and an online public school in a major metropolitan area with a population of about 1.5 million inhabitants. The reason for using different schools was to increase diversity and the potential for high participation. The table below summarizes the two settings.

Table 4
Settings

Characteristic	Public Online School	Private School
Online Student population	5,500 online students	75 online students
Teacher-Student ratio	1-35	1-12
Average Class Size	27	15
Instructor experience	5-10 years *	15-30 years**
LMS	Blackboard LMS*	Blackbaud LMS**
Graduation Rates	79.9%	99%
Online Learning location	Mostly at home*	At home and during study hall**
Access to technology, high-speed Internet (at home and/or at school)	All students have some access in the home, library, or computer lab*	All students have access at home and everywhere in the school building**

*Hilliard, M. (2020, January 14th). Personal communication.

**Scully, P. (2019, November 20th). Personal communication.

In both settings, all students must have access to a laptop, tablet, or desktop computer with Internet access as a precondition for taking online courses. The learning is mostly asynchronous. At the online public school, student learning occurs at different schools in the district during the school day or at home in the evening. The online public school uses the Blackboard PowerSchool LMS. Instructors use the LMS as a platform for designing and delivering the courses and modules from the school's curriculum. The school curriculum only offers courses in the core areas, namely, math, English and language arts, science, social studies, and foreign languages. The school district had a 79.9% graduation rate in the 2018/19 school year. The state average graduation rate for the same year was 89.9%. At the private school, the LMS used is Blackbaud. Blackbaud is used for student attendance, maintaining student grades, and handling all design and delivery of the course content to students. Most online learning at the private school occurs at home and in school during study hall. The private school had a graduation rate of 99% in the 2018/19 school year.

Although the Blackboard and Blackbaud systems are developed by different vendors, they offer similar features that have been customized for K-12 online learning functionality. The online course layout at both the public and private settings follows a similar and standard format for all courses in both LMSs (See Appendix K). The courses have an introduction to the course section, navigation information, course syllabus, course content, assessment, communication, and activities section. The LMSs allow teachers to customize these sections depending on the preferred course structure. Once students are logged into the LMS, they are presented with the course dashboard section. From the dashboard students can navigate to the content instructions

and the related assessments, assignments, discussion boards, due dates, etc. During the courses, students can see their progress in the progress bar. At any time during the course, students can communicate with instructors by sending messages using instant messaging, a chat forum, and email; all these services are available in the dashboard. In addition, students have Web conferencing and phone communication with teachers by appointment. Students can view feedback from their instructors on the dashboard. Student can participate in class discussion through the discussion board, depending on how and when the teacher requires them to post. Students can access the Internet and other online links provided by the instructor to support learning. Students enrolled in math, English, science, and language arts courses take those courses for the whole school year to earn one full credit toward their graduation. Students enrolled in foreign language courses take the courses only one semester to earn half a credit towards graduation.

Instruments

Data collection for this study was done in two parts, one using the environmental and demographics questionnaire and the second using the Transactional Distance Instrument. In the section below, the environmental and demographics questionnaire and Transactional Distance Instrument are described.

Environmental and Demographic Questionnaire

The environmental and demographic questionnaire (see Appendix C) had 11 questions: nine on environmental factors and two on demographic factors. The environmental factors considered were: communication types used in the class, whether the student volunteered to be in the class, whether the class is required, whether they prefer online or face-to-face classes,

whether they have previous online experience, whether they were in middle or high school, and school type (public or private). Demographic factors considered were ethnicity and gender.

Transactional Distance Instrument

The Transactional Distance Instrument (see Appendix D) was used to identify student perceptions of TD. The original instrument was developed on examinations of Moore's theory and subsequent research on TD (Huang et al., 2015). The original instrument used a 7-point Likert scale ranging from 1=strongly agree, to 7= strongly disagree (Huang et al., 2015). The instrument had 103 items that included: 23 items on TD, 25 items on dialogue, 42 items on structure, and 13 items on learner autonomy. As a result of expert review and Exploratory Factor Analysis (Huang et al., 2015), the items were reduced to 85. In the original instrument, TD included closeness, shared understanding, and perceived learning. These three items merged into learner-instructor TD and learner-learner TD (Huang et al., 2015). The original 103-item instrument conceptualized learner-content structure as having the elements of individualization, variety, and formality. In the new instrument, individualization and variety are merged into flexibility. This conceptualization is still consistent with the original definition of the term and reinforces that flexibility is allowed when both individualization and variety are built into formality (Huang et al., 2015). According to Huang et al. (2015), the Exploratory Factor Analysis results support its reliability and the conceptualization of TD in the theoretical model depicted in Figure 1 (see chapter 2).

Permission was granted by the developers to use the instrument for this study (see Appendix E). The instrument conceptualizes TD in a manner consistent with this study's context and age. The instrument items ask for student's responses to their perception of TD constructs in online courses.

Table 5 is a summary of the instrument questions on student perceptions of TD and its constructs.

Table 5
Instrument Questions on Student Perception of Transactional Distance

Construct	Question begins with	Purpose
TD	“I feel...”	To get a student's perception of belonging to the class
Structure	“The course structure is...”	To get a student's perception of the course’s structure.
Dialogue	“I communicate...”	To get student's perception of dialogue.
Learner Autonomy	“I take responsibility...”	To get a student's perception of learner autonomy.

To quantify the measure of TD, the student’s response value for each sub-scale was calculated as follows:

Student’s response score= [(Sum of student’s responses in the sub-scale)/total number of items in the sub-scale.

In the original study (Huang et al., 2016), the researchers used the mean of the scores to categorize responses as high or low. Generally, the use of means to categorize is inappropriate for ordinal data such as Likert scales (Allen & Seaman, 2007). In this study, scores were categorized as follows. A score of 5-7 (positively worded items) was considered as high (+), and a 4 (neutral worded) medium, while score ranging 3-1(negatively worded) was categorized as

low (-) (Harpe, 2015). Students who scored exactly 4 in either dialogue or structure were removed from the analysis. Scores in the 4.01 to 4.99 were included in the high (5-7) category and scores in the 3.99 to 3.01 were included in the low category (1-3). As stated by Garrison (2009), understanding transactional distance depends upon whether TD is considered as a single continuum. To measure the level of each construct, this research adapted the conceptualization of a single continuum, ranging from a minimum of 1 to a maximum of 7, as dictated by the instrument's Likert scale (Dron et al., 2004, Garrison, 2009).

In this study, TD was considered as the psychological distance that creates a separation between learners and learners, and between teacher and learners (Moore 1993), implying a smaller separation is desired. Thus, TD responses score of 7 (strongly disagree) were interpreted as high separation and a score of 1 (strongly agree) interpreted as a low separation (Huang et al., 2016). On the other hand, high structure score of 7 (strongly disagree) implied low structure and a 1 (strongly agree) implied high structure. A high dialogue score implied a low extent of communication between teacher/student and student/student and vice-versa. A high learner autonomy score implied a low ability of the learner to work independently and vice-versa. Thus, TD scores were reverse coded (Huang et al., 2016)

Procedures

Upon IRB approval and approvals from the online and private school principals, the online school's liaison, in collaboration with the enrollment specialist generated a mailing list of parent names, student names, and emails from the school's enrollment database. From this list, an initial recruitment email (see Appendix F) was sent to 280 parents of the online public-school students by the school's liaison. The recruitment email notified them that they will be receiving information about the study. The initial recruitment email was followed by emails to parents with

instructions on consent and assent procedures at both settings. Table 6 provides a summary of the procedures that were followed for the data collection in this study in both the online and private school settings.

Table 6
Summary of Data Collection Procedures

Week	Day	Event
1	1	<ul style="list-style-type: none"> • An initial recruitment email was sent to parents at both settings,
	3	<ul style="list-style-type: none"> • Second email was sent to parents along with the consent document. • More email reminders will be sent as necessary. • Automatic email was sent to the investigator for parents who gave consent by checking a box and signing indicating that he/she has read the consent/assent information and agreed to participate.
2	1	<ul style="list-style-type: none"> • Investigator sent an email to students whose parents consented, informing them about the study and its significance, and including all information regarding the research, the voluntary nature of their participation, and the incentive for participation. • The email asked for their assent to participate in the research by opening the Qualtrics link and checking the assent checkbox and signing the signature pad. • Students who assented by checking a box and signing indicated that they had read the consent/assent information and agreed to participate. Students who consented were directed to the environmental and demographic questionnaire; otherwise they were directed to end of the survey. • Upon completion of the questionnaire, they were automatically directed to the TD survey.
	3	<ul style="list-style-type: none"> • First reminder via email was sent to parents who had not replied.

Table 6 (continued)
Summary of Data Collection Procedures

Week	Day	Event
3	1	<ul style="list-style-type: none"> • First reminder email was sent to all students whose parents had consented but had not participated.
	4-5	<ul style="list-style-type: none"> • Second reminder via email was sent to parents who had not replied at both settings. • Second reminder via email was sent to students who had not participated in both settings.
4	1	Third reminder via email was sent to students who had not participated in both settings.
5	1	Fourth reminder via email was sent to students who had not participated in both settings.

The process took about five weeks. As an incentive for participating, each student who participated had their names entered for a drawing where they could win one of five \$20 gift cards. To make sure that students did not take the survey more than once, the survey protection feature in Qualtrics was used to prevent duplicate responses.

Data Analysis

This section provides a brief description of the research questions, the analysis technique used, and how the variables were calculated. This is followed by descriptions of analytical techniques and the assumptions that were tested for each technique.

Research Question 1

Research Question 1: To what degree, if any, do perceived structure, dialogue, and learner autonomy interact with students' perception of TD?

For hypotheses 1.1 through 1.3, a correlational design using the Pearson correlation was used to test the magnitude and direction of the relation between the constructs and the TD perceived by the students (Creswell & Creswell, 2017; Johnson & Christensen, 2008). Table 7 shows the hypotheses, the variables, data sources, and the analytic techniques for RQ1 (Hypotheses 1.1-1.3).

Table 7
Research Question 1: Hypothesis 1.1-1.3

Hypothesis	Variables	Data Source	Data Analysis
1.1	Dialogue (IV) TD (DV)	TDI (TD items 66-85, Dialogue items 1-20)	Pearson correlation
1.2	Structure (IV) TD (DV)	TDI (TD items 66-85, Structure items 22-55)	Pearson correlation
1.3	Learner Autonomy (IV) TD (DV)	TDI (TD items 66-85), Learner autonomy items (56-65)	Pearson correlation

After the collection of data from the TDI, variables for the four interactive effects of the student's perception of dialogue and structure were obtained (Huang et al., 2016) as explained below. The aim of hypotheses 1.4 to 1.6 is to verify the impact of different interactions of student perception in dialogue and structure with the TD perceived. The four levels (+D+S, +D-S, -D+S, -D-S) for this analysis were categorical while the TD data from the instrument are continuous (Howell, 2008; Huang et al., 2016; Rovai, Baker, & Ponton, 2013). A causal-comparative method was used. The categories were obtained by based on the student's perceived dialogue and structure response as follows:

1. +D+S (high dialogue, high structure): A student was categorized as +D+S when the dialogue and structure scores were both in the high range (4.01-7).
2. +D-S (high dialogue, low structure): A student was categorized as +D-S when the dialogue score was in the high range (4.01-7) and structure score was in the low range (1-3.99).
3. -D+S (low dialogue, high structure): A student was categorized as -D+S when the dialogue score was in the lower range (1-3.99) and the structure score was in the higher range (4.01-7).
4. -D-S (low dialogue, low structure): A student was categorized as -D-S when both the dialogue and structure scores were in the lower range (1-3.99).

Table 8 shows the hypothesis, the variables, the data sources, and analytic techniques for RQ1 (hypotheses 1.4-1.6)

Table 8
Research Question 1: Hypothesis 1.4-1.6

Hypothesis	Variables	Data Source	Data Analysis
1.4	+D+S (IV) TD (DV)	Student responses on structure and dialogue in TDI	ANOVA
1.5	+D-S (IV) TD (DV)	Student responses on structure and dialogue in TDI	
1.6	-D+S (IV) -D-S(IV) TD (DV)	Student responses on structure and dialogue in TDI	

Research Question 2

Research question 2: To what degree, if any, do environmental factors impact student perceptions of TD? Table 9 shows the hypotheses, the variables, data sources, and the analytic techniques for RQ 2.

Table 9
Research Question 2: Hypothesis 2.1-2.9

Hypothesis	Variables	Data Source	Data Analysis
2.1	Students who used: Web Conferencing (IV) Live audio/video communication (IV) Live audio communication (IV) Live text communication broadcast audio/video (IV)	TDI (TD items 66-85) Environmental factors (EF) question 1	ANOVA

	Email and/or discussion forums (IV). TD (DV)		
2.2	Students who used: Live text- communication + live audio communication + live audio/video communication (IV) Email + discussion forums (IV) TD (DV)	TDI (TD items 66-85) EF question 1	<i>t</i> -test
2.3	Students who used: Broadcast audio + broadcast audio/video + live audio communication + live audio/video communication (IV). Email + discussion forums (IV). TD (DV)	TDI (TD items 66-85) EF question 1	<i>t</i> - test
2.4	Students who used: Web2.0 tools (blogs, wikis, Twitter) (IV) Email + discussion forums (IV) TD (DV)	TDI (TD items 66-85) EF question 1	<i>t</i> - test
2.5	Students in; Small classes (IV) Large classes (IV) TD (DV)	TDI (TD items 66-85) School enrollment database	<i>t</i> - test
2.6	Students who; Volunteered (IV) Did not volunteer (IV) TD (IV)	TDI (TD items 66-85) EF question 2	<i>t</i> -test
2.7	Students required to; Participate in group discussion (IV) Not required to participate in group discussion (IV) TD (DV)	TDI items 66-85 EF question 3	<i>t</i> -test

Table 9 (continued)
Research Question 2: Hypothesis 2.1-2.9

Hypothesis	Variables	Data Source	Data Analysis
2.8	Students who prefer; face-to-face classes (IV) Online classes (IV) TD (DV)	TDI item 66-85 EF question 4	<i>t</i> -test
2.9	Students who have; Previous online experience (IV) No previous online experience (IV) TD (DV)	TDI (TD items 66-85), EF question 5	<i>t</i> -test
2.10	Grades: Middle school students (IV) High school students (IV) TD (DV)	TDI (TD items 66-85) DF question 8	<i>t</i> -test
2.11	School type: Public (IV) Private (IV) TD (DV)	TDI (TD items 66-85), DF question 9	<i>t</i> -test

The aim of hypotheses 2.1 and 2.5 was to compare the impact of environmental factors on the perception of TD between different groups of students. The students were grouped according to their responses on the instructional media (2.1) and size (i.e., small was $n \leq 18$) of classes in which they are currently enrolled (2.5). For this reason, ANOVA was used for the tests (Howell, 2008; Huang et al., 2016).

Hypotheses 2.2, 2.4, and 2.6-2.9 compared the impact of environmental factors on the perception of TD between two groups of students. Students were classified based on their answers to the survey questions on communication types and questions on environmental factors

as follows: synchronous vs. asynchronous communications (2.2), live vs. text (2.3), Web 2.0 vs. text (2.4), student who volunteered vs. did not volunteer (2.6), student is required to participate in group discussion vs. not required (2.7), students with previous online experience vs. not having previous experience (2.8), students who prefer online course vs. those that do not (2.9), middle or high school (2.10), and public or private school (2.11). For this reason, *t*-tests were used to compare the mean perceived TD between the groups in hypothesis 2.1 to 2.11 (Rovai et al., 2013).

Research Question 3

Research question 3: To what degree, if any, do demographic factors impact student perceptions of TD?

The aim of hypotheses 3.1 through 3.2 was to compare the impact of demographic factors on the perception of TD between two independent groups of students. Hypothesis 3.2 was not part of the original study under replication but was added based on the context of this study. Students were classified based on their answers to questions on demographic factors (i.e., gender (3.1) and ethnicity (3.2)). For this reason, *t*-tests was used to compare the mean perceived TD between the groups in hypothesis 3.1 to 3.2 (Rovai et al., 2013).

For each hypothesis on environmental factors (2.2, 2.4, and 2.6-2.11) and demographic factors (3.1 to 3.2), each *t*-test was used to compare the mean perceived TD between two different groups. Assuming the assumptions of normality and equal variances between the groups were met, a significance level of $\alpha=0.05$ was enough to ensure tenability each result (Rovai et al., 2013).

Table 10 shows the hypotheses, the variables, data sources, and the analytic techniques for RQ 3.

Table 10
Research Question 3: Hypothesis 3.1-3.2

Hypothesis	Variables	Data Source	Data Analysis
3.1	Gender: Male Public school (IV) Male Private School (IV) TD (DV)	TDI (TD items 66-85) Demographic factors (DF) question 6	<i>t</i> -test
3.2	Ethnicity: White (private) (IV) Non-white (private) (IV) TD (DV)	TDI (TD items 66-85) DF question 7	<i>t</i> -test

Statistical Analysis

The section below explains the statistical procedures that will be used for data analysis in this study and the assumptions for each procedure.

Pearson product moment coefficient. This test was used to test the strength and direction of the relations between structure, dialogue, learner autonomy, and TD constructs. This method was chosen for this research question because the aim is to find the strength and direction of the relationship and not to establish cause and effect (Cohen, West, & Aiken, 2014).

The Pearson product-moment coefficient r ranges from -1 to +1.

The following assumptions were tested:

1. Normality: The test assumes that the population distributions are normally distributed.

To test normality, the histogram will be inspected for evidence of normal distribution.

2. Independence of the observations. Since the sample of about 150 is less than 10% of the total population of the school, observations are assumed to be independent.

3. Linearity: This test assumes that the two variables have a linear relationship. To test linearity, the scatter plots of the data will be inspected.

4. Homoscedasticity: This test assumes two variables have similar variances. To check this assumption, the residual plots will be inspected for even distribution.

If the above assumptions are violated, the Spearman's correlation coefficient (r) could be used instead. The value of r ranges from -1 to +1. Descriptive statistics that were reported are mean (M), standard deviation (SD), and the degrees of freedom (df). The effect size and the strength of the correlation were interpreted based on the value of r using the following guide (see Table 11) (Cohen, 1988). The results will be significant at $p \leq 0.05$. The tests will be carried out in SPSS.

