VERIFICATION OF THEORY BASED DESIGN FEATURES FOR DESIGNING ONLINE INSTRUCTION FOR STUDENTS WITH LEARNING DISABILITIES AND OTHER STRUGGLING LEARNERS

By

CHI-HSUN CHIU

Submitted to the graduate degree program in Educational Leadership & Policy Studies and the Graduate Faculty of the University of Kansas in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

____

Chairperson Ed Meyen

____

Richard Branham

____

Diana Greer

____

Young-Jin Lee

____

Ronald Aust

Date Defended: April 4th 2013

The Dissertation Committee for CHI-HSUN CHIU

certifies that this is the approved version of the following dissertation:

VERIFICATION OF THEORY BASED DESIGN FEATURES FOR DESIGNING ONLINE INSTRUCTION FOR STUDENTS WITH LEARNING DISABILITIES AND OTHER STRUGGLING LEARNERS

____

Chairperson Ed Meyen

Date approved: April, 4th 2013

ABSTRACT

This study involved a comprehensive review of the literature on multimedia design to identify theory based design principles applicable to online instruction. Seven theories were reviewed. They included Cultural Historical Activity Theory (CHAT), Human Computer Interaction (HCI), Cognitive Theory of Multimedia Learning (CTML), Cognitive Load Theory (CLT), Universal Design for Learning (UDL), Kosslyns's (2007) eight Psychological Principles, and Wicken's (1999) thirteen Principles of Display Design. The focus was on all learners including those with disabilities. Forty theory based design principles, supported by research, were verified through Q methodology model (Brown, 1980; McKeown & Thomas, 1988). Three panels of experts in 1) multimedia theory, 2) design/development of online instruction for all K-12, and 3) design/development of online instruction for students with learning disabilities rated the importance of each principle. The Q-sort involved sorting along the dimensions of a quasi-normal distribution scale. This prevented the experts from placing a disproportionate number of principles in any single category.

The response rate for experts was 81.1%. An Analysis of Variance was carried out to ascertain differences among the rating of expert by group and in combination and followed by a Post-Hoc Test. The result showed that only one principle had the *p value* = .042 between Group 1 Multimedia and Group 2 All K-12 Learners at the $p < .05$ significant level. The implications are that there was little differentiation between the focus on all students and the focus on students with learning disabilities. A correlation analysis was conducted with the correlation matrix indicating only six observed relationships were very strong. There were three principles with the most positive correlation coefficients ranging from r =.529 to r =.554. In contrast, there were

three negative correlations coefficient between principles, ranging from r =.462 to r =.503. These results imply that there was considerable independence among the principles.

The factor analysis resulted in five factors being identified i.e., Factor 1: Learner variability, Factor 2: Cognitive strategies, Factor 3: Prerequisites for teaching/learning, Factor 4: Context for learning, and Factor 5: Media presentation.

ACKNOWLEDGEMENTS

Though only my name appears on the cover of this dissertation, a great many people have contributed to its production. Over the past six years I have received support and encouragement from a great number of individuals. I owe my gratitude to all those people who have made this dissertation possible and because of whom my graduate experience at the University of Kansas has been one that I will cherish forever.

My deepest gratitude is to my advisor, who is also my dissertation committee chair, Special Education Professor Ed Meyen, Co-director of the e Learning Design Lab. I have been amazingly fortunate to have an advisor who gave me the freedom to explore on my own, and at the same time the guidance to recover when my steps faltered in this academic journey. He has been supportive since the days I began working in the Lab. His patience, concerns, and great support helped me overcome many crisis situations and finish this dissertation. His guidance has made this a thoughtful and rewarding journey in my life. Without his guidance and persistent help this dissertation would not have been possible. I hope that one day I would become as good an advisor to my students as Dr. Meyen has been to me.

I would like to thank my committee members, Professor Richard Branham, Professor Diana Greer, Professor Young-Jin Lee, and Professor Ron Aust for their great support over the past year as I moved from an idea to a completed study. Their insightful comments and feedback at different stages of my study were thought-provoking and they helped me focus my ideas. I am grateful to them for holding me to a high research standard and enforcing strict validations for each research result.

Particular, I am grateful to Cheryl Harrod for her great concerns and advice when she was an Assistant Director at the e-Learning Design Lab. Cheryl provided needed encouragement and insights and helped me through the past 4 years at the e-Learning Design Lab. I am also thankful to Tom Shorock, the professional system administrators at e-Learning Design Lab, who maintained all the data collection and data responses in my research so efficiently that I never had to worry about viruses, creating backups or losing files. In addition, I am thankful to Jaehoon Lee and Hsiang-Feng Chen for the many valuable discussions and valuable statistical advice during my data collection. Moreover, I appreciate the great efforts of the many experts around the nations for their contributions to the Q-sort Tasks in this research.