Table 11
Correlation Coefficient Interpretation

Range	Interpretation
00-.19	Very weak
.20-.39	Weak
.40-.59	Moderate
.60-.79	Strong
.80-1.00	Very Strong

ANOVA. ANOVA was used to find interaction effects of dialogue and structure on TD. Moore's (1993) TD model considers the interactive effect of dialogue (high or low) and structure (high or low) on TD. Descriptive statistics that were reported are mean (M), standard deviation

(*SD*), effect size and power, and degrees of freedom (*df*). Post hoc tests (multiple comparisons) will be reported. The results will be significant at $p \leq 0.05$. The tests will be carried out in SPSS.

The following assumptions were tested.

1. Normality: This assumption assumes that the population distributions are normal.
2. Equal Variances: This assumption assumes that the population distributions have the same variance.

Independent samples *t*-test. This test was used to determine if the mean TD perceived is different in two different groups of students. The independent variable were the two groups in each hypothesis while TD perceived was the dependent variable. Descriptive statistics that were reported are the mean (*M*), standard deviation (*SD*), *t* value, degrees of freedom (*df*), effect size, and power. The results were considered significant at $p \leq 0.05$. The tests were carried out in SPSS. The following assumptions were tested.

1. Normality: This assumption assumes that the population distributions are normal.
2. Equal Variances: This assumption assumes that the population distributions have the same variance.

Delimitations

This research had delimitations. No cause and effect can be established in correlational research. Research question 1 was focused on finding the degree, if any, of correlation between TD and LMS student activity and then using that correlation to build a prediction model for student perception of TD. The correlational design does not allow the researcher to extrapolate the inferences beyond the range of the data. Thus, the correlation between the two variables did not inform as to which variable affects the other (Johnson & Christensen, 2008). For example, the researcher could not make an inference that changing the dialogue by 100% would result in

an increase or decrease in TD by 100% (Johnson & Christensen, 2008). Another delimitation is the instrument used to find the students' perception of TD was originally developed for higher education online setting; the instrument has never been used in high school and middle school settings. This could have affected the validity and reliability of the instrument when measuring K-12 student perception of TD. Given that participants are 100% online, the researcher expected a high rate of non-response due to lack of face-to-face reminders. This could result in a smaller, non-representative sample. In addition, self-report bias may have occurred because the participants were making responses by themselves with the researchers or teacher interference.

Limitations Due to Threats in Validity

The section below briefly describes two limitations due to internal validity and three limitations due to external validity.

Internal validity. There were several limitations due to threats to internal validity. First is the statistical regression that occurs when some participants have extreme scores. This may occur due to the presence of outliers, such as courses where there are little or no LMS activity and vice-versa. This threat can be limited by the removal of outliers in the data preprocessing stage (Onwuegbuzie, 2003). The second threat is Type I and Type II errors. A Type I error is the probability of rejecting the null hypothesis when it is true. Type I error is the probability of failing to reject the null hypothesis when it is false. Both errors were minimized by increasing sample size and statistical power. In addition, there was a risk of running a high error due to the use of multiple *t*-tests (Onwuegbuzie, 2003). To address this limitation, the significance level was adjusted using the Bonferroni correction (Armstrong, 2014).

External validity. There were several limitations due to threats in external validity. First was temporal validity that refers to the extent to which results can be generalized across time.

Generalization across time is not possible because LMS are evolving rapidly with improvements in user interfaces. It will not be possible to eliminate this threat for this study because online instruction is changing at a rapid rate (Onwuegbuzie, 2003). The second threat is population validity, referring to lack of generalizability due to small samples. It is not possible to remove this threat because large samples will be difficult to obtain due to practical considerations of the amount of time to collect a large sample (Onwuegbuzie, 2003). The third and final threat is ecological validity, which refers to the extent to which results can be generalized across online schools. It may not be practical to generalize across different online school using different OLE models (Onwuegbuzie, 2003).

Summary

The goal of this chapter was to outline the research method used to answer the research questions. A discussion of the procedures, the specifics of how the study will be conducted, who will participate in the study, and the data collection procedures using the TD instrument were outlined. The TD scale was presented after gaining permission for its use in this study. Description of the instrument, its content, its origin, and its appropriateness for use in K-12 education OLE were given in detail. Explanation of the scoring information for the composite and subscales and the possible range of scores were discussed. In addition, the environmental and demographics questionnaire was explained. The data analysis and statistical procedures used to test the hypotheses were outlined. Finally, the limitations and delimitations of the procedures were outlined.

CHAPTER FOUR: RESULTS

Introduction

The purpose of this study was to empirically verify the association between TD and its constructs in high and middle school Online Learning Environments. The study also examined how demographic factors such as communication type, class size, group discussion, preference for online classes, previous experience, and type of school impact TD. In addition, the study investigated how demographic factors such as ethnicity and gender impacted TD.

Data Collection

A total of 280 parents of students who had taken about 50% of a full-year online science course were asked for consent to allow students to take part in this study via introductory E-mail. A total of 110 parents (39.3%) signed the consent forms allowing the researcher to send the introductory email and ask for assent from the students. One hundred and ten emails were then sent to these students. After five weeks, and four reminders, 94 students (33.6%) had participated in the survey. The response rate for students whose parent gave consent was 85.5%. Eight students did not complete the survey and so their responses were not included in the results. The final sample in the analysis was $N = 86$, representing a 78.8% response rate. The data collection phase started in early January 2020 and ended in the first week of February 2020.

Tables 12, 13, and 14 below shows the demographics of the respondents.

Table 12:
Respondents by Gender

	Public school	Percent	Private school	Percent
Male	23	26.7	47	54.6
Female	16	18.6	0	0
Total	39	45.3	47	54.6

Table 13:
Respondents by Ethnicity

	Public school	Percent	Private school	Percent
Caucasian	22	25.6	34	39.5
Non-Caucasian	17	19.7	13	15.1
Total	39	45.3	47	54.6

Table 14:
Respondents by School

	Public School	Percent	Private School	Percent
High School	36	41.8	47	54.6
Middle School	3	3.5	0	0
Total	39	45.3	47	54.6

Results

Table 14 shows the descriptive statistics for TD, dialogue, structure, and learner autonomy.

Table 14:

Descriptive for TD, Dialogue, Structure, and Learner Autonomy

Variable	<i>M</i>	<i>SD</i>	Min	Max	Range
TD	2.66	.93	.40	4.7	4.3
Dialogue	5.64	.81	3.3	7.0	3.7
Structure	5.42	.73	4.0	6.91	2.91
Learner Autonomy	5.31	.83	3.80	7.0	3.20

Note: Data was collected using a 7-point-Likert Scale.

The results showed that TD ranged from a minimum of .40 to a maximum of 4.7, with a mean of 2.66 ($SD = .93$). The result showed that TD scores, on average, tended to be on the

lower range (1–3). Regarding dialogue, the results showed that dialogue ranged from a minimum of 3.3 to a maximum of 7.0, with a mean of 5.64 ($SD = .81$). The result implied that dialogue, on average, tended to be on the upper range (5-7). On structure, the results showed that structure ranged from a minimum of 4.0 to a maximum of 6.91, with a mean structure of 5.42 ($SD = .73$). The result implied that structure scores, on average, tended to be in the upper range (5-7). Regarding learner autonomy, the results showed that learner autonomy ranged from a minimum of 3.8 to a maximum of 7.0, with a mean of 5.31 ($SD = .83$). The results demonstrate that learner autonomy scores tended in the upper end of range (5-7).

Results for Research Question 1

The goal of research question 1 was to find out how TD, structure, dialogue, and learner autonomy relate with each other and how they impact student perceptions of TD. There were six hypotheses, 1.1 to 1.6. Hypothesis 1.1-1.3 sought to find the association between TD and dialogue, structure, and learner autonomy. Hypotheses 1.4 to 1.6 examined if there was a perceived difference in TD between different groups of high and low structure.

Pearson Correlation

For hypotheses 1.1 to 1.3, all the assumptions for Pearson correlation were tested to make sure there were no violations (Warner, 2012). The Shapiro-Wilk test was not significant for TD ($p = .12$) and structure ($p = .07$) indicating that the variables were normally distributed. The Shapiro-Wilks test was significant for dialogue ($p = .001$) and learner autonomy ($p = .01$) indicating a violation of normality. Further inspection of the dialogue and learner autonomy histograms showed that the assumption of normality was not grossly violated due to its roughly symmetric shape (Warner, 2012). Despite this violation, a Pearson correlation was performed due to its robustness against violations of normality (Bishara & Hittner, 2012).

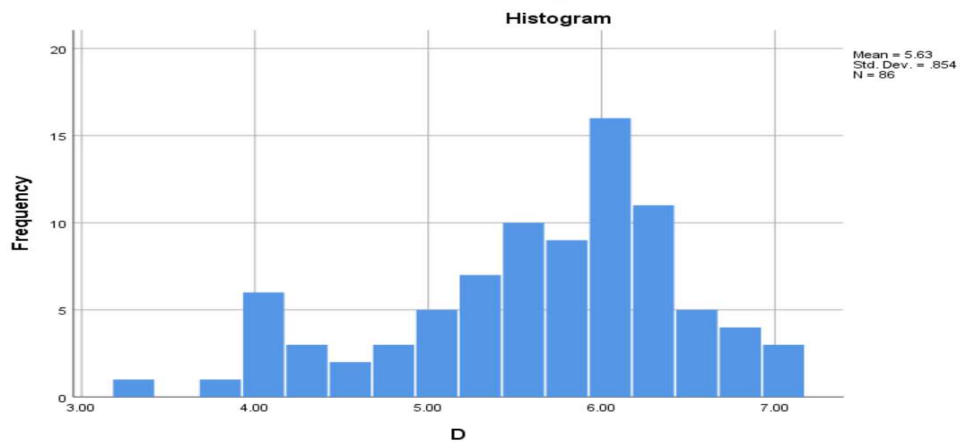


Figure 2: Histogram of Dialogue

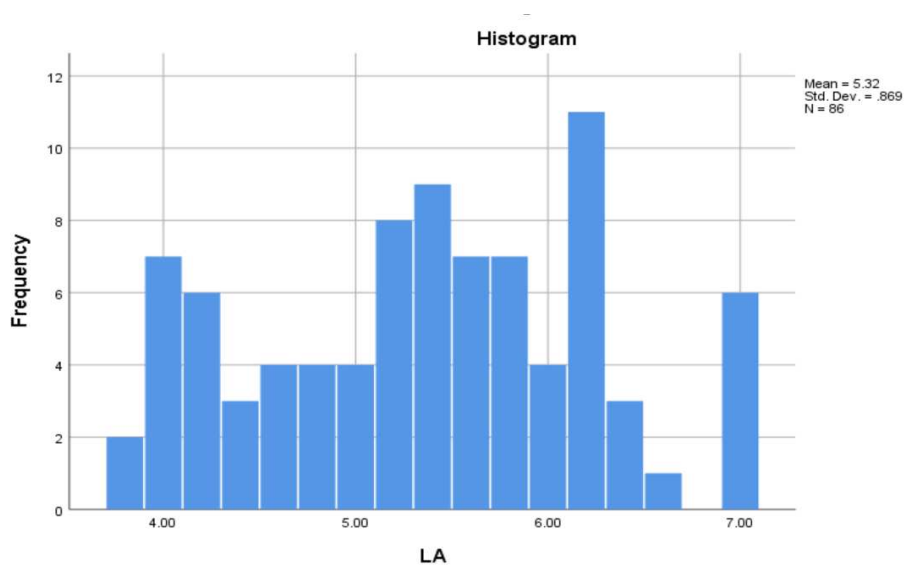


Figure 3: Histogram of Learner Autonomy

The box plots for TD, structure, and learner autonomy showed no outliers. Dialogue had one outlier (Fig 4). The outlier was not removed because the Pearson Correlation test is sufficiently robust against mild outliers (Abdullah, 1990).

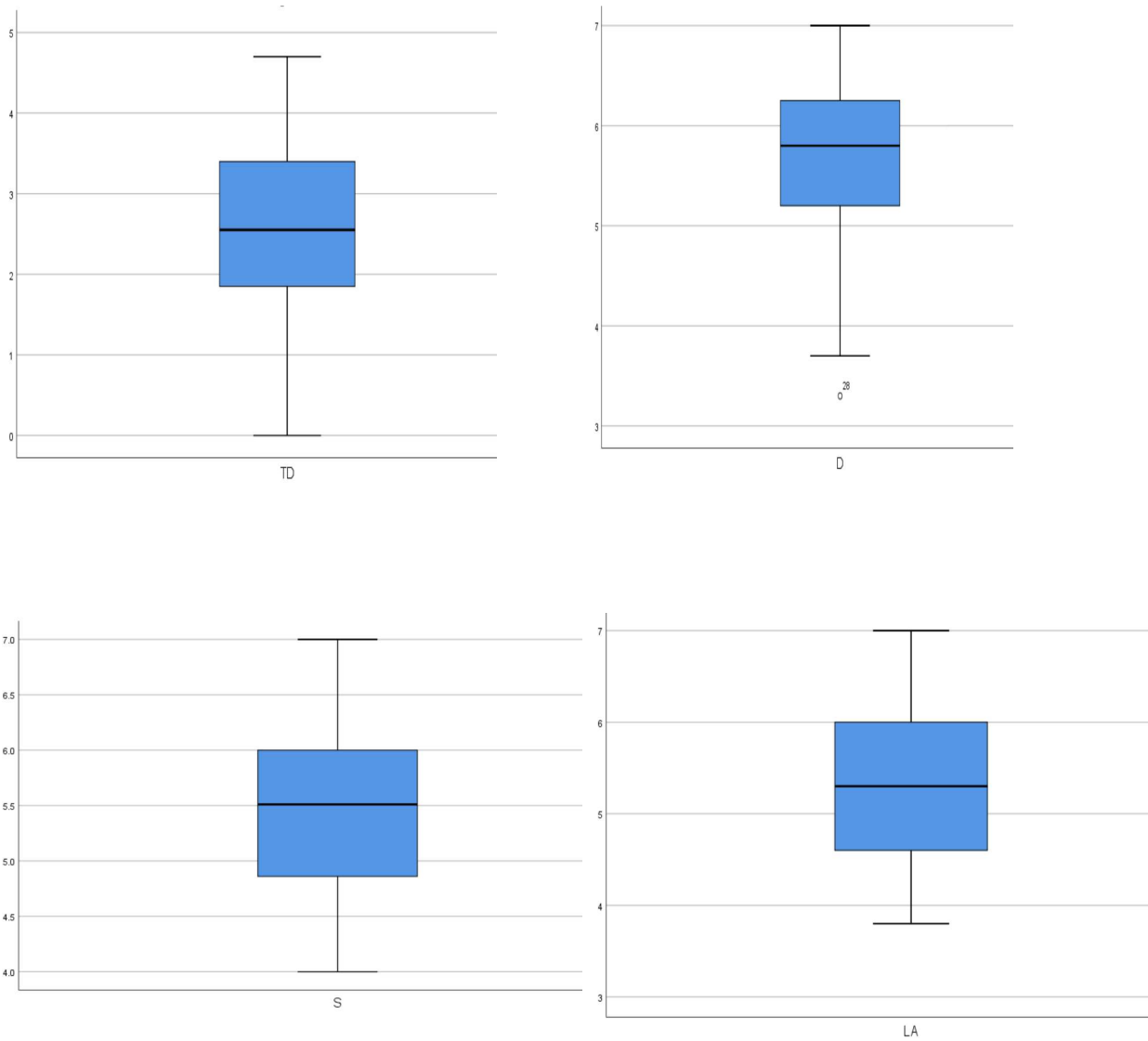
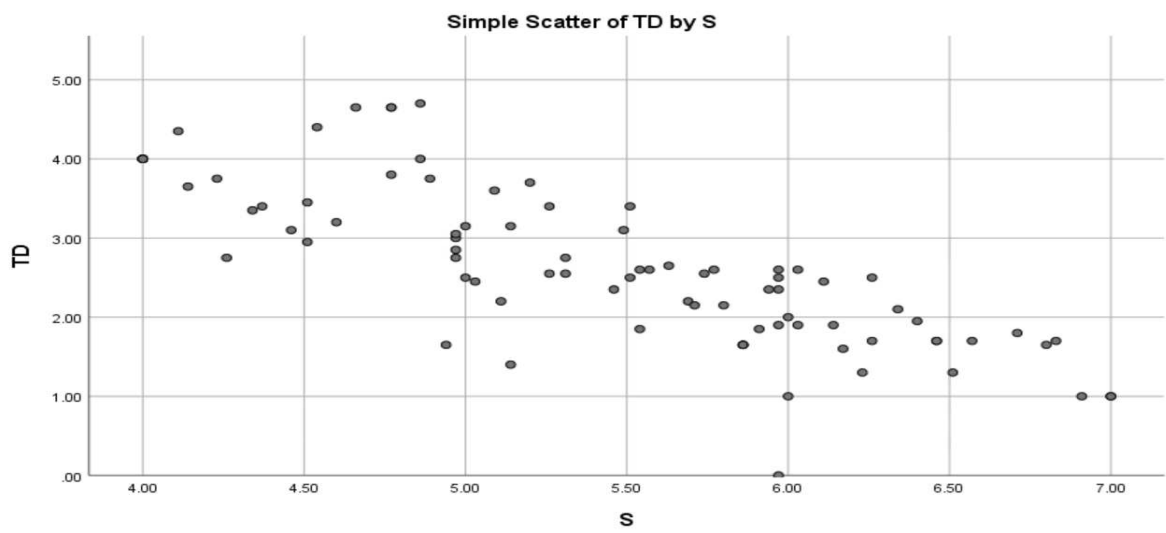
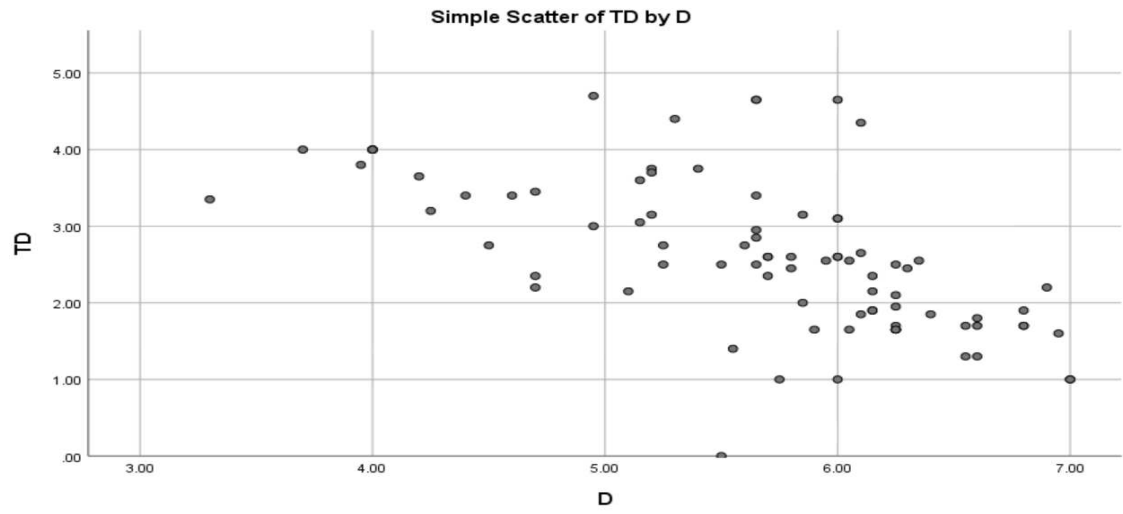


Figure 4: Box plots for TD, Dialogue, Structure, and Learner autonomy

In addition, an inspection of the respective pair of scatter plots indicated a general linear variation between TD and dialogue, TD and structure, and TD and learner autonomy (Figure 5).