Last, but by no means least, I thank my friends for their support and encouragement throughout my time at the University of Kansas. I will be grateful forever for your friendship.

DEDICATION

This dissertation is dedicated to my special friends and my lovely family in Taiwan.

To my friend of life, Jun-Ming Guo, thank you so much for your great support, love, and concerns accompanying me throughout the hard time of my dissertation journey. These great memories has been sustained me during my time of sadness in the past four years. To my friends of life, Yi-Shan Chang, Pei-Shan Huang, and Shian-Ying Liu, thank you for your support during my academic journey and all the other journeys over the last fourteen years. I am looking forward to the journeys yet to come.

Most importantly, none of this would have been possible without the love and patience of my family. I would like to express my heart-felt gratitude to my family, my father, Shian-De Chiu, my mother, Yue-Shiou Hu, and my brother, Jr-Peng Chiu, has been a constant source of love, concern, support and strength in the past ten years. Thank you for your constant belief in me throughout my lifetime. You provided the roots that allowed me to have wings. I felt an immense gratitude to my amazing family for their support all these years. I appreciate their support and love to me every great moment whenever I needed it. I would like to thank them in Chinese.

獻給我最愛的爸爸媽媽哥哥,

感謝你們十年來一路相伴不離不棄的鼓勵與關懷

真摯的愛 從來無關風月 只是在歲月流年裡粹練成永恆

因為是你們 再多困難挑戰 眼角淌淚也不忘初心

因為有你們 支持我的夢想 讓我勇敢飛翔

這些年 我走得很慢 卻活的精彩

滿滿感恩與愛 在此生的心裡。

Finally, thank you for your love and encouragement over the last ten years. Everything is beyond description. I love you all.

TABLE OF CONTENTS

LIST OF APPENDICES

CHAPTER ONE

Introduction

The most significant impact of the online instructional movement in K-12 education may be the need to design and develop instructional resources in advance of offering instruction via the Internet. This feature of online instruction is not unique to K-12 education, however. It is also true for postsecondary education. The difference lies in the degree of emphasis on Internet-delivered content and the integration of such instruction with the in-class learning environment created by K-12 teachers.

The publishing industry has traditionally had a significant influence on K-12 education in the United States through published curricula, textbooks, tests, and other resources that were compatible with state and local standards and needs. When online instruction gained popularity in K-12 education, the scene shifted to the need for instructional software, user tools, and content structured in a manner that could be easily accommodated in online instruction.

The expectation that technology would greatly impact learner outcomes in K-12 education was high; consequently, a market potential was in place for the commercial sector to target and expand. Not surprisingly, therefore, industry was quick to respond. New companies were developed. Publishing companies expanded to become organizations that attempted to be responsive to the online needs of schools while sustaining a publishing capacity. Entrepreneurs also quickly became major players in the development and marketing of e-learning resources and the delivery of online instruction.

While schools continue to employ many of the curriculum and instructional models of the past, a paradigm shift has occurred. The growth of online programs has redefined how educational technology can be used to address the needs of all students. While online education has been an option for postsecondary education for many years, it has only recently emerged as a significant option for K-12 educationwithin the last 5 to 10 years (Rauh, 2011). Specifically, according to The International Association for K-12 Online Learning (iNACOL, 2012), 27 states have state-operated virtual schools. In 2006, Michigan became the first state to require online learning for high school graduation; the same requirement was added in Alabama in 2008 (iNACOL, 2010). Florida was the first state to offer full-time and part-time options to all students in grades K-12 as of 2012 (Watson, et Al., 2012). In the 2009-2010 school year, 1,816,400 students were enrolled in online courses in K-12 school districts (Queen & Lewis, 2011).

This expansion of online instruction in K-12 education, combined with the need for online resources, underscores the importance of ensuring that those responsible for developing online resources are highly skilled in design theory and principles. Unfortunately, the growth in online instruction has not been paralleled by a pattern of theory-based research to guide design and development decisions. Nor is there much evidence that extensive attention has been given to exploring the body of theory and research that existed in the fields of multimedia design, cognitive psychology, and the learning sciences at the time when online instruction initially started evolving.

Universal design for learning (UDL) represents an exception, however (Rose et al., 2005). The concepts inherent in UDL have been found to be particularly effective for the delivery of online instruction (Rose & Meyer, 2005). Central to UDL is the inclusion of multiple means of representation, multiple means of expression and action, and multiple means of engagement in curriculum designs, which increase access in higher education for diverse learners, including students with disabilities (SWD) (Rose & Meyer, 2002).

As significant as UDL is in ensuring quality online instruction, it is interesting that much of the early theoretical work preceding UDL seems to have been overlooked by this growing field during its early stages. This is especially true in the context of how information/instruction is framed for visual display purposes via the monitor, which is central to online instruction. Yet, a very large industry has emerged over the past 15 years solely in the development and marketing of online instruction. Given the varied conditions under which of online instruction is delivered, this is particularly significant. The growth may be due more to the commercial availability of online resources than to evidence-based designs or research on practices.

While varied forms of online instruction have emerged (e.g., hybrid, blended, and flipped courses), one critical element generalizes to the content and experiences that are delivered online largely via visual display – the monitor. It is reasonable to believe that the visual display in some form will remain a critical element of online instruction in the foreseeable future. With this in mind, the early theories in multimedia become even more important to the design and development of online instruction. Examples of design theories that have been extant in the literature and were researched for this study include the early and subsequent work of the following theorists and their associates:

1. Cultural historical activity theory, also known as CHAT (Vygotsky, 1920)
2. Human computer interaction (HCI) (Kaptelinin & Nardi, 2006; Nardi, 1996a)
3. Cognitive theory of multimedia learning, also known as CTML (Mayer, 2005; Mayer & Moreno, 2007).
4. Cognitive load theory, also known as CLT (Sweller, 1994, 2003; Sweller, Merrienboer, & Pass, 1998)
5. Universal design for learning (UDL) (Rose & Meyer, 2005)

6. Eight psychological principles (Kosslyn, 2007)
7. Thirteen principles of display design (Wickens et al., 2004)

Application of Technology for All Learners

Prior to and paralleling the emergence of online instruction has been a major shift in public policy to ensure that all students have access to the general education curriculum and to demonstrating academic performance aligned with national curriculum standards. These changing conditions in educational policy are reflected in the passage and reauthorization of the Individuals with Disabilities Education Act (IDEA) of 1997 and 2004, the No Child Left Behind (NCLB) legislation in 2000, and the American Recovery and Reinvestment Act (ARRA) of 2009 (Crowe, 2011). With the passage of NCLB (2001) and IDEA (2004), students with disabilities are expected to meet the same standards as their nondisabled peers.

These expectations are supported by the Race to the Top (RTTT) authorized under Sections 14005 and 14006 of the American Recovery and Reinvestment Act of 2009 (ARRA), which addresses four reforms, including enhancing standards and assessments. A centerpiece of the RTTT reform is supported by an ARRA $4.35 billion grant program designed to encourage education innovation and reform by states, achieve significant improvement in student learning outcomes, close achievement gaps, improve high school graduation rates, and ensure students' preparation for success in college and future career (U.S. Department of Education, 2009).

Common Core Standards developed by the states are internationally benchmarked and include the knowledge and skills that equip students to succeed in college and career (U.S. Department of Education, 2010). The Common Core Standards set forth rigorous expectations in the areas of mathematics, reading, writing, speaking, and listening in order to prepare students to be college- and career-ready (U.S. Department of Education, 2009). The purpose of the RTTT is to be supportive of the conditions underlying the goals of the Common Core standards (U.S. Department of Education, 2009).

Based on research and best practices, the Common Core Standards were developed to help teachers, students, and parents know what is needed for students to succeed in college and careers. They are also intended to enable states, school districts, and educators to more effectively collaborate to enhance learning for all learners and close achievement gaps (U.S. Department of Education, 2010).

Recent policy changes in the United States not only represent a major effort to ensure equity in education but also to set high expectations for the impact of technology. The policy shift has not set separate standards for students with disabilities (SWD), although they created requirements for assistive devices and access to technology. This approach presumes that if SWDs have access to technology and, where appropriate, are provided with accommodations and assistive technologies that they will benefit from online instruction.

Thus, an immediate consequence of the previously described policy shift was the creation of conditions that value equity in education for all students. A related consequence was increasing the focus on the performance gap among many groups of students. This is particularly true when the comparing the academic performance of students with disabilities to that of nondisabled students on state level exams. A performance gap in academic achievement between students with disabilities and their peers without disabilities was well documented in the literature prior to the emergence of Internet-based instruction. Researchers have found that the performance of students with disabilities on state assessments is consistently lower than the performance of students without disabilities (Abedi, Leon, & Mirocha, 2003; Darling-Hammond, 2003; Thurlow, Bremer, & Albus, 2008). According to Judge (2011), many students with disabilities lag behind their peers without disabilities in school achievement especially in mathematics.

There is also evidence that the gap between students increases as students progress across grade levels. For example, the National Assessment of Educational Progress (NAEP, 2005) reported that Grade 4 students with disabilities scored lower than nondisabled students on all NAEP tests, including reading and mathematics. The same was evident in Grade 8 for students with limited English proficiency (LEP), whose average scaled scores in 2005 were lower than those of non-LEP students on NAEP tests in reading and mathematics (NAEP, 2005).