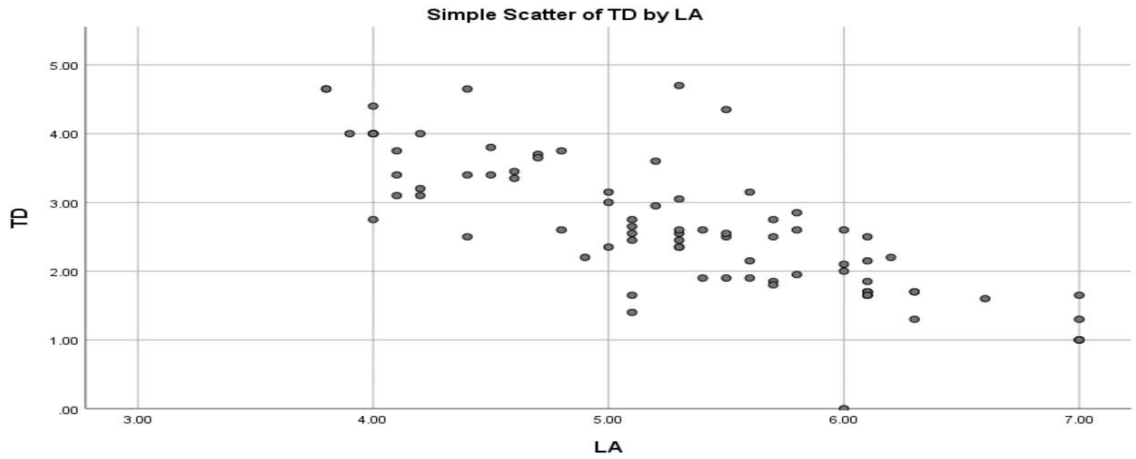
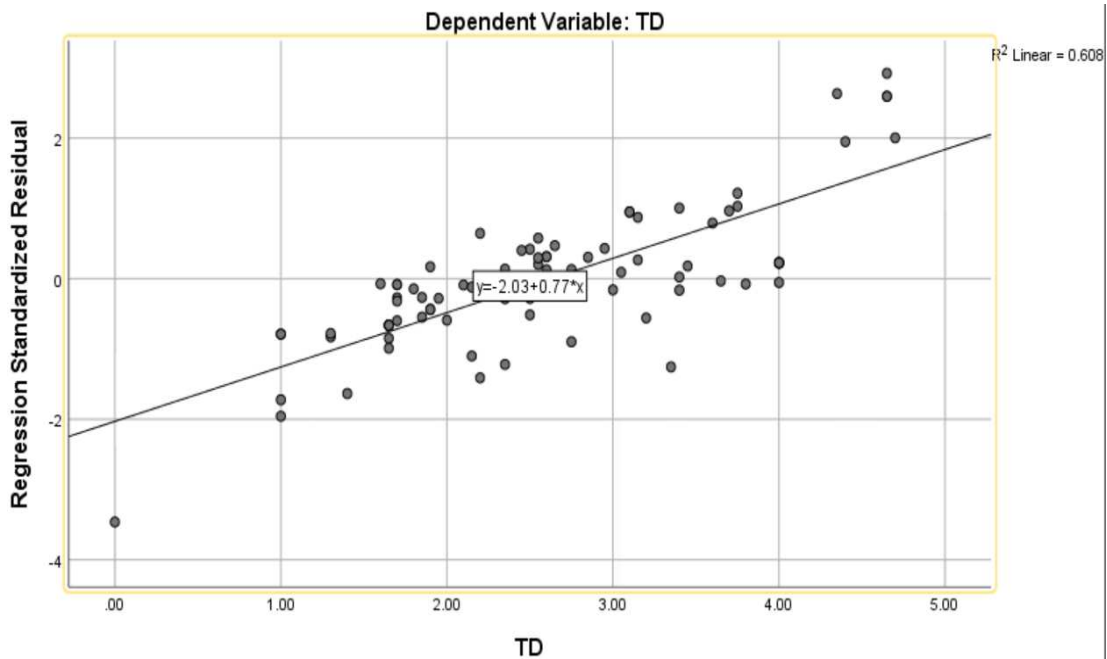


Figure 5: TD, Dialogue, Structure, and Learner autonomy scatter plots

Inspection of the residual plots showed the data points were widely and evenly spread about the regression line (Figure 6), indicating the assumption of homoscedasticity was tenable (Warner, 2012).



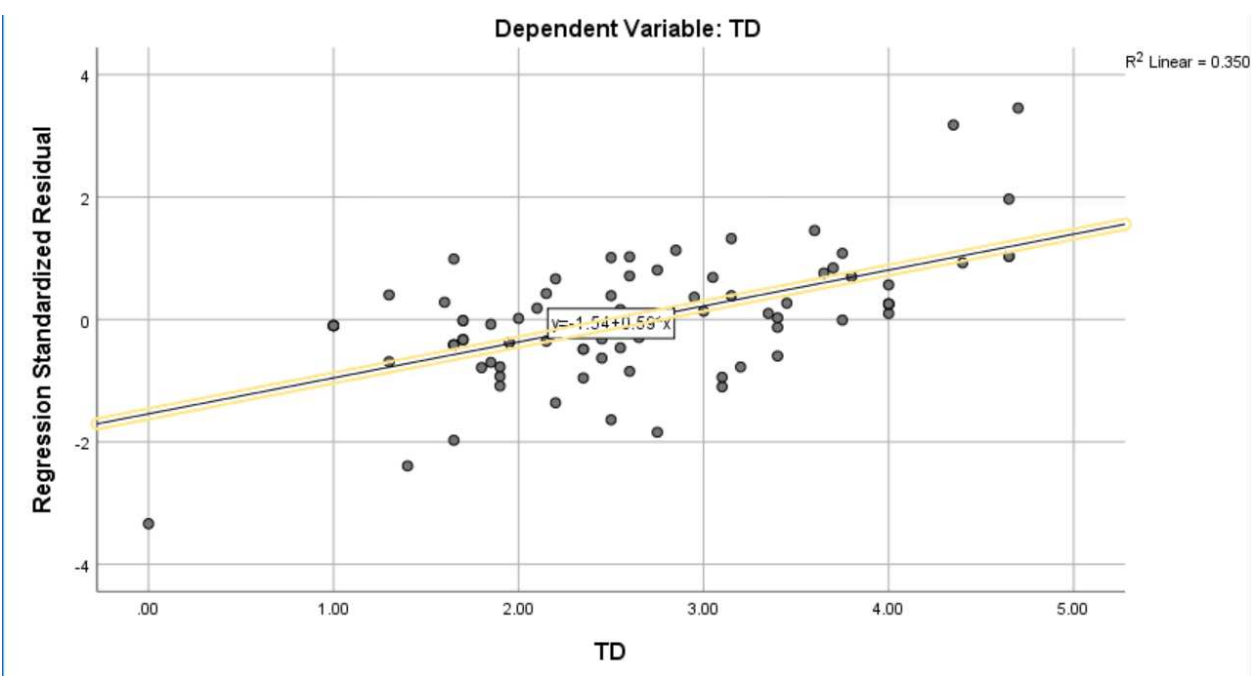
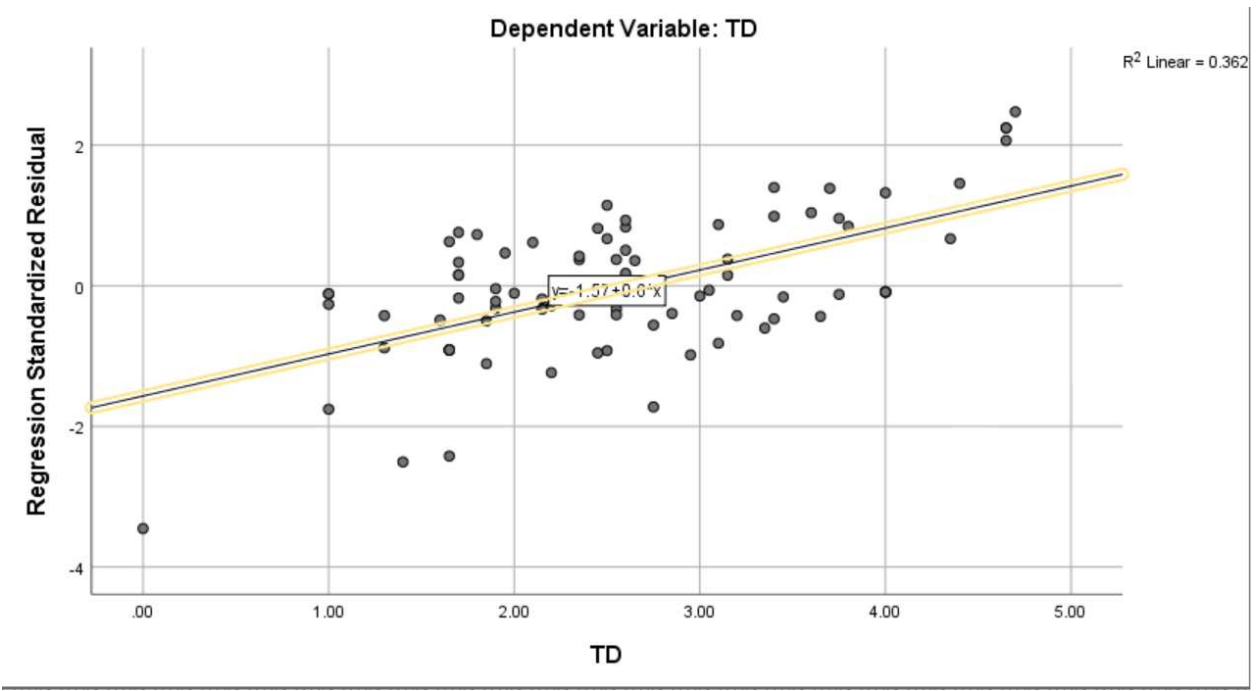


Figure 6: Residual plots for TD and Structure, TD and Dialogue, TD and Learner Autonomy.

Table 15 below shows the results of the Pearson Correlation.

Table 15:
Pearson correlations between transactional distance, structure, dialogue, and learner autonomy

Variable	TD	Dialogue	Structure	Learner Autonomy
TD	-----			
Dialogue	-.67*	-----		
Structure	-.80*	.74*	-----	
Learner Autonomy	-.77*	.69*	.80*	-----

* $p < 0.001$ $N = 86$

- H_0 1.1 stated that there is no statistically significant correlation between dialogue and perceived TD. Result of the Pearson correlation was statistically significant and showed that TD and dialogue are moderately negatively correlated: $r(86) = -0.67, p < .001$.
- H_0 1.2 stated that there is no statistically significant correlation between structure and perceived TD. Results of the Spearman correlation was statistically significant and showed that TD and structure are strongly negatively correlated: $r(86) = -0.80, p < .001$.
- H_0 1.3 stated that there is no statistically significant correlation between learner autonomy and perceived TD. Results of the Pearson correlation was statistically significant and showed that TD and learner autonomy are strongly positively correlated: $r(86) = -0.77, p < .001$.

Table 16:
Summary of Results in RQ1(Hypothesis 1.1 to 1.3)

Hypothesis	Correlation Coefficient	p value	DV	IV	Conclusion
1.1	$r = -.67$	$p < .000$	TD	Dialogue	Rejected H_0
1.2	$r = -.80$	$p < .000$	TD	Structure	Rejected H_0
1.3	$r = -.77$	$p < .000$	TD	Learner Autonomy	Rejected H_0

One-Way-ANOVA

For hypothesis 1.4 to 1.6, all the assumptions for One-Way ANOVA were tested to make sure there were no violations. The Shapiro-Wilk test indicated the dependent variable was normally distributed in all three groups:

+D+S ($W(55) = .97, p = .23$), +D-S ($W(13) = .91, p = .15$), and -D-S ($W(10) = .96, p = .73$). The Levene's test of homogeneity of variances ($F(3,80) = 1.78, p = .16$) was not significant, indicating that the group's distributions had similar variances. The -D+S group ($n = 3$) was not included in the assumptions testing and the one-way-ANOVA because the small sample did not meet the minimum threshold for robust testing based on a priori sample size estimation in chapter 3.

The ANOVA results showed that hypothesis 1.4 to 1.6 were rejected. Regarding how dialogue, structure and learner autonomy interact and impact student perceptions of TD, the ANOVA results showed significant differences among the four categories: +D+S, +D-S, +D-S, $F(2,75) = 32.00, p < .001, \eta^2 = .56$.

Table 17 below shows the results of the ANOVA.

Table 17:
One-Way ANOVA Results of the Perception of TD among Different Dialogue and Structure Groups

Source	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>p</i>
Between groups	2	34.22	17.11	32.00	< .000
Within groups	75	40.1	.54		
Total	77	75.33			

For the One-Way ANOVA results on table 14, the effect size was $\eta^2 = .56$.

To understand differences between the three groups, Post Hoc tests were run.

The Table 18 below shows the Post Hoc results of the ANOVA Comparisons of TD for the three categories.

Table 18:

One-Way ANOVA Post Hoc Comparisons of TD for Four Categories

Category	n	M	SD	Tukey's HSD Comparisons		
				+D+S	+D-S	-D-S
+D+S+	55	2.11	.70	-----		
+D-S	13	3.58	.94	<.001	-----	
-D-S	10	3.53	.55	<.001	.7	-----

- H₀ 1.4 stated that there is statistically no significant effect of high dialogue and high structure (+D+S) on student perception of TD (Huang et al., 2016). The results of one-way ANOVA showed that the mean difference in TD perceived by students in +D+S, -D-S, and +D-S was statistically significant ($F = 21.47, p < .000$). Post Hoc analysis indicated that students in +D+S perceived significantly lower TD ($p < .001$) than students in -D-S (Table 18).
- H₀ 1.5 stated there is statistically no significant effect of low dialogue and low structure (-D-S) on student perception of TD. The results of one-way ANOVA showed that the mean difference in TD perceived by students in +D+S, -D-S, and +D-S was statistically significant ($F = 21.47, p < .001$). Post Hoc analysis indicated that students in -D-S perceived significantly higher TD ($p < .001$) than students in +D+S (Table 18).

- H 1.6 stated that low dialogue-high structure (-D+S) and high dialogue-low structure (+D-S) do not lead to a TD that is between the TD perceived by students in high dialogue-high structure (+D+S) and TD perceived by students in low dialogue-low structure (-D-S) (i.e., $TD(+D+S) < TD(-D+S)$ or $TD(+D-S) < TD(-D-S)$). The results of one-way ANOVA showed that the mean difference in TD perceived by students in +D+S, -D-S, and +D-S was statistically significant ($F = 21.47, p < .000$). However, post hoc analysis indicated that students in +D-S did not perceive significantly different TD ($p = .7$) than students in +D-S (Table 18). -D+S was not considered due to the small sample size.

Results for Research Question 2

The goal of research question 2 was to understand how environmental factors (e.g., instructional media, class size, required courses, required participation in group discussions, number of previous online courses taken and preference for online courses) impact student perceptions of TD.

For hypothesis 2.1, due to the small sample size of students using Web conferencing ($n = 3$), the groups were merged into “Web Conference/live audio” for a total size of 15. Similarly, the small number of students in Web 2.0 ($n = 2$) required merging this group in the “Email/discussion/Web 2.0 tools” for a total size of 45. In addition, the “posted video/audio” group was omitted from the analysis due to the small sample size ($n = 6$) and could not be merged with either live communications or the text-based email/discussion forum because these are two-way communication channels.

The Shapiro-Wilk test for normality were not significant for Web conference/live audio ($W(15) = .95, p = .5$), and Email/Discussion forum/Web 2.0 ($W(45) = .98, p = .66$), indicating the

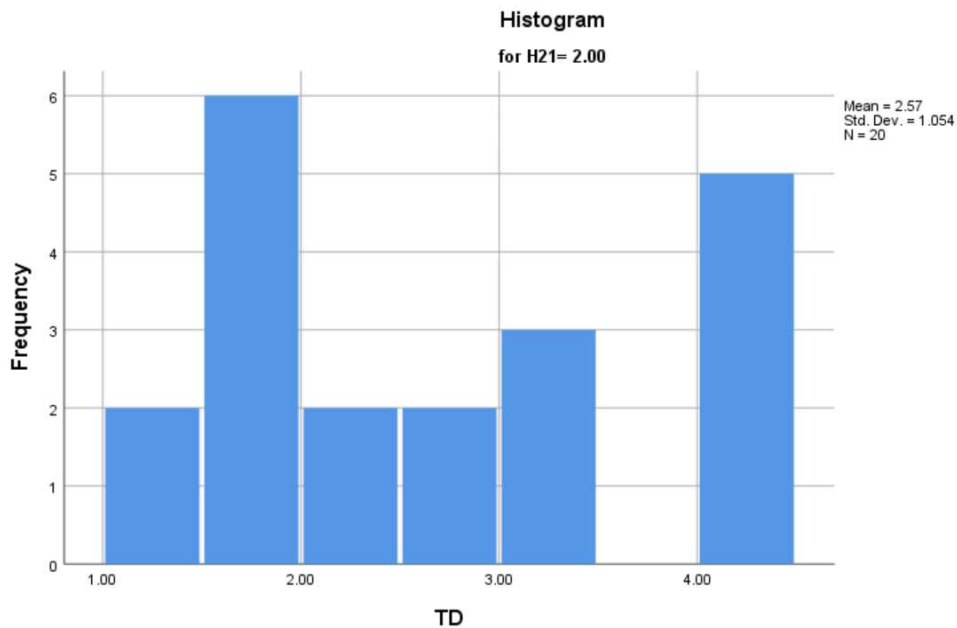


Figure 7: Histogram for Text Messages Group

assumption was met. Text messages ($W(20) = .89, p = .03$) group was significant. An inspection of the histogram showed the assumption was violated for this group (Figure 7). The ANOVA test was carried out due to its tolerance of non-normal data with only a small effect on the Type I error rate (Lix et al., 1996).