The major conditions that have been strengthened by recent educational mandates and legislation are the clear expectation of high performance by all learners, technologies to offer support for meeting high expectations, and the capacity to identify the contributors to the achievement gaps that have become so evident.

Various measurements, such as grades, standardized test scores, course selections, dropout rates, and college-completion rates, have been used to evaluate achievement differences and to illustrate performance gaps by ethnicity, such as African Americans, Hispanic, and Latinos in the nation (Education Week, 2007; National Governors Association, 2005, para. 5). Students from some minority groups (e.g., African American and Hispanic) also fail to compare favorably with nondisabled peers (National Governors Association, 2005, para. 5). According to Olszewski-Kubilius and Thomson (2010), the gaps in academic achievement for children with learning disabilities and minority students of all ages show larger disparities than those of their counterparts. Noguera (2008) reported that efforts to close the racial achievement gap is politically and socially significant because reducing the performance gap will ensure that all students, regardless of their backgrounds and ethnicity, will receive a quality education and have equal opportunities to experience academic success.

Instruction

An instructional area in which students with disabilities have demonstrated a consistent pattern of low performance compared to peers without disabilities has been in the STEM-related (i.e., Science, Technology, Engineering, and Mathematics) fields such as mathematics. The performance gap of the students with learning disabilities is particularly evident in mathematics. This is not a new phenomenon, however. For example, approximately 6% to 7% of the school-age population suffer from learning difficulties in mathematics (Augustyniak, Murphy, & Phillips, 2005; Badian, 1983; Gross-Tsur, Manor, & Shalev, 1996; Kosc, 1974).

Although achievement in mathematics for all students has improved over the years, the achievement rates of students with disabilities remain considerably lower than those of other students (Jitendra & Star, 2011). According to the National Center for Education Statistics (NCES, 2012), data for international comparisons of education in fourth-grade mathematics in Asia or Europe (i.e., China, Taiwan, United Kingdom, Hong Kong SAR, Japan, Kazakhstan, Latvia, the Russian Federation, and Singapore) reveal that students from these countries outperformed students from the United States.

Many researchers agree that computer-based technologies have the potential to enhance the learning of children, adolescents, and adults with learning disabilities (Lewis, 2005). Okolo (2000) describes technology supports such as the use of electronic books, anchored instruction, and network-based learning as effective instructional supports for students with learning disabilities. For example, the technology-based instructional program “Read 180” Hasselbring (1996) has been found to be effective with students with learning disabilities. “Read 180” is built on scientifically based research and collaboration of the nation's leading researchers and reading experts (Hasselbring, 1996). According to Hasselbring (1996), "Read 180" makes use of adaptive technology to help readers lacking reading skills to become successful. It is also designed to enhance learning in students with mild disabilities and those who are at-risk of school failure.

Multimedia Theory

Research has demonstrated that various types of multimedia instruction in electronic formats can play an important role in inspiring students and enhancing cognitive learning, resulting in increased academic achievement for students with disabilities (Lewis, 2005). For example, viewing television programs with an educational purpose that are associated with cognitively enriching experiences is linked positively with academic achievement, whereas viewing television that only has entertainment valuee has been found to be linked negatively with learning achievement (Schmidt & Vandewater, 2008). Specificially, Schmidt and Vandewater (2008) reported that electronic multimedia, in particular, enhance students' cognitive skills and impact the learning performance of school-aged children and adolescents. In addition, playing video games has been found to not only enhance visual spatial skills, such as visual tracking, mental rotation, and target localization but also to improve problem-solving skills (Schmidt & Vandewater, 2008). These authors suggest that content appears to be the crucial element and that content delivered by electronic media is far more influential than the media used (i.e., technological devices).

According to Blackhurst (2005), while technology can serve as a tool for the delivery of instruction, the use of technology cannot compensate for instruction that is poorly designed. This supports the perspective that instructional content should be designed for appropriate cognitive proposes to enhance the performance of students with learning disabilities. John Sweller's cognitive load theory (CLT; 1988), Vygotsky's cultural-historical activity theory (CHAT; 1978), and Richard Mayer's cognitive theory of multimedia learning (CTML; 2001, 2009) have stimulated research on multimedia instruction. For example, based on CLT (Sweller, 1999, 2005), Mayer provided multimedia learning design principles to design instruction useful in reducing extraneous cognitive load (Mayer, 2005c).

A body of research indicates that learning with multiple representations (MR) can potentially benefit students with learning difficulties (Berthold, Eysink, & Renkl, 2009; Eilam & Poyas, 2008). For example, multiple representations (MR) of display of information (i.e., two or more representations), such as illustrations, visual and textual modes (Eilam & Poyas, 2008) increase learning. Further, illustrated text, pictures, and applied multimedia compared to text alone results in higher student engagement (Carney & Levin, 2002; Levie & Lentz, 1982; Levin, Anglin, & Carney, 1987). These consequences are called the multimedia effect (Mayer, 1997), which represent multimedia principles in Mayer's CTML concepts (Fletcher & Tobias, 2005), and are suitable to specific learning conditions (Mayer, 2009; Schnotz, 2005).

These theories offer important implications related to learning and educational designs for students with learning disabilities. Learning and instructional design based on human cognitive architecture are central to CLT (Sweller, 2004; van Merriënboer & Ayres, 2005). Beginning in the 1980s, researchers applied CLT to issues such as memory processing, transfer of learning, instructional design, and measurement of cognitive load (Clark, Nguyen, & Sweller, 2006). The result of this research has established evidence-based guidelines for classroom instruction (Clark et al., 2006) and multimedia instruction (Mayer & Moreno, 2003) that have application for designing standards-based instruction and assessments that are more accessible for students with or without learning disabilities in (Elliott, Kurz, Beddow & Frey, 2009).

According to Helsinki (2010), CHAT focuses on artifact-mediated and object-oriented activities formulated by Russian psychologists (Vygostsky et al.) in the 1920s. CHAT has been applied across diverse ranges of technological domains and industrial designs (Gay & Hembrooke, 2004). Additionally, Norman (2005) claimed that CHAT may provide a framework for analyzing learner needs in a human-centered way.

Students with disabilities may experience limited access under different conditions, such as cultural differences, cognitive deficit, and in social situations. The principles of CHAT are proposed as being compatible to different conditions and in assisting students with disabilities to compensate for their deficiencies (Daniels, 2004). Daniels (2004) also noted that CHAT has potential for describing and analyzing the complexity of learning required by students with special needs.

CTML addressed by Mayer (2009) illustrates a framework for presenting diverse multimedia materials in instruction. CTML (Moreno & Mayer, 2001) combines three important cognitive processes: selecting, organizing, and integrating. These cognitive processes can help educators in teaching and students in learning by using effective multimedia tools. Indeed, it has been suggested that CTML (Mayer, 2005c, 2009) and CLT (Chandler & Sweller, 1991; Sweller, 1999, 2005) are the most influential models to inspect for differences in using multimedia when teaching students with special educational needs (Sajadi, 2010). Moreover, Schwamborn et al. (2011) claimed that multimedia instruction enhances students' learning (e.g., from text & pictures to text alone) in ways that are consistent with CLT (Sweller, 1999, 2005) and CTML

(Mayer, 2009) by promoting appropriate active processing during learning while reducing extraneous cognitive processing.

Statement of the Problem

There is a long history of theory and research in visual display design within multimedia. The problem addressed by this study was to identify design principles applicable to online instruction for all, learners including students with learning disabilities, and to subject the identified principles to verification through a review process involving expert judges. The need for this study was influenced by the unprecedented growth in the development of virtual schools and the application of online instruction in traditional K-12 schools. Within the enrollment growth in virtual schools, there has been wide variability in the proportion of the enrollment comprised of students with disabilities. Further, there is little evidence that the designs of online learning environments are theory- and/or research-based. This study was designed to investigate the applicability of literature-based design principles to the design of online instruction in K-12 education.

A comprehensive review of the literature based on the previously cited theories was conducted to identify design principles applicable to online instruction for all students, including students with learning disabilities. A nomination process was employed to identify individuals to serve as experts on three panels to judge the importance of the identified principles to online instruction.

Three panels of experts included representatives of the following groups:

- Experts in multimedia theory and the application of design theory to online instruction

- Experts in design/development of online instruction for all students in K-12 education
- Experts in design/development of online instruction for students with learning disabilities in K-12 education. This group was comprised largely of professors with expertise in the characteristics of students with learning disabilities and teaching methodologies.

Because of the relative newness of online instruction for K-12 education, the population of knowledgeable and experienced candidates to serve on expert panels, while not known, was fairly small. Nominations were sought from highly experienced individuals in multimedia theory and online instruction in K-12 education. Nominees found to have collaborated with the theorists whose theories were reviewed for this study were excluded from the pool of experts.

Additionally, the status of the field also appears to have contributed to a situation where the roles of those who design and/or develop online instruction for delivery via the Internet is not well defined. For example, the rapid growth of the e-learning industry was stimulated by a fast emerging market. This drove the industry in the production of online resources to meet the demand. The result is that expertise specific to design and specific to development may not have evolved to the level needed, leading to reliance on experts with a wide array of expertise who engage in the design/development processes. That may be a situational context for new and fast growing fields driven high demand for a product.

Research Questions

Four major questions guided this study:

1. What are the underlying design principles, derived from the literature on multimedia theory, that apply to the design and development of online instruction?