The Levene's test of homogeneity of variances ($F(2, 77) = 1.52, p = .23$) was not significant, indicating that the group's distributions had similar variances.

Table 20 shows the descriptive statistics for communication types.

Table 20:
Descriptive Statistics for TD among Communication Types

Variable	<i>n</i>	<i>M</i>	<i>SD</i>
Live audio	15	2.71	1.08
Text messages	20	2.57	1.05
Email/Discussion forums	45	2.52	.91

Table 21 shows the ANOVA results of TD perceived among students who used different communication channels.

Table 21
ANOVA Results of the Perception of TD among Different Communication Types

Source	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>p</i>
Between groups	2	.41	.21	.21	.81
Within groups	77	74.19	.96		
Total	79	74.60			

- H_0 2.1 stated that the perception of TD does not occur in the ranked order from least to most: live audio/video communication media (least TD), live audio communication, live text communication, broadcast audio/video, and traditional email and/or discussion forums (Most TD). The results of the one-way ANOVA indicated that there was no statistically significant difference in perceived TD among the students who used live audio or/and video communication media, student who used text communication, and those who use email/discussion forums/Web 2.0 tools $F(3, 77) = .81, p = .13, \eta^2 = .07,$ and $d = .48$. The observed power was .07, which indicates that a Type I error was likely.

For hypothesis 2.2 to 2.11, the Shapiro-Wilk test and the Levene's test of homogeneity of variances were applied to the data for all tests to ensure normality and confirm the variances in both groups were similar. To address the risk of increasing Type I errors by running multiple *t*-tests, the Bonferroni correction was applied to each test. The alpha level for significance from the Bonferroni correction was $p = .007$, obtained by dividing alpha (.05) by the number of tests (7) in research question 2 (Sedgwick, 2012).

Table 22 shows the descriptive statistics for environmental factors

Table 22:
Descriptive Statistics of TD among Environmental Factors

Group 1	Group 2	Group 1			Group 2		
		<i>n</i>	<i>M</i>	<i>SD</i>	<i>n</i>	<i>M</i>	<i>SD</i>
Synchronous Communications	Asynchronous Communications	41	2.56	.9	34	2.59	1.04
Live audio/video Communications	Text-based communications	15	2.9	1.14	40	2.56	.91
Small Classes	Large Classes	46	2.39	.92	39	2.8	1.08
Group Discussion	No-group Discussion	69	2.57	.96	17	2.85	1.16
Prefer Online	Prefer Face-to-face	19	3.33	1.05	67	2.42	.90
Previous online experience	No previous online experience	26	2.62	.91	60	2.62	1.04
Public School (male)	Private School (male)	45	2.51	.87	23	2.47	.96

Table 23 shows *t*-test results for hypotheses 2.2 to 2.11 on environmental factors.

Table 23:
t-test Results on Environmental Factors

<i>t</i> -test	<i>df</i>	<i>t</i>	<i>p</i> -value*	<i>d</i>
Synchronous-Asynchronous Communications	73	-.12	.90	.28
Live-Text Based communications	53	-1.06	.3	.33
Small-Large classes	83	-1.41	.16	.31
Required to participate- Not required to participate in group discussion	84	-1.04	.30	1.08
Prefer face-to-face -Prefer online	84	3.75	< .001	.97
Have previously taken-Have not previously taken online classes	84	-.03	.98	.07
Private-Public school (Male)	66	.17	.87	.29

*Bonferroni correction applied: $p \leq .007$ (Sedgwick, 2012)

- H_0 2.2 stated that there is no statistically significant difference in TD perceived by students who have used synchronous communication (live text communication + live audio communication + live audio/video communication) and students who have only used traditional asynchronous communication (email + discussion forums). The Shapiro-Wilk test showed that TD scores for students who used live text communication + live audio communication + live audio/video communications ($W(41) = .97, p = .45$) were normally distributed while TD scores for students who used Email/Discussions ($W(34) = .93, p = .04$) were not. However, a visual inspection of the histogram (Figure 8) showed that the data was approximately normal (Razali & Wah, 2011). The t -test was carried out because of its robustness against violations of normality (Havlicek & Peterson, 1974).

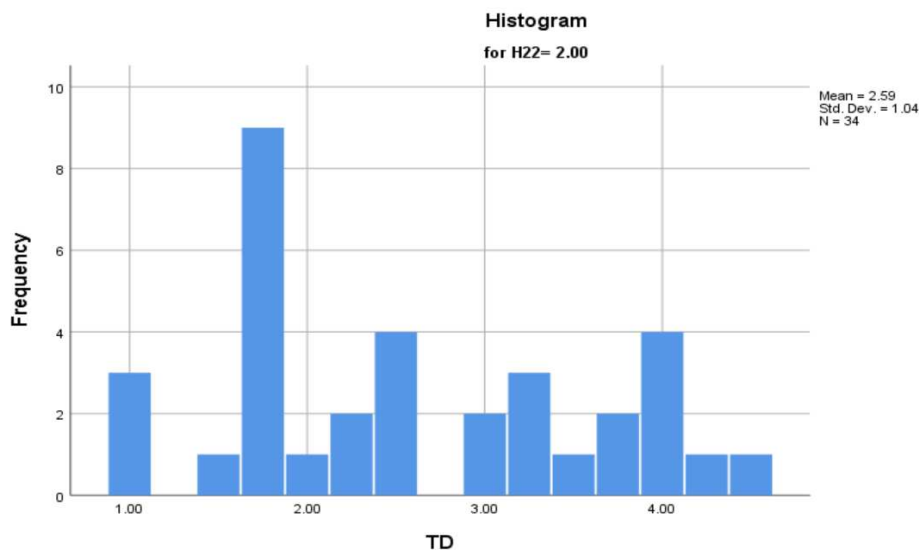


Figure 8: Histogram of TD in Email + Discussion Forum Group

The Levene's test ($F(73) = 3.3, p = .07$) was not significant, indicating that the two group's distributions had similar variances. The results of an independent t -test of 41 students who used synchronous communications ($M = 2.56, SD = .9$) and 34 students

who used asynchronous communications ($M = 2.59$, $SD = 1.04$) suggested no statistically significant difference in the TD perceived ($t(73) = -.12$, $p = .9$, $d = .28$). The effect size was medium based on Cohen (1988) classification.

- H₀ 2.3 stated that there is no statistically significant difference in TD perceived by students who use audio/video communication (broadcast audio + broadcast audio/video + live audio communication + live audio/video communication) and students who have used only traditional text-based communication (email + discussion forums). The Shapiro-Wilk test showed that TD scores for students using audio/video communications ($W(40) = .98$, $p = .54$) and TD scores for students using traditional text-based communications ($W(12) = .9$, $p = .55$) were normally distributed. The Levene's test ($F(50) = 1.76$, $p = .19$) showed that the two group's distributions had similar variances. The results of an independent t -test of 15 students who used live audio/video communications ($M = 2.9$, $SD = 1.14$) and 40 students who used email and discussion forums ($M = 2.56$, $SD = .91$) suggested no statistically significant difference in the TD perceived ($t(50) = -1.06$, $p = .3$, $d = .33$). The effect size was small based on Cohen (1988) classification.
- H₀ 2.4 stated that there is no statistically significant difference in TD perceived by students who use Web2.0 tools (blogs, wikis, Twitter) and those who used text-based communication (email + discussion forums). However, the small sample size of students using Web 2.0 ($n = 3$) prevented this analysis from being run.
- H₀ 2.5 stated that there is no statistically significant difference in TD perceived by students in smaller size classes and students in larger classes. The Shapiro-Wilk test showed that TD scores for students in small class sizes ($W(46) = .98$, $p = .8$) were

normally distributed but TD scores for students large class sizes ($W(39) = .92, p = .01$) were not normally distributed. However, a visual inspection of the histograms (see Figure 9) showed a roughly symmetrical shape (Razali & Wah, 2011). The t -test was carried out because of its robustness against violations of normality (Havlicek & Peterson, 1974).

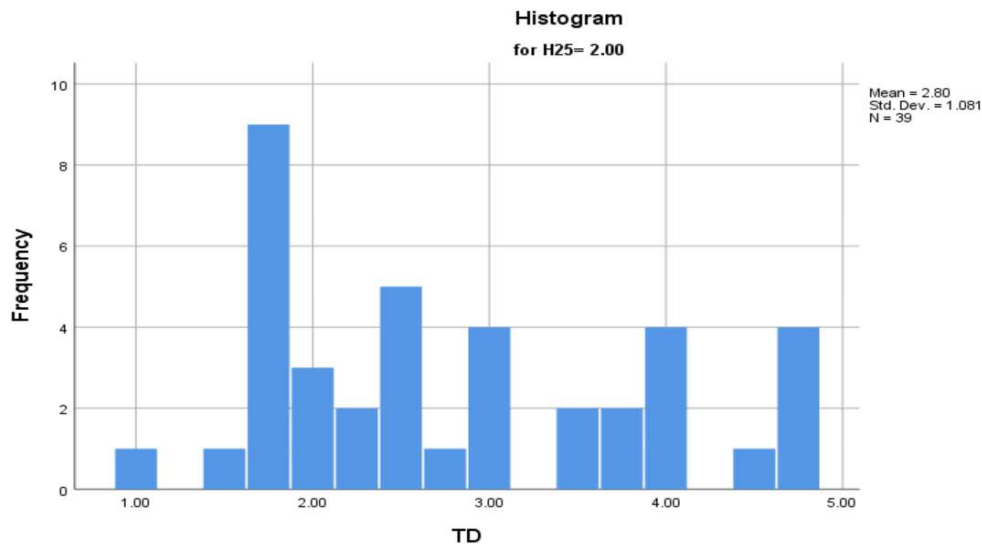


Figure 9: Histogram of TD in Large Class Size Group

The Levene's test ($F(83) = 3.4, p = .07$) showed that the equal variances assumption was met. The results of the t -test of 46 students who were in small-sized classes ($M = 2.39, SD = .92$) and 39 students who were in large classes ($M = 2.80, SD = 1.08$) suggested no statistically significant difference in the TD perceived ($t(83) = -1.41, p = .16, d = .31$). The effect size was medium based on Cohen (1988) classification.

- H_0 2.6 stated that there is no statistically significant difference in TD perceived by students who volunteered and those who did not volunteer to take online classes.

However, the small sample size of student who volunteered ($n = 9$) prevented the test from being run.

- H_0 2.7 stated that there is no statistically significant difference in TD perceived by students who are required to participate in group or class discussion and those who are not required. The Shapiro-Wilk test showed that TD scores for the students who participated in group discussions ($W(69) = .98, p = .38$) and TD scores for the students who did not participate in group discussions ($W(17) = .93, p = .20$) were normally distributed. The Levene's test ($F(84) = 2.17, p = .14$) showed that the assumption of homoscedasticity was met. The results of the t -test of 69 students who were required to participate in group discussion ($M = 2.57, SD = .96$) and 17 students who were not required ($M = 2.85, SD = 1.16$) suggested no statistically significant difference in the TD perceived ($t(84) = -1.04, p = .3, d = 1.08$) between the two groups. The effect size was large based on Cohen (1988) classification.
- H_0 2.8 stated that there is no statistically significant difference in TD perceived by students who prefer online classes and those who prefer face-to-face. The Shapiro-Wilk test showed that TD scores for the students who preferred online classes ($W(19) = .89, p = .03$) were not normally distributed and TD scores for the students who did not prefer online classes ($W(67) = .97, p = .1$) were normally distributed. An inspection of the histogram for students who preferred face-to-face showed the data was roughly normal (Figure 10). The t -test was carried out because of its robustness against violations of normality (Havlicek & Peterson, 1974).

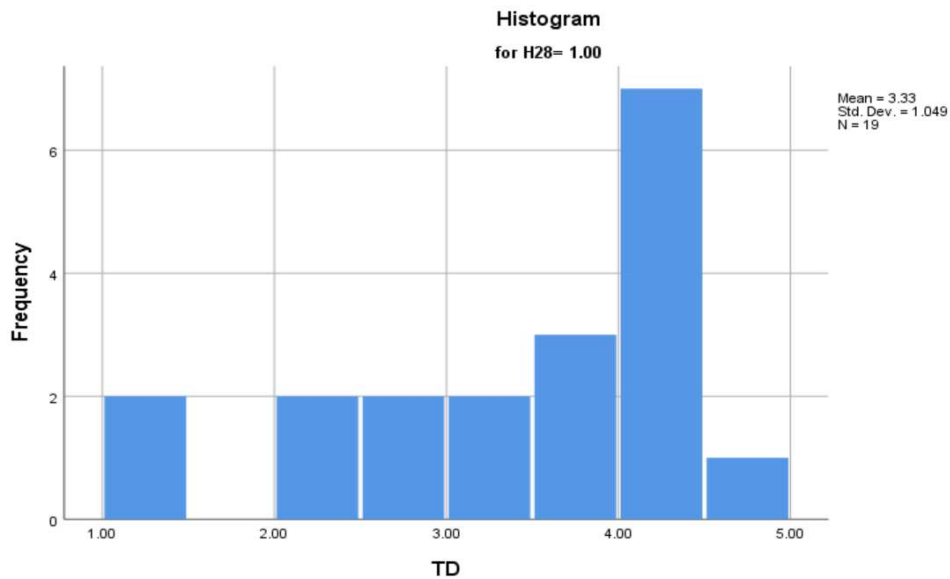


Figure 10: Histogram of TD for Students who Preferred Face-to-Face.

The Levene's test ($F(84) = 1.18, p = .28$) showed that the assumption of homoscedasticity was met. The results of the t -test of 19 students who reported that they preferred online classes ($M = 3.33, SD = 1.05$) and 67 students who said they preferred face-to-face classes ($M = 2.42, SD = .9$) suggested there was a statistically significant difference in the TD perceived ($t(84) = 3.75, p < .001, d = .97$) between the two groups. The effect size was large based on Cohen (1988) classification.

- H_0 2.9 stated that there is no statistically significant difference in TD perceived by students who have previous online experience than those that do not. The Shapiro-Wilk test showed that TD scores for the students with previous online experience ($W(26) = .98, p = .85$) and TD scores for the students without previous online experience ($W(60) = .96, p = .07$) were normally distributed. The Levene's test ($F(84) = 1.05, p = .31$) showed that the assumption of homoscedasticity was met. The results of the t -test of 26 students who reported that they have previous online experience ($M = 2.62, SD = .91$) and 60 students

who said they had no experience ($M = 2.62, SD = 1.04$) showed that there was no statistically significant difference in the TD perceived ($t(84) = -.03, p = .98, d = .07$) between the two groups. The effect size was small based on Cohen (1988) classification.

- H₀ 2.10 stated there is no statistically significant difference in TD perceived by students in middle and high schools. However, the small sample size ($n = 2$) of middle school students prevented this analysis from being run.
- H₀ 2.11 stated that there is no statistically significant difference in TD perceived by male students in private schools and male students in public schools. The Shapiro-Wilk test showed that TD scores for male students ($W(45) = .98, p = .79$) and TD scores for female students ($W(23) = .92, p = .06$) were normally distributed. The Levene's test ($F(66) = .28, p = .6$) showed that the assumption of homoscedasticity was met. The results of the t -test of 45 private school male students ($M = 2.51, SD = .87$) and 23 public school male students ($M = 2.47, SD = .96$) showed that there was no statistically significant difference in the TD perceived ($t(66) = .17, p = .87, d = .29$) between the two groups. The effect size was small based on Cohen (1988) classification.

Table 24:
Summary of Results in RQ2

Hypothesis	Test Statistic	p -value	M/SD -Group 1	M/SD -Group 2	Conclusion
2.1	$F = .21$	$p = .81$			Failed to reject H ₀
2.2	$t = -.12$	$p = .90$	2.56, .9	2.59, 1.04	Failed to reject H ₀
2.3	$t = -1.06$	$p = .3$	2.9, 1.14	2.56, .91	Failed to reject H ₀
2.4					Test was not run
2.5	$t = -1.41$	$p = .16$	2.39, .92	2.8, 1.08	Failed to reject H ₀
2.6					Test was not run
2.7	$t = -1.04$	$p = .30$	2.57, .96	2.85, 1.16	Failed to reject H ₀
2.8	$t = 3.75$	$p < .001$	3.33, 1.05	2.42, .90	Rejected H ₀
2.9	$t = -.03$	$p = .98$	2.62, .91	2.62, 1.04	Failed to reject H ₀
2.10					Test was not run
2.11	$t = .17$	$p = .87$	2.51, .87	2.47, .96	Failed to reject H ₀

Results for Research Question 3

The goal of research question 3 was to understand how demographic factors (e.g., gender, ethnicity) impact student perceptions of TD. The Levene's test for homogeneity and the Shapiro-Wilk test for normality were applied before the tests. The alpha level for significance from the Bonferroni correction was $p = .025$ obtained by dividing alpha (.05) by the number of test (2) in research question 3 (Sedgwick, 2012).

The tables 25 and 26 below shows *t*-test results for hypotheses 3.1 and 3.2 on demographic factors.