2. How do experts in multimedia theory and experts in design/development of online instruction for all students compare in their perceptions of whether design principles derived from a review of the multimedia literature apply to online instruction for all students at the K-12 level?
3. How do experts in multimedia theory and experts in design/development of online instruction for students with learning disabilities compare in their perceptions of whether design principles derived from a review of the multimedia literature apply to online instruction for students with learning disabilities at the K-12 level?
4. How do experts in multimedia theory, experts in design/development of online instruction for all students, and experts in design/development of online instruction for students with learning disabilities compare in their perceptions of whether design principles derived from a review of the multimedia literature apply to online instruction for all students at the K-12 level?

Limitations

This study had the following limitations.

1. The population of individuals nationally with knowledge about design and experience in online design for K-12 students is currently not large. This is due to the relative newness of the field in contrast to areas such as curriculum design. Consequently, the number of individuals recommended as appropriate for serving as members of the three expert judges was not large.
2. The theories selected for review were limited to those recommended by a small group of experts in multimedia theory and the related research carried out by the researcher in searching for design principles with implications for online instruction.

3. Each selected theory was reviewed to identify key principles representative of the theory from which it was derived. Due to the large number of indicators that might be considered as principles aligned with a particular theorist, some were not included.

Definitions

The following terms are pertinent to this paper and are defined as:

Multimedia. Multimedia is defined as a platform that offers learners access to information in a variety of formats, which can include text, still images, animation, video, and audio presentations (Moos & Marroquin, 2010).

Multimedia learning. Multimedia learning occurs when people *"*build mental representations from words (such as spoken text or printed text) and pictures*"* (such as illustrations, photos, animation, or video) (Mayer, 2001, p. 2).

Instructional technology. "Instructional technology ... is a systematic way of designing, carrying out, and evaluating the total process of learning and teaching in terms of specific objectives, based on research in human learning and communication and employing a combination of human and non- human resources to bring about more effective instruction" (The Commission on Instructional Technology, 1970*, p. 199*).

Educational technology. "Educational technology is the study and ethical practice of facilitating learning and improving performance by creating, using, and managing appropriate technological processes and resources" (AECT, 2008, p. 24).

Interactivity. Sims (1997) indicates that ''interactivity can be viewed as a function of input required by the learner while responding to the computer, the analysis of those responses by the computer and the nature of the actions by the computer" (p. 159).

Learning disabilities. The Individuals with Disabilities Education Act (IDEA, 2006) retained the definition of specific leaning disabilities as included in previous versions (IDEA, 2004, 2005) of the law and regulations. Specifically, learning disabilities is defined as a disorder in one or more of the basic psychological processes involved in understanding or in using language, spoken or written, which disorder may manifest itself in the imperfect ability to listen, think, speak, read, write, spell, or do mathematical calculations (IDEA, 2006).

CHAPTER TWO

Literature Review

A critical factor in online instruction is that the content, structure of content, design for presentation of instruction via visual display, navigation options, creation of media and graphics, and intended interactivity must all be designed and development prior to students being engaged. This is true even when using learning management systems (LMS). These conditions apply to both asynchronous and synchronous online instruction. The requirements may vary somewhat in the emerging delivery formats of hybrid, blended and flipped models. However, the visual display will likely remain a constant in the near future as the monitor serves as the vehicle for presenting the information and engaging the online learner.

This is the core of online instruction outside of what teachers do in structuring the online instructional environment to accommodate what they bring to the teaching learning process. Commercial developers of online programs marketed to schools must be even more diligent in the decisions they make in designing and developing online instruction that utilizes visual displays in delivery. Once adopted, commercially developed online instructional programs impact large numbers of students and teachers. Therefore, it is important for those doing the design and development of online instruction for K-12 students to be knowledgeable of the theories and research that underlie the design of how information is most effectively presented via visual display technology. This is central to the process of maximizing the effectiveness of online instruction.

The focus of this study does not imply that one theory is more applicable to online instruction than others. Rather, it supports the view that there is merit in knowing the design principles that over time have been researched as part of the collective effort in maximizing the effectiveness of online instruction.

The literature search for research-based design principles focused primarily on seven theories included Vygotsky's cultural historical activity theory, also known as CHAT (Vygotsky, 1978); human computer interaction (HCI; Kaptelinin & Nardi, 2006; Nardi, 1996a); Mayer's cognitive theory of multimedia learning, also known as CTML (Mayer, 2005; Mayer &Moreno, 2007); Sweller's cognitive load theory, also known as CLT (Sweller, 1994, 2003; Sweller, Merrienboer, & Pass, 1998); universal design for learning (UDL; Rose & Meyer, 2005); 8 psychological principles (Kosslyn, 2007); and 13 principles of display design (Wickens et al., 2004). Each theory will be reviewed as a framework for developing guidelines for the design of online instruction. The emerging work on activity, environment, individual, object, understanding (AEIOU) by Branham (NKUAS, 2011) will also be reviewed as it addresses the process of framing designs. In addition, it offers a very applied approach to the iterative process of ensuring that all elements of design, to the extent reasonable, are considered in creating designs. Design principles were not derived from AEIOU, but it merits consideration in the design process. The review will end with a listing of the design principles derived from the review. The respective theory from which each principle was derived will be cited.