Table 25:
Descriptive Statistics of TD among Demographic Factors

Group 1	Group 2	Group 1			Group 2		
		<i>n</i>	<i>M</i>	<i>SD</i>	<i>n</i>	<i>M</i>	<i>SD</i>
Male (public)	Female (public)	23	2.47	.95	16	3.24	1.14
Caucasian (private)	Non-Caucasian (private)	37	2.49	.88	10	2.49	1.07

Table 26:
t-test Results of the Perception of TD among Demographic Factors

	<i>df</i>	<i>t</i>	<i>p</i> -value*	<i>d</i>
Male -female (public)	37	2.31	.03	3.33
Caucasian-non-Caucasian (private)	45	-.007	.99	.15

Bonferroni correction, $p \leq .025^*$

- H_0 3.1 stated that there is no statistically significant difference in TD perceived by male and female students in public school. The Shapiro-Wilk test showed that TD scores for male students ($W(23) = .92, p = .03$) were normally distributed and TD scores for the female students ($W(16) = .87, p = .02$) were not normally distributed. However, a visual inspection of the histograms (Fig 10) and box plots showed that the violation was not

massive (Razali & Wah, 2011). The t -test was carried out because of its robustness against violations of normality (Havlicek & Peterson, 1974).

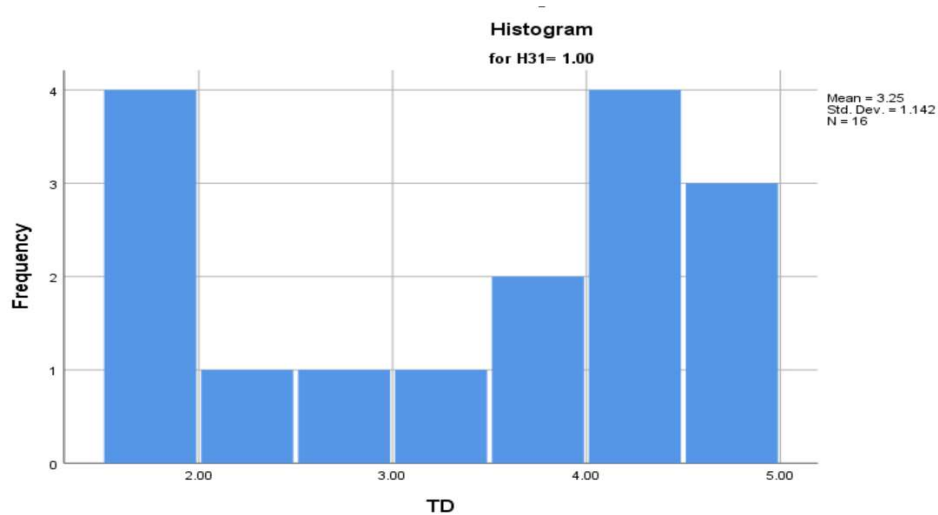


Figure 11: Histogram of TD Scores for Female Students

The Levene's test ($F(37) = 2.19, p = .15$) showed that the assumption of homoscedasticity was met. The results of the t -test of 23 male high school students ($M = 2.47, SD = .95$) and 16 female high school students ($M = 3.24, SD = 1.14$) showed that there was no statistically significant difference (Based on the Bonferroni correction, $p \leq .25$) in the TD perceived ($t(37) = 2.31, p = .03, d = 3.33$) between the two groups. The effect size was large based on Cohen's (1988) classification.

- H_0 3.2 stated that there is no statistically significant difference in TD perceived students from different ethnicities. The Shapiro-Wilk test showed that TD scores for Caucasian students ($W(37) = .98, p = .65$) and TD scores for non-Caucasian students ($W(10) = .93, p = .41$) were normally distributed. The Levene's test ($F(45) = 1.57, p = .22$) showed that

the assumption of homoscedasticity was met. The results of the *t*-test of 37 Caucasian students in private school ($M = 2.49$ $SD = .88$) and 10 non-Caucasian students in private school ($M = 2.49$, $SD = 1.07$) showed that there was no statistically significant difference in the TD perceived ($t(45) = -.007$, $p = .99$, $d = .15$) between the two groups. The effect size was small based on Cohen (1988) classification

Table 27:
Summary of Results in RQ3

Hypothesis	<i>t</i> -test statistic	<i>p</i> value	<i>M/SD</i> - Group 1	<i>M/SD</i> - Group 2	Conclusion
3.1	2.31	.03	2.47, .95	3.24, 1.14	Failed to reject H_0
3.2	-.007	.99	2.49, .88	2.49, 1.07	Failed to reject H_0

Summary

The results in this chapter revealed that TD correlates negatively with dialogue, structure, and learner autonomy. The results further suggested that the paired model of high dialogue and high structure (+D+S) was the most effective in reducing TD and that the low dialogue low structure (-D-S) model was the least effective. Regarding the environmental factors, the results showed that none of the following categories had a statistically significant impact on TD: different types of instructional media, synchronous or asynchronous communications, volunteering to take online classes, participation in group discussions, class size, school attended, previous online experience, and gender.. However, the preference for online classes was found to have a statistically significant impact on TD. Regarding demographic factors, there was no statistically significant difference in TD perceived between male and female students in public school and no significant differences in perceived TD between Caucasian and non-Caucasian students.

CHAPTER FIVE: DISCUSSION AND CONCLUSIONS

Introduction

The purpose of this correlational and causal-comparative study was to empirically verify the association between transactional distance (TD), structure, dialogue, and learner autonomy and to investigate the impact of environmental and demographic factors on TD in courses offered at online schools (Grade 7-12) in Memphis, Tennessee. This chapter includes sections on the summary of the discussions of the findings and suggestions on improvement of practice. The chapter concludes with a discussion of the limitations of the study, recommendations for future research, and a summary. This chapter contains discussions to help answer the three research questions for the study:

1. How do structure, dialogue, and learner autonomy impact student perceptions of TD?
2. How do environmental factors (e.g., instructional media, class size, required courses, required participation in group discussions, number of previous online courses taken, preference for online courses, school type, grade) impact student-perceptions of TD?
3. How do demographic factors (gender and ethnicity) impact student perceptions of TD?

Summary of Discussions and Findings

In this section, for each finding, an assertion of the results is made, followed by a discussion. A link to the literature explaining how the finding compares to existing literature will be discussed.

Summary and Discussion of Research Question 1

The results found that there exists an inverse relationship between TD and the constructs (i.e., high dialogue, high structure, and high learner autonomy leads to low TD). This finding supported existing literature that high dialogue reduces TD (Benson & Samarawickrema,2009;

Kearsley&Lynch,1996; Moore,1993). High structure has been cited in literature as contributing to low TD (Dron et al, 2004; Saba & Shearer, 1994). A previous study suggests that high structure affects TD directly due to the presence of multiple communication channels, which increases dialogue and therefore reduces TD (Chen, 2001a). Another study reinforces the inverse relationship between learner autonomy and TD (Moore & Kearsley, 2005). However, this study's results showed a stronger correlation between both TD and structure and learner autonomy and TD than between TD and dialogue; this result is inconsistent with literature identifying dialogue as the most effective in reducing TD (Benson & Samarawickrema, 2009). The reason for this inconsistency could be due to the use of multiple communication and interactive channels. These channels impact the possible formats of dialogue and structure, and thus lead to a lower perception of TD overall (Chen, 2001b). Although this study did not focus on the correlation between structure and dialogue, results showed that dialogue and structure were directly related. This result agrees with literature suggesting that increasing structure also increases dialogue (Dron et al, 2004; Saba & Shearer, 1994). The direct relation may be attributed to student's accessibility to more modern, usable, and functional learner-interphase components of structure that increase dialogue (Huang et al., 2015).

The results showed that high dialogue and high structure (+D+S) leads to lower TD than high dialogue-low structure (+D-S). It also showed that low dialogue and low structure (-D-S) leads to the highest TD. These results are consistent with previous research (Benson & Samarawickrema, 2009, Moore, 1991, 1993; Moore & Kearsley, 2005). Looking at the post hoc comparisons, students in +D+S and -D-S groups showed the largest difference in TD perceived. In addition, students in the +D-S group did not perceive a TD that was lower than the TD perceived by students in -D-S group, a result that is not consistent with previous research

suggesting that high dialogue lowers TD even in less structured classes (Benson & Samarawickrema, 2009; Huang et al., 2015; Moore, 1991, 1993; Moore & Kearsley, 2005). This inconsistency could be explained by the fact that students reported that dialogue in the courses under study was mostly asynchronous and thus may not have had an impact on TD (Huang et al., 2016; Moore & Kearsley, 2005). The small number of students ($n = 3$) in the -D+S category required that this group be excluded from the analysis. Furthermore, eliminating this group did not affect the overall finding that +D+S led to the lowest TD and -D-S led to the highest TD-- though additional research should consider the -D+S category.

Summary and Discussions of Research Question 2

The study hypothesized that there was no statistically significant difference in TD perceived by students using different communication types. The communication types considered were Web-Conferencing (e.g., hangouts, Skype), live audio (e.g., phone), text (e.g., text messages), broadcast audio/video, email and discussion forums, and Web 2.0 tools (e.g., Blogging, Twitter, Social media). Due to the small sample of students using Web-conferencing, student in this group were merged into the synchronous live audio group. Similarly, the small number of students who reported using Web 2.0 were merged with the asynchronous group of email and discussion forums. Web conferencing and live audio (e.g., phone) were considered live and offered a two-way communication channel. Web 2.0 tools such as Blogs and email/discussion forums were considered as asynchronous and two-way. Posted audio/video were considered as one-way communications and could not be merged into either synchronous/two way or asynchronous/two-way channel categories. Therefore, this category was removed from the analysis. The results found that the type of communication used did not significantly affect TD. This result is inconsistent with literature that suggests newer, more

interactive communications have an impact on the quality of dialogue and are more effective in reducing TD (Chen, 2001b, Huang et al., 2015; Moore, 1993; Moore & Kearsley, 2005). There were no statistically significant differences in TD perceived by students who used synchronous communications and students who used asynchronous communications. The results also suggested no statistically significant difference in TD perceived between students using live audio and email and discussion forums and between students using Web 2.0/email/discussion forums. Looking at the descriptive statistics, students who reported using Web conference and live audio (synchronous) revealed a slightly higher perception of TD than students using email/discussion (asynchronous). The above results contrast with studies finding that newer, more interactive channels increase the quality of dialogue than the less interactive ones (Chen, 2001b, Huang et al., 2015; Moore, 1993; Moore & Kearsley, 2005). The reason for this inconsistency could be due to students using multiple communication channels. Thus, there could be an overlap in how each communication type impacted TD during instruction (Chen, 2001b).

The descriptive statistics showed that students in small classes perceived lower TD than those in larger classes although the result was not statistically significant. These results occur from applying a more conservative significant level using the Bonferroni correction and contrast with Chen & Willits (1998) who concluded that the larger the class size created greater rigidity of course delivery and lower quality dialogue. According to literature on structure, a small class size implies less rigidity due to individualization of the content (Moore & Kearsley, 2005). On dialogue, smaller class sizes have been cited in literature as facilitating more communication frequency and quality of feedback between the teacher and learner (Saba & Shearer, 1994). In addition, the results found no statistically significant difference in perceived TD between

students who voluntarily took online courses and students who did not. This result agrees with Huang et al. (2015) who found that volunteering to take online classes did not impact TD.

There was also no statistically significant evidence that participation in group or class discussion impacted TD. This is contrary to literature that suggests the presence of class discussion forums may help alleviate some of the perceived distance by making up for low teacher-student dialogue and providing an opportunity for students to share in knowledge creation (Chen & Willits, 1998; Ekwunife-Orakwue & Teng, 2014; Garrison, 2000; Moore, 1993). The conclusions from previously mentioned studies were made in a setting where students are more mature and capable of engaging in higher quality discussions. According to literature, the quality of discussion has an impact on TD (Dron, 2005; Moore, 1993). In high school classroom discussions, very structured moderation by the teacher is required to make the discussions purposeful and constructive, even in face-to-face settings. Therefore, in this study, although no metric was in place to measure it, discussion quality could have played a part in impacting dialogue and therefore TD.

Students who preferred face-to-face classes and students who preferred online classes were found to perceive significantly different TD, a result that agrees with the original study by Huang, et al (2016). According to Huang, preference for online courses may have been influenced by previous experience. In this study, previous experience was not included in the analysis due a small sample of students with previous experience. The results showed that more students preferred face-to-face courses and more students reported having no previous experience, possibly the result of study respondents being younger learners.

On middle and high school students, the small sample size of middle school students ($n = 2$) prevented this analysis from being run. In addition, whether a student attended public or

private school had no statistically significant impact on TD. In this study, the comparison was done between male students in private and public schools. Although there is no literature on perception of TD between private and public schools, the lack of statistically significant difference is in contrast with the fact that the private school in this study generally had smaller class sizes and students in smaller classes have been cited in literature as perceiving lower TD (Chen & Willits, 1998).

Summary and Discussions of Research Question 3

This study found that gender did not have a statistically significant impact on TD. The comparison was done among male and female students in public school. This result agrees with Chen (2001a) who concluded that gender does not have a statistically significant effect on TD. In this study, the small number of female respondents in the sample could have increased the probability of Type I error. Furthermore, the small effect size implies that the difference between the two groups was not large. Concerning ethnicity, the comparison was made between Caucasian and non-Caucasian students at the private school.

On ethnicity, there was no statistically significant difference in TD perceived by Caucasian and non-Caucasian students in agreement with literature asserting that ethnicity does not have an impact on TD (Huang et al, 2016). The lack of a statistically significant difference could be a result of the Caucasian and non-Caucasian students at the private school originating from similar social-economic backgrounds. Overall, the lack of impact by demographic factors could be partly explained by the fact that OLEs offer learning opportunities in ways that transcend the traditional brick and mortar learning model, evening out the differences in resources, time and space (Pulham & Graham, 2018).

Limitations

There were several limitations to this study compared to the original study. The first limitation was the small sample size of students using Web Conferencing and Web 2.0 tools, female students, and middle school (grade 6-8) students. The small samples and the uneven numbers across groups may have contributed to a high probability of Type I errors and low power of the tests. The second limitation was that students were asked to report the most used type of communications in their classes. In the environmental and demographic questionnaire, students were asked to choose between Web conferencing, phone, text messaging, posted audio/video, email, discussion forums, or Web 2.0 (i.e., blogs, wikis, Twitter) as the most used channel of communication in their online classes. This data was used to group students into classes that were either synchronous or asynchronous. Student who indicated that either Web conferencing, phone, or text messaging were mostly used in their classes were classified as synchronous. Students in classes that mostly used email, discussion forums, or Web 2.0 were classified as asynchronous. Students could have been in classes that were asynchronous for lessons that did not require interaction but the switched to a more interactive tool such as Web conferencing during activities that required more interaction. Thus, there could have been an overlap of students being in classes that were both synchronous and asynchronous, resulting in the two groups not being mutually exclusive. The third limitation may have been due to the use of multiple *t*-tests which may have increased the probability of committing Type I errors. This was addressed by applying the Bonferroni correction. The fourth limitation was how to interpret school type. The private school had smaller class sizes than the online public school. It was not possible to tell if the impact of class size on TD was confounded by other factors such as social-economic differences between public and private school students. The fifth limitation was that full year science courses at the public school were mostly offered to honors students because

such courses require more rigor and are faster paced than one-semester online courses. By focusing on full-year science courses, the sample excluded most students in the public online school who took non-honors online courses. This was not the case in the private school where any student in the school could take full-year online science courses. Thus, the sample may not have been representative of most students in the online public-school population, leading to selection bias. Furthermore, this study did not have data on the demographics of the honors student's population in the public school. Given the selection effect described above, demographic data in honors classes may help to explain why Caucasian students were much more highly represented in the sample given that the online public school operates in a district with a large population of non-Caucasian students. The sixth limitation was the instrument. As noted in chapter three, the instrument was developed in higher education settings. Some of the items in structure had an overlap with dialogue due to the nature of feedback given in higher education. In the case of structure, the variable had 35 items, contributing to the overall 85 item long survey, a reason that could have contributed to 8 students quitting the survey midway. The seventh limitation was that the instrument asked students to report their perception of TD and thus it was not possible to tell if this was the actual TD experienced during online instruction

Recommendations for Future Research

Given the above limitations, future research should incorporate the following features that were not adequately addressed in this study.

Expand number of subjects. As noted in the limitations above, students taking full-year science courses were mostly honors students in the public setting while regular students took the same courses in private school. This may have excluded regular students from the sample in public schools and limited the sample sizes. To address this, future research should

include students from other subjects, especially the core subject of Math, English and Language Arts and Social Studies. This could result in a larger sample for the environmental factors. In addition, broadening the sample to include students from multiple subjects could reduce the chance of having uneven groups and reduce the chances for violations of normality in the ANOVA and the *t*-tests.

Combine variables. As noted in the limitations, some environmental factors overlapped, such as in the synchronous and asynchronous groups. To avoid this limitation, future research could exclude classifying students as synchronous and asynchronous and instead focus on variables that are mutually exclusive. Further, students in the Web 2.0, live audio, and text messaging groups could all be combined into a larger group of live communications in future research. This study also sought to understand the impact on TD of school type. As stated in the limitation, distinguishing what factors in public or private school caused the difference was impossible due to multiple confounding factors in the two settings. Instead, future research should eliminate this question and only focus on specifics, such as class size in specific settings. Reducing the number of environmental factors in the original design would increase the statistical power (i.e., reduce probability of committing Type I errors) and reduce the probability of having multiple violations of normality that were observed in the data.

Modify the TD instrument. As noted in the limitations, the instrument was very long and could have contributed to some students quitting midway during the survey. Future studies on this topic may consider revising the instrument to reduce the number of items by eliminating items where, for example, structure and dialogue seemed to be asking the same questions. In addition, questions relating to previous research should be reworded to ensure the student understands the previous research refers to their previous experience in online courses only.

Furthermore, to address the limitation of students self-reporting their perception of TD, the instrument could be extended to also correlate their perception of TD with their actions as recorded by the LMS during instruction.

Suggestions to Improve Practice

The results of this research provide important suggestions for the instructional designers of online courses, online teachers, school administrators, and technology coordinators.

Suggestions for Instructional Designers of K-12 Online Courses

Education K-12 online programs rely on already designed courses delivered by course design vendors. Such courses might be very rigidly composed by the instructional designer, and leave no room for instructor modification (Borup, Graham, & Drysdale, 2014; Moore, 1993). To improve their courses, instructional designers can increase structure through the inclusion of learner-content and learner-interphase interactions. Learner-content interaction can be increased by adding elements of formality (e.g. clearly defined objectives, activities, and assessments) and individualization (e.g. flexible pacing). Learner-interphase can be improved by delivering content through user-friendly and intuitive tools (Saba & Shearer, 1994). Instructional designers also need to make room for functionality that allows for customization by online instructors, to further modify the learning objectives, activities, evaluation, and how technology is used for individual learners. In addition, designers need to incorporate Web conferencing capabilities to the LMS to improve synchronous teacher-learner interaction.

Suggestions for Online Teachers

The results for this study emphasize the necessity of online instructors to evaluate the level of student's learner autonomy at the beginning of the course. The less autonomous learners can then have more opportunities for dialogue made available to them, considering high

dialogue has been found in literature to be effective in reducing TD. Online students could also have their courses customized to improve structure by increasing the learner-content and learner-interphase elements of the course. This can be achieved by increasing the length of time they need to complete assignments, modification of their learning objectives, activities, evaluation, how they will use the technology during instruction, and use of the adaptive technology to assist those learners (Pulham & Graham, 2018). Online instructors should also consider utilizing multiple synchronous communication channels to improve teacher-learner and learner-learner dialogue. As the results show, synchronous learning was rarely used in both context under study. The results showed that preference for online or face-to-face classes had a significant effect on student perception of TD. For this reason, instructors need ask students about their preferences before assigning students into online classes. Special attention should be paid to incorporate strategies to reduce TD for those students who prefer face-to-face courses but are required to take an online course.

Suggestions for School Administrators and Technology Coordinators.

First, the results of this study can inform school administrators and technology coordinators on teacher-student ratio. As was revealed by the results on the question of class sizes, smaller classes have an impact on dialogue and structure of online courses. Smaller class sizes improve the frequency and quality of feedback, and thus improving dialogue. Smaller class sizes allow an online instructor to increase structure by using a variety of strategies (e.g. discussion, reflection, demonstration, group work, and case studies) to meet the learner's needs individually (Pulham & Graham, 2018). In addition, the learner-interphase component of structure can be improved by the administration purchasing or leasing an LMS that has user-friendly interphase, synchronous communication capabilities, and design easy to learn.

Conclusion

The goal of this study was to empirically investigate the association between TD and structure, dialogue, and learner autonomy and additionally investigate the impact of environmental and demographic factors on TD in courses offered at online schools (Grades 7-12). By applying the TD theory, this study aimed to empirically determine if the relationships between TD, structure, dialogue, and learner autonomy hold and how environmental and demographic factors are manifested in TD in middle and high school online learning environments. This study was a replication of a study conducted in a higher-education setting.

Research question 1 sought to investigate the relation between TD and structure, dialogue and learner autonomy. All hypotheses in research question 1 were supported by the results that showed an inverse relationship between TD and structure, between TD and dialogue, and between TD and learner autonomy, as stated in Moore's theory. Further, the study validated the finding that combining a high dialogue and high structure in online learning results in the lowest perception of TD. Thus, research question 1 was empirically verified. The results provide very significant implications and suggestions to online instructors, instructional designers of K-12 online courses, and school administrators involved in the implementation of K-12 OLE.

Research question 2 sought to investigate if environmental factors had an impact on TD. The study's results only supported the hypothesis that preference for online classes had a significant impact on TD. The differences in TD between all other groups (i.e. communication types, synchronous teaching, class size, volunteering, class discussion, and type of school) were very small and could not meet the standards for statistical significance. The overall conclusion, therefore, is that environmental factors did not have a statistically significant effect on TD

perceived by students taking online courses in grades 7-12. Thus, research question 2 was not empirically verified. However, looking at the descriptive statistics, the recurring theme was that students who had small classes and discussion groups perceived less TD. Overall, research questions 2 warrants further investigation with larger sample sizes.

Research question 3 sought to find if demographic factors of gender and ethnicity have a statistically significant impact on TD. Gender and ethnicity did not have a statistically significant impact on TD. Thus, research question 3 was not empirically verified by the results. However, the lack of impact of gender on TD maybe due to the small number of female students in this study. Research questions 3 merits further investigation with larger sample sizes.

REFERENCES

- Abdullah, M. B. (1990). On a robust correlation coefficient. *Journal of the Royal Statistical Society: Series D (The Statistician)*, 39(4), 455-460.
- Allen, I. E., & Seaman, C. A. (2007). Likert scales and data analyses. *Quality progress*, 40(7), 64-65.
- Allen, I. E., Seaman, J., Poulin, R., & Straut, T. T. (2016). *Online report card: Tracking online education in the United States*. Babson Survey Research Group and Quahog Research Group, LLC. Retrieved at <http://onlinelearningsurvey.com/reports/online-report-card.pdf>
- Archambault, L., & Crippen, K. (2009). Examining TPACK among K-12 online distance educators in the United States. *Contemporary Issues in Technology and Teacher Education*, 9(1), 71-88.
- Armstrong, R. A. (2014). When to use the Bonferroni correction. *Ophthalmic and Physiological Optics*, 34(5), 502-508
- Avella, J. T., Kebritchi, M., Nunn, S. G., & Kanai, T. (2016). Learning analytics methods, benefits, and challenges in higher education: A systematic literature review. *Online Learning*, 20(2), 13-29. <https://doi.org/10.24059/olj.v20i2.790>
- Baker, J. D., Bouras, C., Hartwig, S. M., & McNair, E. R. (2005). K12 Inc. and the Colorado Virtual Academy: A virtual charter school. In Z. L. Berge & T. Clark (Eds.), *Virtual schools: Planning for success*. New York, NY: Teachers College Press.
- Barbour, M. K., & Reeves, T. C. (2009). The reality of virtual schools: A review of the literature. *Computers and Education*, 52(2), 402-416.

- Barnett, E., & Kim, J. (2014). *Expanding access to dual enrollment and college: A case study of Memphis city schools*. Retrieved from the National Alliance of Concurrent Enrollment Partnerships website: <http://nacep.org/docs/research-and-policy/MCSCaseStudy.pdf>
- Beck, D., & LaFrance, J. (2017). Online schooling in the United States: A response to Saultz and Fusarelli. *Journal of School Choice, 11*(1), 42-59.
<https://doi.org/10.1080/15582159.2016.1272937>
- Benson, R., & Samarawickrema, G. (2009). Addressing the context of e-Learning: Using transactional distance theory to inform design. *Distance Education, 30*(1), 5-21.
<https://doi.org/10.1080/01587910902845972>
- Bishara, A. J., & Hittner, J. B. (2012). Testing the significance of a correlation with non-normal data: comparison of Pearson, Spearman, transformation, and resampling approaches. *Psychological methods, 17*(3), 399.
- Bischoff, W. R., Bisconer, S. W., Kooker, B. M., & Woods, L. C. (1996). Transactional distance and interactive television in the distance education of health professionals. *American Journal of Distance Education, 10*(3), 4-19. <https://doi.org/10.1080/08923649609526937>
- Borup, J. (2016). Teacher perceptions of parental engagement at a cyber high school. *Journal of Research on Technology in Education, 48*(2), 67-83.
- Borup, J., Graham, C. R., & Drysdale, J. (2014). The nature of online teacher engagement at an online high school. *British Journal of Educational Technology, 45*, 793-806.
- Boyd, R., & Apps, J. (1980). *Redefining the Discipline of Adult Education*. San Francisco, CA: Jossey-Bass.
- Carliner, S. (2005). Course management systems versus learning management systems. *Learning Circuits, 6*(11), 1-7.

- Cassidy, L., Keating, K., & Young, V. (2010). *Dual enrollment: Lessons learned on school-level implementation*. Retrieved from <https://www2.ed.gov/programs/slcp/finaldual.pdf>
- Cavanaugh, C. (2001). The effectiveness of interactive distance learning technologies in K-12 learning: A meta-analysis. *International Journal of Educational Telecommunications*, 7(1), 73-78.
- Cavanaugh, C., Gillan, K. J., Kromrey, J., Hess, M., & Blomeyer, R. (2004). *The effects of distance education on K-12 student outcomes: A meta-analysis*. Retrieved from <https://files.eric.ed.gov/fulltext/ED489533.pdf>
- Chen, N. S., Kinshuk, P., Hsieh, S. W., & Yang, S. J. (2006). Interaction comparison between traditional classroom and cyber classroom using transactional distance. *Sixth IEEE International Conference of Advanced Learning Technologies (ICALT '06)*, 626-628. <https://doi.org/10.1109/ICALT.2006.1652519>
- Chen, Y. J. (2001a). Dimensions of transactional distance in World Wide Web learning environment: A factor analysis. *British Journal of Educational Technology*, 52(4), 459-470.
- Chen, Y. J. (2001b). Transactional distance in World Wide Web learning environments. *Innovations in Education and Teaching International*, 55(4), 327-338. <https://doi.org/10.1080/14703290110074533>
- Chen, Y. J., & Willits, F. K. (1998). A path analysis of the concepts in Moore's theory of transactional distance in a videoconferencing learning environment. *American Journal of Distance Education*, 13(2), 5-65.
- Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Hillsdale, NJ: Erlbaum.

- Cohen, P., West, S. G., & Aiken, L. S. (2014). *Applied multiple regression/correlation analysis for the behavioral sciences* (3rd ed.). Mahwah, NJ: Erlbaum.
- Creswell, J. W., & Creswell, J. D. (2017). *Research design: Qualitative, quantitative, and mixed methods approaches* (5th ed.). Thousand Oaks, CA: SAGE Publications.
- De la Varre, C., Keane, J., & Irvin, M. J. (2011). Enhancing online distance education in small rural US schools: A hybrid, learner-centered model. *Journal of Asynchronous Learning Networks*, 15(4), 193-205 <https://doi.org/10.24059/olj.v15i4.205>
- Dewey, J., & Bentley, A. (1949). *Knowing and the known*. Boston, MA: Beacon Press.
- Diep, A. N., Zhu, C., Struyven, K., & Blicek, Y. (2017). Who or what contributes to student satisfaction in different blended learning modalities? *British Journal of Educational Technology*, 48(2), 473-489. <https://doi.org/10.1111/bjet.12431>
- Dixson, M. D. (2010). Creating effective student engagement in online courses: What do students find engaging? *Journal of the Scholarship of Teaching and Learning*, 10(2), 1–13.
- Dron, J., Seidel, C., & Litten, G. (2004). Transactional distance in a blended learning environment. *ALT-J*, 12(2), 163-174. DOI: 10.1080/0968776042000216219
- Dron, J. (2005). E-learning and the building habits of termites. *Journal of Educational Multimedia and Hypermedia*, 14, 321-342.
- Ekwunife-Orakwue, K. C., & Teng, T. L. (2014). The impact of transactional distance dialogic interactions on student learning outcomes in online and blended environments. *Computers & Education*, 78, 414-427. <https://doi.org/10.1016/j.compedu.2014.06.011>

- Fathema, N., Shannon, D., & Ross, M. (2015). Expanding the Technology Acceptance Model (TAM) to examine faculty use of Learning Management Systems (LMSs) in higher education institutions. *Journal of Online Learning & Teaching*, 11(2), 210-237.
- Firat, M., & Yuzer, V. (2016). Learning analytics: Assessment of mass data in distance education. *International Journal on New Trends in Education and Their Implications*, 7(2), 51-63.
- Fritz, J. (2016). LMS course design as learning analytics variable. In J. Greer, M. Molinaro, X. Ochoa, & T. McKay (Eds.), *Proceedings of the 1st Learning Analytics for Curriculum and Program Quality Improvement Workshop* (pp. 15-19). Retrieved from <http://ceur-ws.org/Vol-1590/>
- Garrison, D. R. (2000). Theoretical challenges for distance education in the 21st century: A shift from structural to transactional issues. *The International Review of Research in Open and Distance Learning*, 1(1), 1-17.
- Giossos, Y., Koutsouba, M., Lionarakis, A., & Skavantzios, K. (2009). Reconsidering Moore's transactional distance theory. *European Journal of Open, Distance and E-Learning*, 12, 1-6.
- Goel, L., Zhang, P., & Templeton, M. (2012). Transactional distance revisited: Bridging face and empirical validity. *Computers in Human Behavior*, 28(4), 1122-1129.
<https://doi.org/10.1016/j.chb.2012.01.020>
- Gorsky, P., & Caspi, A. (2005). A critical analysis of transactional distance theory. *Quarterly Review of Distance Education*, 6(1), 45-56.

- Greene, K., & Hale, W. (2017). The state of 21st century learning in the K-12 world of the United States: Online and blended learning opportunities for American elementary and secondary students. *Journal of Educational Multimedia & Hypermedia*, 26(2), 131-159.
- Harpe, S. E. (2015). How to analyze Likert and other rating scale data. *Currents in Pharmacy Teaching and Learning*, 7(6), 836-850.
- Hassell, B. C., & Terrell, M. G. (n.d.). *How can virtual schools be a vibrant part of meeting the choice provisions of the No Child Left Behind Act?* Retrieved from <http://nmoled.org/Hassel-Terrell-VirtualSchools.pdf>
- Havlicek, L. L., & Peterson, N. L. (1974). Robustness of the t test: A guide for researchers on effect of violations of assumptions. *Psychological Reports*, 34(3_suppl), 1095-1114.
- Hawkins, A., Barbour, M. K., & Graham, C. R. (2012). “Everybody is their own island”: Teacher disconnection in a virtual school. *The International Review of Research in Open and Distributed Learning*, 13(2), 124-144.
- Hilliard, M. (2020, January 14th). Personal interview.
- Howell, D. C. (2008). *Fundamental statistics for the behavioral sciences* (6th ed.). Belmont, CA: Wadsworth.
- Huang, H. (2002). Student’s perceptions in an online mediated environment. *International Journal of Instructional Media*, 29(4), 405–422.
- Huang, X., Chandra, A., DePaolo, C., Cribbs, J., & Simmons, L. (2015). Measuring transactional distance in web-based learning environments: An initial instrument development. *Open Learning*, 30(2), 106–126. <https://doi.org/10.1080/02680513.2015.1065720>

- Huang, X., Chandra, A., DePaolo, C. A., & Simmons, L. L. (2016). Understanding transactional distance in web-based learning environments: An empirical study. *British Journal of Educational Technology*, 47(4), 734-747. <https://doi.org/10.1111/bjet.12263>
- Hussar, W. J., & Bailey, T. M. (2017). *Projections of education statistics to 2025* (NCES 2017-019). Retrieved from <https://files.eric.ed.gov/fulltext/ED576296.pdf>
- Ingram, V. H. (2016). Georgia virtual school: Student success in a computer-generated world. *Distance Learning*, 4(1), 33-37.
- Johnson, B., & Christensen, L. (2008). *Educational research: Quantitative, qualitative, and mixed approaches* (3rd ed.). Thousand Oaks, CA: SAGE Publications.
- Kasim, N. N. M., & Khalid, F. (2016). Choosing the right learning management system (LMS) for the higher education institution context: A systematic review. *International Journal of Emerging Technologies in Learning*, 11(6), 57-61. <https://doi.org/10.3991/ijet.v11i06.5644>
- Kassandrinou, A., Angelaki, C., & Mavroidis, I. (2014). Transactional distance among Open University students: How does it affect the learning process? *European Journal of Open, Distance and E-learning*, 17(1), 26-42. <https://doi.org/10.2478/eurodl-2014-0002>
- Kearsley, G., & Lynch, W. (1996). Structural issues in distance education. *Journal of Education for Business*, 71, 191–195. <https://doi.org/10.1080/08832323.1996.10116783>
- Kellogg, L., & Politoski, K. (2002). *Virtual schools across America: Trends in K-12 online education*. Los Angeles, CA: Peak Group Research Corporation.
- Kena, G., Hussar, W., McFarland, J., de Brey, C., Musu- Gillette, L., Wang, X., . . . Dunlop Velez, E. (2016). *The Condition of Education 2016* (NCES 2016-144). Retrieved from <https://nces.ed.gov/pubsearch/pubsinfo.asp?pubid=2016144>

- Kilgore, W., & Wagner, E. (2017). Dual enrollment from two points of view: Higher education and K-12. *College and University*, 92(3), 57–62.
- King, S. B. (2014). Graduate student perceptions of the use of online course tools to support engagement. *International Journal for the Scholarship of Teaching and Learning*, 8(1). doi:10.20429/ijstl.2014.080105
- Larkin, K., & Jamieson-Proctor, R. (2015). Using transactional distance theory to redesign an online mathematics education course for pre-service primary teachers. *Mathematics Teacher Education and Development*, 17(1), 44-61.
- Lazar, J., Jones, A., Bessiere, K., Ceaparu, I., & Shneiderman, B. (2004). User frustration with technology in the workplace. *AMCIS 2003 Proceedings. Paper 283*. Retrieved from <http://aisel.aisnet.org/amcis2003/283>
- Lix, L. M., Keselman, J. C., & Keselman, H. J. (1996). Consequences of assumption violations revisited: A quantitative review of alternatives to the one-way analysis of variance F test. *Review of educational research*, 66(4), 579-619.
- Marken, S., Gray, L., & Lewis, L. (2013). *Dual enrollment programs and courses for high school students at postsecondary institutions: 2010–11* (NCES 2013-002). Retrieved from <https://nces.ed.gov/pubs2013/2013002.pdf>
- McKee, H. (2017). An instructor learning analytics implementation model. *Online Learning*, 21(3), 87-102. <https://doi.org/10.24059/olj.v21i3.1230>
- Miron, G., & Gulosino, C. (2016). *Virtual schools report 2016: Directory and performance review*. Boulder, CO: National Education Policy Center. Retrieved from <http://nepc.colorado.edu/publication/virtual-schools-annual-2016/>

- Miron, G., & Urschel, J. L. (2012). *Understanding and improving full-time virtual schools: A study of student characteristics, school finance, and school performance in schools operated by K12 Inc.* Retrieved from <http://nepc.colorado.edu/publication/understanding-improving-virtual>
- Martin, F., & Bolliger, D. U. (2018). Engagement matters: Student perceptions on the importance of engagement strategies in the online learning environment. *Online Learning, 22*(1), 205-222. doi:10.24059/olj.v22i1.1092
- Molnar, A., Miron, G., Gulosino, C., Shank, C., Davidson, C., Barbour,...Nitkin, D. (2017). *Virtual schools in the U.S. 2017.* Retrieved from <http://nepc.colorado.edu/publication/virtualschoolsannual-2017>
- Moore, M. G. (1980). Independent study. In R. D. Boyd & J. W. Apps (Eds.), *Redefining the discipline of adult education* (pp. 16–31). San Francisco, CA: JosseyBass.
- Moore, M. (1990). Recent contributions to the theory of distance education. *Open Learning, 5*(3), 10-15. <https://doi.org/10.1080/0268051900050303>
- Moore, M. G. (1991). Editorial: Distance education theory. *The American Journal of Distance Education, 5*(3), 1–6. <https://doi.org/10.1080/08923649109526758>
- Moore, M. (1993). Theory of transactional distance. In D. Keegan (ed.), *Theoretical principles of distance education*. New York: Routledge, 22–38
- Moore, M. G. (2007). The theory of transactional distance. In M. G. Moore (Ed.), *Handbook of distance education* (pp. 89–105). Mahwah, NJ: Lawrence Erlbaum Associates.
- Moore, M. G. (2013). The theory of transactional distance. In M. G. Moore (Ed.), *Handbook of distance education* (3rd ed., pp. 66-85). New York, NY: Routledge.