Cultural Historical Activity Theory's (CHAT)

Description. Cultural historical activity theory (CHAT) was originally developed by Soviet Russian psychologists Lev Vygotsky (1978), A.N. Leont'ev (1978, 1981), and A. R. Luria (1928) during the 1920s (Veresov, 2010). Based on Lazarou's views (2011), CHAT is a theory for understanding human activity and explaining the complex psychological functioning of individuals. CHAT also refers to an interdisciplinary approach to studying human learning and cognitive development, especially in the areas of play and learning (LCHC, 2005). Moreover, CHAT is a social theory focused on artifact-mediated and object-oriented activities formulated by the Russian psychologists mentioned above (University of Helsinki, 2004). CHAT addresses a clear framework that "a human individual never reacts directly to the environment, instead, human individual and objects of environment are mediated by cultural means, tools and signs" (University of Helsinki, 2004, para. 2).

CHAT has been used in a wide range of analyses. According to Nardi (1996), CHAT is "evolving, growing, and has a tremendous energy that is being applied in a broad range of research efforts in Russia, Europe, North America, and Australia" (p. 5). CHAT provides ample room in the intellectual development for advanced research and the pioneering of research "in a broad range of disciplines in philosophy, psychology, anthropology, linguistic, and education" (Nardi, 2006, p. 5).

In terms of cognitive learning and development, Dewey's viewpoints (Seaman & Nelsen, 2011) address concepts that are similar to those of CHAT and across different philosophical concerns from psychology to cultural-historical evolution, from critical thinking to practical activity, and from human interaction to artificial intellectual technology in social context (Seaman & Nelsen, 2011).

Many researchers over the years have espoused educational concepts that compare with CHAT. For example, Hedegaard and Chaiklin (2005) noted that "the radical-local themes of individual agency and social reconstruction match with the concept of Cultural Historical Activity Theory (CHAT) in teaching and cognitive learning" (p. 3). The radical-local approach aimed at teaching and learning is focused on helping children connect everyday knowledge they experience to daily schooling (Seaman & Nelsen, 2011). "Using historical issues as a tool for solving contemporary problems, evolving with the changes of various social practices, and adapting themselves in diverse of social conditions" strongly match the concepts of learning by doing from CHAT (Seaman & Nelsen, 2011, p. 21). The main purpose of radical-local approach, then, is to plan and implement practices to help connect children's cognitive knowledge of subject-mater content to the cultural-historical conditions of their lives (Hedegaard & Chaiklin, 2005).

These examples illustrate the role that CHAT plays as an intellectual tool for understanding the specific historical impacts and cultural developed conditions that are reflected in the children's life. In short, CHAT explains the relationship between people and things and describes changes of human consciousness in a wider activity system, which is related to a person's social conditions (Nardi, 1996).

Theoretic framework (principles). There are five theoretical principles of the CHAT approach that provide direction for people to evaluate major design processes, implement educational technology use in the classroom and workplace training, effectively distribute e-learning with international and cultural understanding in global learning, and provide insights into how socio-cultural changes may impact the use of technology in educational settings (Murphy & Rodriguez-Manzanares, 2008).

The five principles of CHAT formulated by Engeström (2001) include the hierarchical structure of activity, object-orientedness, internalization/externalization, tool mediation, and development. These principles are clarified in the following.

Hierarchical structure of activity. The most fundamental principle of CHAT is the hierarchical structure of activity, which means the unity of consciousness and activity (Kaptelinin & Nardi, 2007). "Consciousness in this expression means the human mind as a whole, and activity means human interaction with the objective reality" (Kaptelinin & Nardi, 2007, p. 54). Moreover, activities are composed of goal-directed actions that must be undertaken to fulfill the object (Kaptelin & Nardi, 1997). According to this principle, the human mind consists of human interaction with the environment.

Objective-orientedness. The second principle is "objective-orientedness," which involves the nature of the environment that human beings are interacting with (Kaptelinin & Nardi, 2007). CHAT considers "social/cultural properties of environment to be as objective as physical, chemical, or biological ones" (Kaptelinin & Nardi, 2007, p. 55). In the other words, this environment consists of all kinds of objective features, including the cultural-historical, economic elements that determine the ways people act on these entities (Kaptelinin & Nardi, 2007).