- Moore, M. G. & Kearsley, G. (2005). *Distance education: A systems view* (2nd ed.). Belmont, CA: Wadsworth Publishing Company.
- Murphy, E., & Rodriguez-Manzanares, M. A. (2008). Revisiting transactional distance theory in a context of web-based high-school distance education. *Journal of Distance Education, 22*(2), 1-14.
- Onwuegbuzie, A. J. (2003). Expanding the framework of internal and external validity in quantitative research. *Research in the Schools, 10*(1), 71-90.
- Osguthorpe, R. T., & Graham, C. R. (2003). Blended learning environments: Definitions and directions. *Quarterly Review of Distance Education, 4*(3), 227-33.
- Paas, F., van Merriënboer, J. J. G., & Adam, J. J. (1994). Measurement of cognitive load in instructional research. *Perceptual and Motor Skills, 79*, 419-30.
<https://doi.org/10.2466/pms.1994.79.1.419>
- Paul, R. C., Swart, W., Zhang, A. M., & MacLeod, K. R. (2015). Revisiting Zhang's scale of transactional distance: Refinement and validation using structural equation modeling. *Distance Education, 36*(3), 364-382.
<https://doi.org/10.1080/01587919.2015.1081741>
- Percell, J. C. (2016). Data collaborative: A practical exploration of big data in course wikis. *Quarterly Review of Distance Education, 17*(4), 63-67.
- Porter, M. (2015). *Toward an understanding of faculty perceptions about factors that influence student success in online education*. Retrieved from <http://digitalcommons.fiu.edu>
- Pourreau, L. (2015). Interview with Joe Freidhoff: A bird's eye view of K-12 online learning. *Online Learning, 19*(5), 13. <https://doi.org/10.24059/olj.v19i5.746>

Powell, A., Watson, J., Staley, P., Patrick, S., Horn, M., Fetzer, L., ... International Association for K-12 Online Learning. (2015). *Blending Learning: The Evolution of Online and Face-to-Face Education from 2008-2015. Promising Practices in Blended and Online Learning Series. International Association for K-12 Online Learning*. International Association for K-12 Online Learning.

Pulham, E., & Graham, C. R. (2018). Comparing K-12 online and blended teaching competencies: A literature review. *Distance Education, 39*(3), 411-432.
<https://doi.org/10.1080/01587919.2018.1476840>

Razali, N. M., & Wah, Y. B. (2011). Power comparisons of shapiro-wilk, kolmogorov-smirnov, lilliefors and anderson-darling tests. *Journal of statistical modeling and analytics, 2*(1), 21-33.

Rice, K. L. (2006). A comprehensive look at distance education in the K-12 context. *Journal of Research in Technology in Education, 38*(4), 425-448.
<https://doi.org/10.1080/15391523.2006.10782468>

Rovai, A. P., Baker, J. D., & Ponton, M. K. (2013). *Social science research design and statistics: A practitioner's guide to research methods and IBM SPSS* (2nd ed.). Chesapeake, VA: Watertree Press LLC.

Ryan, S., Kaufman, J., Greenhouse, J., She, R. & Shi, J. (2016). The effectiveness of blended online learning courses at the community college level. *Community College Journal of Research and Practice, 40*(4), 285-298. <https://doi.org/10.1080/10668926.2015.1044584>

Saba, F. & Shearer, R. L. (1994). Verifying key theoretical concepts in a dynamic model of distance education. *The American Journal of Distance Education, 8*(1), 36-59.
<https://doi.org/10.1080/08923649409526844>

- Saultz, A., & Fusarelli, L. D. (2017). Online schooling: A cautionary tale. *Journal of School Choice, 11*(1), 29-41. <https://doi.org/10.1080/15582159.2016.1272928>
- Scully, P. (2019, November 20th). Personal interview.
- Sedgwick, P. (2012). Multiple significance tests: the Bonferroni correction. *Bmj, 344*, e509.
doi: <https://doi.org/10.1136/bmj.e509>
- Sessions, D. N., & Stevans, L. K. (2006). Investigating omitted variable bias in regression parameter estimation: A genetic algorithm approach. *Computational Statistics & Data Analysis, 50*(10), 2835-2854. <https://doi.org/10.1016/j.csda.2005.04.003>
- Shea, J., Joaquin, M., & Wang, J. (2016). Pedagogical design factors that enhance learning in hybrid courses: A contribution to design-based instructional theory. *Journal of Public Affairs Education, 22*(3), 381-397. <https://doi.org/10.1080/15236803.2016.12002254>
- Siemens, G., & Baker, R. S. d. (2012). Learning analytics and educational data mining: Towards communication and collaboration. *Proceedings of the 2nd International Conference on Learning Analytics and Knowledge, 252-254*. <https://doi.org/10.1145/2330601.2330661>
- Simonson, M., Schlosser, C., & Orellana, A. (2011). Distance education research: A review of the literature. *Journal of Computing in Higher Education, 23*(2), 124-142.
<https://doi.org/10.1007/s12528-011-9045-8>
- Sistek-Chandler, C., Tolbert, D., & Amber, V. K. (2012). Online learning is not flat: An analysis of online learning that promotes interactivity. *Distance Learning, 9*(4), 55-75.
- Stein, D. S., Wanstreet, C. E., Calvin, J., Overtoom, C., & Wheaton, J. E. (2005). Bridging the transactional distance gap in online learning environments. *The American Journal of Distance Education, 19*, 105-118. https://doi.org/10.1207/s15389286ajde1902_4

- Stockless, A. (2018). Acceptance of learning management system: The case of secondary school teachers. *Education and Information Technologies*, 23(3), 1101-1123.
<https://doi.org/10.1007/s10639-017-9654-6>
- U.S. Department of Education (2017). *Reimagining the role of technology in education: 2017 national education technology plan update*. Retrieved from
<https://tech.ed.gov/files/2017/01/NETP17.pdf>
- Warner, R. M. (2012). *Applied statistics: From bivariate through multivariate techniques*. Thousand Oaks, CA: Sage Publications
- Wang, Y., & Decker, J. (2014). Can virtual schools thrive in the real world? *TechTrends*, 58(6), 57-62.
- Waters, L. H., Barbour, M. K., & Menchaca, M. P. (2014). The nature of online charter schools: Evolution and emerging concerns. *Journal of Educational Technology & Society*, 17(4), 379-389.
- Watson, J., Gemin, B., Ryan, J., & Wicks, M. (2009). *Keeping pace with K-12 online learning: An annual review of state-level policy and practice*. Retrieved from
<https://www.evergreenedgroup.com/s/KeepingPace-2009.pdf>
- Wikeley, F., & Muschamp, Y. (2004). Pedagogical implications of working with doctoral students at a distance. *Distance Education*, 25(1), 125-142.
- Zhang, A. M. (2003). *Transactional distance in web-based college learning environments: Toward measurement and theory construction* (pp. 1-234). Virginia Commonwealth University, Richmond. Retrieved from <https://www.learntechlib.org/p/117282/>

APPENDIX A

Environmental and Demographic Survey

There are eleven questions on environmental and demographic factors. The survey should take about two minutes to complete.

Environmental Factors

1. In this class, the most used means of communication between me and my instructor was:
 - a) Live audio and video communication (Web Conference)
 - b) Live audio communication (Phone)
 - c) Live text communication (Text messages)
 - d) Broadcast audio/video (Posted audio/video messages)
 - e) Email and/or discussion forums
 - f) Web 2.0 (Blogs, Wikis, or Twitter)
2. Are you taking a yearlong online science course?
 - a) Yes
 - b) No
3. Did you volunteer to take this class or was there an option for you to take the course in a regular class?
 - a) Yes
 - b) No
4. In this class, are you required to participate in group discussion?
 - a) Yes
 - b) No
5. Do you prefer online or face-to-face classes?

- a) Online
 - b) Face-to-face
6. Prior to the semester, I have taken other online classes.
- a) Yes
 - b) No
7. I am a full-time online student.
- a) Yes
 - b) No
8. Are you in middle school or high school?
- a) Middle school
 - b) High School
9. Are you in public or private school?
- a) Public
 - b) Private

Demographic Factors

- 10 Gender
- a) Male
 - b) Female
1. Ethnicity
- a) White
 - b) Other

APPENDIX B

TRANSACTIONAL DISTANCE INSTRUMENT

There are 85 questions on your perception of an online yearlong science course that you are currently taking. Make sure you are referencing only that course. The survey should take about 15 minutes to complete. The key below will help you make your choices. There are no right or wrong answers.

Key

SD	MD	DS	N	AS	A	SA
Strongly Disagree	Disagree	Disagree Somewhat	Neutral	Agree Somewhat	Agree	Strongly Agree

Transactional Distance Instrument

Item	Dialogue: Learner-Instructor	SD	MD	DS	N	AS	A	SA
1	I communicate with my instructor on course-related issues at least once a week	0	0	0	0	0	0	0
2	I communicate with my instructor through multiple communication channels (e.g. emails, phone, discussion board and online chat)	0	0	0	0	0	0	0
3	I have opportunities to communicate with my instructor real time in this online class	0	0	0	0	0	0	0
4	Communication between me and the instructor in this online class is a dynamic two-way communication	0	0	0	0	0	0	0
5	I actively engage in dialogues with my instructor to construct and share knowledge	0	0	0	0	0	0	0
6	My communication with the instructor in this online class is intensive	0	0	0	0	0	0	0
7	My communication with the instructor in this course is constructive/helpful in achieving learning objectives	0	0	0	0	0	0	0
8	My communication with the instructor in this online class is something I look forward to	0	0	0	0	0	0	0

9	I value my communication with the instructor on course-related issues	0	0	0	0	0	0	0
10	The instructor values my input in our communication	0	0	0	0	0	0	0
Item	Dialogue: Learner-Learner	0	0	0	0	0	0	0
11	I communicate with my fellow students on course-related issues at least once a week	0	0	0	0	0	0	0
12	I communicate with my fellow students through multiple communication channels (e.g. email, phone, discussion board, and online chat)	0	0	0	0	0	0	0
13	I have opportunities to communicate with my fellow students in real time during this online class	0	0	0	0	0	0	0
14	Communication between me and other students in this online class is a dynamic two-way communication	0	0	0	0	0	0	0
15	I actively engage in dialogues with other students to construct and share knowledge	0	0	0	0	0	0	0
16	My communication with other students in this online class is intensive	0	0	0	0	0	0	0
17	My communication with other students in this course is constructive/helpful in achieving learning objectives	0	0	0	0	0	0	0
18	My communication with other students in this online class is something I look forward to	0	0	0	0	0	0	0
19	I value my communication with other students on course-related issues	0	0	0	0	0	0	0
20	I believe that other students value my input in our communication	0	0	0	0	0	0	0
Item	Structure: learner-content interaction	SD	D	DS	N	MA	A	SA
21	I receive individualized feedback on my assignments, projects or other required course tasks	0	0	0	0	0	0	0
22	The course is structured in a way that provides me ample opportunities to ask questions and receive useful feedback	0	0	0	0	0	0	0
23	The course is structured in a way that enables me to work at my own pace to meet the course goals and objectives	0	0	0	0	0	0	0
24	The course is structured in a way that encourages me to negotiate with the instructor on the learning objectives, activities, evaluation, and technology use for this online course	0	0	0	0	0	0	0
25	The course is tailored to my learning needs that enable me to apply my learning to real-world experiences	0	0	0	0	0	0	0

26	The course is structured in a way that my difficulties during the learning process (e.g. unexpected problems) are accommodated.	0	0	0	0	0	0	0
27	The course is structured in a way that enables me to incorporate my previous experience into the course	0	0	0	0	0	0	0
28	I am challenged to achieve to the best of my abilities through instructor focus on individualized instruction and additional resources for advanced learning	0	0	0	0	0	0	0
29	The course is structured in a way that the instructor uses our feedback to modify course material to better meet our learning needs	0	0	0	0	0	0	0
30	The course is structured in a way that encourages me to make my learning needs clear	0	0	0	0	0	0	0
31	The course content is presented using multiple formats such as text, audio, and video	0	0	0	0	0	0	0
32	A variety of instructor strategies (e.g. discussion, reflection, demonstration, group work, and case study) are used in this course to meet our learning needs	0	0	0	0	0	0	0
33	The course is structured in a way that multiple methods (e.g. assignments, discussion participation, projects and exams) are used to assess my class performance	0	0	0	0	0	0	0
34	The course provides both one-way and two-way communication channels for me to connect to my instructor and fellow students	0	0	0	0	0	0	0
35	I have been given ample opportunities to practice before the final assessment of my performance	0	0	0	0	0	0	0
36	A detailed syllabus with clearly defined course objectives and schedule of content is provided at the beginning of the semester for this online course	0	0	0	0	0	0	0
37	Clear guidelines/rubrics on assignments, projects, or other course-related tasks are provided for this online course	0	0	0	0	0	0	0
38	Clear guidelines regarding the desired quantity/quality of communications in this online course are provided	0	0	0	0	0	0	0
39	Specific due dates for assignments and other course-related tasks are set for this online course	0	0	0	0	0	0	0

40	A detailed course schedule/calendar is provided for this online course	0	0	0	0	0	0	0
41	A detailed course policy (e.g. late submission, missed tests, and online discussion behaviors) is provided for this online course	0	0	0	0	0	0	0
42	Course expectations are clearly laid out at the beginning of the semester	0	0	0	0	0	0	0
43	Course content is organized in manageable segments (e.g. distinct learning modules)	0	0	0	0	0	0	0
Item	Structure: learner–interface interaction	SD	D	DS	N	MA	A	SA
44	I am comfortable working with the course delivery system (e.g. Blackboard) and other technologies required for this course	0	0	0	0	0	0	0
45	I understand how to effectively use the technologies required for this online class	0	0	0	0	0	0	0
46	I have the necessary knowledge and skills to use the technologies required for this online class	0	0	0	0	0	0	0
47	I have the freedom to choose the technologies I feel comfortable using to communicate with my instructor and fellow students	0	0	0	0	0	0	0
48	A variety of delivery media (e.g. broadcast audio or video, 2-way video, and DVD) are used in this course	0	0	0	0	0	0	0
49	I have been given ample opportunities to practice the technologies before I am required to use them for course activities	0	0	0	0	0	0	0
50	The course content is spatially and visually well organized	0	0	0	0	0	0	0
51	The course site is attractive and visually appealing	0	0	0	0	0	0	0
52	The instructor provides resources or tutorials/links to tutorials on technologies used in this online class	0	0	0	0	0	0	0
53	The instructor provides technical support information in case we encounter technical problems for this online class	0	0	0	0	0	0	0
54	It is easy to navigate the course site to look for the information that I need	0	0	0	0	0	0	0
55	I often get lost looking for the information in the course site	0	0	0	0	0	0	0
Item	Learner Autonomy	SD	D	DS	N	MA	A	SA
56	I enjoy new learning experiences	0	0	0	0	0	0	0
57	Even when tasks are difficult, I try to stick with them	0	0	0	0	0	0	0
58	I enjoy finding information about new topics on my own	0	0	0	0	0	0	0

59	I am open to new ways of doing familiar things	0	0	0	0	0	0	0
60	I take responsibility for my learning experiences	0	0	0	0	0	0	0
61	I enjoy being given a challenge	0	0	0	0	0	0	0
62	I frequently find excuse for not getting down to work	0	0	0	0	0	0	0
63	I plan my time for study effectively	0	0	0	0	0	0	0
64	I am good at meeting deadlines	0	0	0	0	0	0	0
65	My time management is good	0	0	0	0	0	0	0
Item	Transactional Distance:	SD	D	DS	N	MA	A	SA
66	I feel a strong sense of belonging to this online course	0	0	0	0	0	0	0
67	I feel this online class is a cohesive learning community	0	0	0	0	0	0	0
68	I feel a strong sense of belonging to a cohesive learning community in this online course	0	0	0	0	0	0	0
69	I feel closely connected to my instructor in this online course	0	0	0	0	0	0	0
70	I feel a strong sense of 'being with' my instructor during my learning process	0	0	0	0	0	0	0
71	I feel the presence of my instructor in this online course, despite the physical distance between us	0	0	0	0	0	0	0
72	I feel a strong rapport with my instructor in this online course	0	0	0	0	0	0	0
73	I feel a sense of isolation from my instructor in this online course	0	0	0	0	0	0	0
74	I feel I have a shared understanding of the course goals with my instructor	0	0	0	0	0	0	0
75	I feel I have a shared understanding of the course content with my instructor	0	0	0	0	0	0	0
76	I feel I have a shared understanding of the course activities with my instructor	0	0	0	0	0	0	0
77	I feel I have a shared understanding of the assessment methods of my learning with my instructor	0	0	0	0	0	0	0
78	I feel my learning expectations have been met in this online course	0	0	0	0	0	0	0
79	I feel I have learned a great deal in this online course	0	0	0	0	0	0	0
80	I feel closely connected to my fellow students in this online course	0	0	0	0	0	0	0
81	I feel a strong sense of 'being with' my fellow students during my learning process							

82	I feel the presence of my fellow students in this online course, despite the physical distance between us	0	0	0	0	0	0	0
83	I feel a strong rapport with my fellow students in this online course	0	0	0	0	0	0	0
84	I feel a sense of isolation from my fellow students in this online course	0	0	0	0	0	0	0
85	I feel students in this online class have a shared understanding of each other's learning experiences	0	0	0	0	0	0	0

APPENDIX C

Parental Consent

STATEMENT OF CONSENT

I have had the opportunity to consider the information in this document. I have asked any questions needed for me to decide about my participation. I understand that I can ask additional questions through the study.

By signing below, I volunteer to participate in this research. I understand that I am not waiving any legal rights. I have been given a copy of this consent document. I understand that if my ability to consent for myself changes, my legal representative or I may be asked to consent again prior to my continued participation

Name of Adult Participant	Signature of Adult Participant	Date
----------------------------------	---------------------------------------	-------------

Researcher Signature (To be completed at the time of Informed Consent)

I have explained the research to the participant and answered all of his/her questions. I believe that he/she understands the information described in this consent and freely consent to participate.

Name of Research Team Member	Signature of Research Team Member	Date
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APPENDIX D

Student Assent Form

ASSENT FORM

You are invited to be in a research study “Transactional Distance in a Middle and High School Online Learning Environment: An Empirical Study” being done by Silas Njoroge from the University of Memphis. You are invited because of your experience in online courses.

If you agree to be in this study, you will be asked to fill a 9-item environmental and demographic questionnaire and an 85-item survey online. The survey will ask you about your perceptions and experiences in your online classes.

Your parents/guardians will know you are in the study. If anyone else is given information about you, they will not know your name.

You can ask Silas Njoroge questions any time about anything in this study.

Signing this paper means that you have read this, or had it read to you, and that you want to help to be in the study. If you do not want to be in the study, do not sign the paper.

Signature of person agreeing to be in study

Date signed

APPENDIX E

Use of Instrument Permission Letter

Hi Silas,

Thank you for introducing yourself and for reaching out about your research. It's exciting to know that you have been working on the topic of transactional distance for your dissertation. Yes, feel free to use the instrument in my study. The validated questionnaire items are included in the published article "Measuring transactional distance in web-based learning environments: an initial instrument development" (see the attached). I administered the survey online through Qualtrics. You can find more information in the "Procedure and participants" section of the article. This is a 7-point Likert scale (1 = Strongly disagree, 7 = Strongly agree). Hope it helps. Let me know if you have any questions. Good luck on your dissertation and I look forward to your completed study!

Sincerely,

Silvie

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<https://www.facebook.com/wku.instructional.design>

APPENDIX F

Initial Parent Email

I am writing to inform you that your child has been identified as a potential participant in a study on understanding transactional distance in middle and high school online learning. Your child has been selected due to their experience in online courses that they are enrolled in at their school. This study aims to understand the communication gaps due the separation of teachers/students and students/students in online learning for middle and high school students. You child's participation in this survey, with your consent, is completely voluntary and all their responses are anonymous. None of the responses will be connected to identifying information. All responses will be kept confidential. They will only be used for statistical purposes and will be reported only in aggregated form. The survey will be in two parts: a 9-item environmental and demographic questionnaire and an 85-item survey and will take about 20-25 minutes to complete. Soon, you will be receiving the consent documents via email. Participants will be included in a drawing where they can win \$20 after completing all parts of the survey.

The principal investigator in this study is a doctoral student at the University of Memphis. If have any questions about the study, please contact the researcher using any of the contacts below.

Silas Njoroge, sknjorog@memphis.edu

Initial Student Recruitment Email

Dear Student,

I am writing to inform you that you have been identified as a potential participant in a study on understanding transactional distance in middle and high school online learning. You have been selected due to their experience in an online course that you are enrolled in current or in the past. In addition, your parent has consented to your voluntary participation.

This study aims to understand the communication gaps due the separation of teachers/students and students/students in online learning for middle and high school students. Your participation in this survey, with your assent, is completely voluntary and all their responses are anonymous. None of the responses will be connected to identifying information. All responses will be kept confidential. They will only be used for statistical purposes and will be reported only in aggregated form. The survey will be in two parts, a 9-item environmental and demographic questionnaire, and an 85-item survey and will take about 20-25 minutes to complete. Soon, you will be receiving the consent documents via email. Participants will be included in a drawing where they can win \$20 after completing all parts of the survey.

To the best of our knowledge, the things that you be asked to do will do have no more risk of harm than you would experience in everyday life. There are potential risks of anxiety about taking a survey in a course you are currently enrolled in. Your participation will in no way influence your standing in their school or course. There is no guarantee that you will get any benefit from taking part in this study. Your willingness to participate, however, may help society better understand this research topic. The principal investigator in this study is a doctoral student at the University of Memphis. If have any questions about the study, please contact the research using any of the contacts below.

Silas Njoroge,

sknjorog@memphis.edu

APPENDIX G

Informed Consent Documents



Institutional Review Board
315 Administration Bldg.
Memphis, TN 38152-3370
Office: 901.678.2705
Fax: 901.678.2219

Consent for Research Participation

Title:	Transactional Distance in a Middle and High School Online Learning Environment: An Empirical Study.
Researcher:	Silas K. Njoroge, University of Memphis
Researcher Contact Info:	901-550-4331, sknjorog@memphis.edu
Advisors and Contact Info:	Craig Shepherd, cshphrd2@memphis.edu Yvonne Earnshaw, ycrnshaw@memphis.edu

You are being asked to participate in a research study. The box below highlights key information for you to consider when deciding if you want to participate. More detailed information is provided below the box. Please ask the researcher(s) any questions about the study before you make your decision. If you volunteer, you will be one of about 200 people to do so.

Key Information for You to Consider

Voluntary Consent: You are being asked to volunteer for a research study. It is up to you whether you choose to participate or not. There will be no penalty or loss of benefits to which you are otherwise entitled if you choose not to participate or discontinue participation.

Purpose: The purpose of this research is to empirically verify the association between

transactional distance and its constructs and to investigate the impact of environmental and demographic factors on transactional distance in online courses offered at an online high school (Grade 7-12) in Memphis, Tennessee. You are being invited to take part in this research study because you experience in an online class.

Duration: It is expected that your participation will last about 25 minutes.

Procedures and Activities: You will be asked to answer a 9-item questionnaire, followed by an 85-item survey on Qualtrics.

Risk: To the best of our knowledge, the things you will do have no more risk of harm than you would experience in everyday life.

Benefits: There is no guarantee that you will get any benefit from taking part in this study. Your willingness to participate, however, may help society as a whole better understand this research topic.

Alternatives: Participation is voluntary, and the only alternative is to not participate

Who is conducting this research?

Silas K. Njoroge of the University of Memphis, Department of Education is in charge of the study. His faculty advisors are Dr. Craig Shepherd and Dr. Yvonne Earnshaw. There may be other research team members assisting during the study. No member of the research team has a significant interest and/or conflict of interest related to this research.

What happens if I agree to participate in this Research?

If you agree, you will be asked to answer two separate online surveys. The first is a 9-item questionnaire, followed by an 85-item survey on your perception of transactional distance in online classes. You can fill out the survey at any location at any time during the specified time constraints. During the survey, you can skip any question that makes you uncomfortable and you can stop at any time. The questions in the questionnaire are “yes” or “no” while the questions in the survey are 7-point Likert-type with the following choices: entirely disagree, mostly disagree, slightly disagree, neither agree nor disagree, slightly agree, mostly agree, and entirely agree. The timeline of events appears in the table below.

Week	Day	Event
1	1	The investigator sends an initial email to parents informing about what students will do, how long it will take, and assure them of their confidentiality if they choose to participate.
	3	Second email along with the consent/assent and survey document. Parental consent to have their children participate

in the research will be sought first.

2	1	Email to student whose parents have consented. Informs about the study and its significance, including all information regarding the research, the voluntary nature of their participation, and the incentive for participation. Asks students for their assent to participate in the research. Students who assent are directed to the questionnaire or else they are directed to end of survey. Upon completion of the questionnaire, they will be directed to the survey.
	3	First reminder via email reminder to parents who have not replied.

3	1-3	First email reminder for all students whose parents have consented but have not participated.
	4-5	Second reminder via email reminder to parents who have not participated. Second reminder via email reminder to students who have not participated.

What happens to the information collected for this research?

Your information will be combined with information from other students taking part in the survey. When we write about the study to share it with other researchers, we will write about the combined information we have gathered. You will not be personally identified in these written materials. We may publish the results of this study; however, we will keep your name and other identifying information private.

How will my privacy and data confidentiality be protected?

We will utilize the functions in Qualtrics that allow the administrator to delete responses and hide email addresses. We will make every effort to prevent anyone not on the research team from knowing that you gave us information or what that information is.

Participants will be given a number so that their names are not attached to the data. The data will be stored in a secure device and only uploaded to secure software for analysis.

We will take measures to protect your privacy and security of your personal information as best we can. Although you need to know about some limits to this promise. Measures we will take include:

- Anonymity in responses, i.e., you will not be asked for your name or any other personal information.
- Demographic information on gender, ethnicity, and school type will be asked, which could decrease anonymity.
- The data will be stored on a secure device and only uploaded to secure software for analysis.

Individuals and organizations that monitor this research may be permitted access to inspect the research records. This monitoring may include access to your private information and Quartics records. These individual and organization include Institutional Review Board.

What if I want to stop participating in this research?

It is up to you to decide whether you want to volunteer for this study. It is also ok to decide to end your participation at any time. There is no penalty or loss of benefits to which you are otherwise entitled if you decided to withdraw your participation. Your decision about participating will not affect your relationship with the researcher(s) or the University of Memphis.

Will it cost me money to take part in this research?

There are no costs associated with participation in this research study.

Will I receive any compensation or reward for participating in this research?

You will not be compensated for taking part in this research.

Who can answer my question about this research?

Before you decide to volunteer for this study, please ask any questions that might come

to mind. Later, if you have questions, suggestions, concerns, or complaints about the study, you can contact the investigator Silas Njoroge at sknjorog@memphis.edu. If you have any questions about your rights as a volunteer in this research, contact the Institutional Review Board staff at the University of Memphis at 901-678-2705 or email irb@memphis.edu. We will give you a signed copy of this consent to take with you.

STATEMENT OF CONSENT

I have had the opportunity to consider the information in this document. I have asked any questions needed for me to decide about my participation. I understand that I can ask additional questions through the study.

By signing below, I volunteer to participate in this research. I understand that I am not waiving any legal rights. I have been given a copy of this consent document. I understand that if my ability to consent for myself changes, my legal representative or I may be asked to consent again prior to my continued participation

Name of Adult Participant	Signature of Adult Participant	Date
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Researcher Signature (To be completed at the time of Informed Consent)

I have explained the research to the participant and answered all of his/her questions. I believe that he/she understands the information described in this consent and freely consent to participate.

Name of Research Team Member	Signature of Research Team Member	Date
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ASSENT FORM

You are invited to be in a research study “Transactional Distance in a Middle and High School Online Learning Environment: An Empirical Study” being done by Silas Njoroge from the University of Memphis. You are invited because of your experience in online courses.

If you agree to be in this study, you will be asked to fill a 9-item environmental and demographic questionnaire and an 85-item survey online. The survey will ask you about your perceptions and experiences in your online classes.

Your parents/guardians will know you are in the study. If anyone else is given information about you, they will not know your name.

You can ask Silas Njoroge questions any time about anything in this study.

Signing this paper means that you have read this, or had it read to you, and that you want to help to be in the study. If you do not want to be in the study, do not sign the paper.

Signature of person agreeing to be in study

Date signed

APPENDIX H

Letters of Support



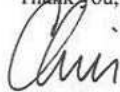
November 18, 2019

Dear Silas,

You have our permission to perform your research on transactional distance in the Information and Design Technology program at the University of Memphis. This permission is granted with the understanding that you will follow all APA research guidelines and standards, especially in regard to your research participants.

If I can be of any further assistance, please let me know.

Thank you,


Chris Fay
Principal

Principal
Memphis Virtual School
2601 Ketchum Road
Memphis, TN 38114

To: Silas Njoroge
January, 10, 2020

Good Morning,

Thanks for your interest in conducting research at our school. I am available to speak with you on next Tuesday about your data collection at Memphis Virtual School.



Dr. Marilyn Peete Hilliard
Principal
Memphis Virtual School
2601 Ketchum Road
Memphis, TN 38114
Phone: (901) 416-0115
Email: hilliardmp@scsk12.org

APPENDIX I

Shelby County Schools Approval



Department of Research and Performance Management

160 S. Hollywood • Memphis, TN, 38112 • (901) 416-5455 • www.scsk12.org

Jeffery A. Shive, Ph.D.
Manager, Research
(901) 416-1295
ResearchMgmt@scsk12.org

November 26, 2019

To: Silas Njoroge
Re: Research Proposal

After considering your proposal, "Transactional Distance in a Middle and High School Online Learning Environments: An Empirical Study," we can conditionally approve your request to conduct this study in Shelby County Schools. Final approval is contingent on your supplying your school's final IRB approval to this department. Meantime, you can use this letter as notification of conditional approval for your study.

Note that the district-level [conditional] approval granted with this letter does not obligate any school or any person to participate in this project. The principal of any participating school must still approve the project before the study can begin at that school. Moreover, individuals must be given the option of not participating. Note, too, that this approval requires that you use your findings for only for the purpose of the research described in the proposal.

We look forward to working with you in the completion of this project.

Sincerely,

Handwritten signature of Jeffery A. Shive in cursive script.
Jeffery A. Shive



Department of Research and Performance Management

160 S. Hollywood • Memphis, TN, 38112 • (901) 416-5455 • www.scsk12.org

Jeffery A. Shive, Ph.D.
Research Manager
(901) 416-1295
ResearchMgmt@scsk12.org

January 8, 2020

To: Silas Njoroge

Re: Research Proposal

After consideration of your proposal, "Transactional Distance in a Middle and High School Online Learning Environments: An Empirical Study," we approve your request to conduct this study in Shelby County Schools. You should use this letter as official notification of approval for your study.

Note that the district-level approval granted with this letter does not obligate any school or any person to participate in your project. Approval by the principal of any participating school is still needed before the study can begin at that school, and individuals must be given the option of not participating. Approval also requires that you use your findings for only the purpose of the study described in the proposal.

Sincerely,

A handwritten signature in blue ink that reads "Jeffery A. Shive".

Jeffery A. Shive

APPENDIX J

IRB Approval



Institutional Review Board
Division of Research and Innovation
Office of Research Compliance
University of Memphis
315 Admin Bldg
Memphis, TN 38152-3370

December 18, 2019

PI Name: Silas Njoroge

Co-Investigators:

Advisor and/or Co-PI: Craig Shepherd

Submission Type: Initial

Title: Understanding Transactional Distance High and Middle School Online Learning
Environment: An Empirical Study

IRB ID : #PRO-FY2019-507

Exempt Approval: December 18, 2019

The University of Memphis Institutional Review Board, FWA00006815, has reviewed your submission in accordance with all applicable statuses and regulations as well as ethical principles.

Approval of this project is given with the following obligations:

1. When the project is finished a completion, submission is required
2. Any changes to the approved protocol require board approval prior to implementation
3. When necessary submit an incident/adverse events for board review
4. Human subjects training is required every 2 years and is to be kept current at citiprogram.org.

For any additional questions or concerns please contact us at irb@memphis.edu or 901.678.2705

Thank you,

James P. Whelan, Ph.D.

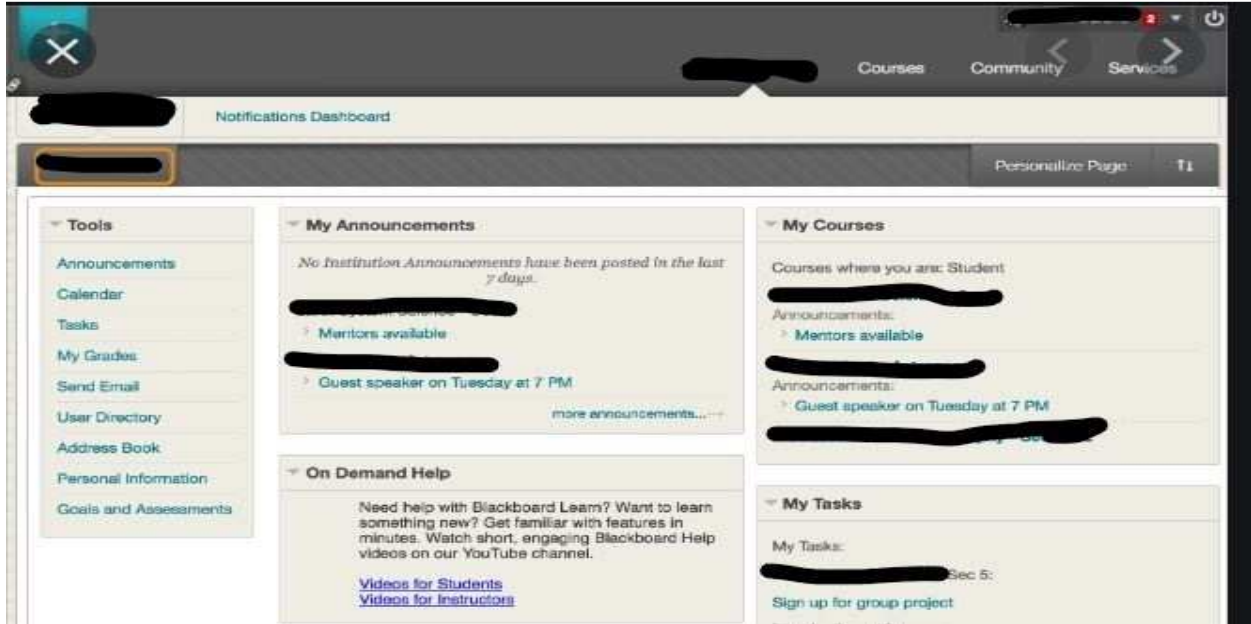
Institutional Review Board Chair

The University of Memphis

APPENDIX K

Blackboard and Blackbaud Course Homepage Screen Shots

Blackboard Course Page



Blackbaud Course Page