Internalization/externalization. The third principle of CHAT is internalization/ externalization, which claims that humans' mental processes are derived from external actions in the social environment (Kaptelinin & Nardi, 2007). According to Vygotsky (1978), internalization (mental processes) is created by the process of people interacting with others (social environment). Human beings' mental processes manifest themselves in external actions and can be verified and corrected in different situations (Nardi, 1996).

Mediation. The fourth principle emphasizes that a broad range of tools, such as external behaviors or internal concepts, mediate human activity (Kaptelinin & Nardi, 2007). Such tools influence the nature of external behavior and also affect the mental functioning of individuals (Nardi, 1996). In the other words, tools carry cultural-historical knowledge, bring social experience, shape the way people act, and influence the nature of cognitive development (Kaptelinin & Nardi, 2007).

Development. According to Engeström (2001), "understanding a phenomenon to know how it has developed into its existing form is the principle of development" (p. 136). This principle encourages taking into consideration the other principles through scientific analysis to understand the complex phenomena (Engeström, 2001).

These CHAT principles are not isolated, but are closely interrelated and integrated with various aspects of the human being and the environment. According to Murphy and Rodriguez-Manzanares (2008), "CHAT has also been relied on to study the contexts of implementation of innovation in education, such as when new technology is introduced and conflicts occur between teachers' beliefs and their actual practices" (p. 444). That is, these principles are considered an integrated system and could be applied as an e-learning platform in any educational settings.

Much of the literature has shown evidence that (a) there are biological causes of different types of disabilities and (b) associated deficits affect students' learning achievement. Vygotsky`s CHAT provides a basic, unique vision with a social perspective for developing educational models for helping student with special needs (Gindis 2003). In the international research literature, Vygotsky's theoretical and methodological concepts regarding special education have been largely influential in Russia (Rodina, 2007).

According to Dammeyer and Bottcher (2012), CHAT emphasizes how a person with a learning disability behaves in social interactions compared to individuals without learning disabilities. As such, CHAT provides a theoretical basis, developmental intervention, and pedagogic approach to working with children, adolescents, and adults with learning disabilities. CHAT plays an important role in understanding students with learning disabilities ranging from the medical aspect to a cultural-historical approach (Bottcher & Dammeyer, 2012). In summary, Vygotsky formulated a practice-oriented paradigm of education for children with special needs.

Human Computer Interaction (HCI) & CHAT

Description. CHAT is related to the theory on human computer interaction (HCI). Thus, many researchers indicate that the concept of CHAT is gradually being applied as theoretical supports in technology. According to Nardi (1996), CHAT expands cognitive science by understanding human thoughts and cognitive behavior and supports technology as a theoretical application that mediates individual activity in a social context.

There has been an increasing discussion in the literature of the computer technology used between CHAT and HCI research (Kaptelinin & Nardi, 2006; Nardi, 1996a). Cognitive science has been the dominant theoretical voice in HCI studies (Kuutti 1996; Mwanza 2001). Furthermore, CHAT has been discussed in connection with the potential to produce a wider context of usable and useful computer tools to fulfill users' needs and motives, and expand the concept of cognitive learning into more practical ways (Lazarou, 2011).

CHAT provides a clear theoretical framework for fulfilling users' needs in the wider context and "could be used as a methodological framework for producing usable and useful computer tools for actively involving real users in the design process" (Lazarou, 2011, p. 424). According to Bodker (1991), CHAT can be applied and reshaping HCI to a new humanized design field.

CHAT, created by Vygotsky (1978), is currently widely applied to study technology-based learning and working situations (Engstrom, 2001; Issroff & Scanlon, 2001). CHAT has been viewed as a useful and important approach in HCI research toward learning and development in social and cultural context (Nardi, 1996). Many researchers note that CHAT offers a significant methodological tool for design and technological use in education (Bellamy, 1996; Collins et al., 2002). According to Nardi (1996), CHAT is the solution in the design process and provides the best framework to ascertain how technology can fit into users' actual needs and remedy users' problems in social environments. Nardi (1996) argued that CHAT evaluates how technology can be applied to creative innovation and shows how technology can maximize human-centered concepts to ensure users' needs are met. In addition, Gay and Hembrooke (2004) noted that CHAT is used across a broad range of technologies for analyzing and producing design to meet users' need. Finally, Norman (2005) claimed that design based on CHAT principles provides a better framework for analyzing the consumer's needs in a human-centered way.

In terms of implementation of technology in education, CHAT has been applied in a diverse range of areas. Some researchers believe that the principles of CHAT are not only relevant for the core development of the daily activities in school (Kaptelinin 1996; Kuutti 1996), but can also enhance teachers' pedagogical practices (Bellamy, 1996; Hardman, 2005; Lim & Hang, 2003). For instance, Engeström first reformulated CHAT as an analytical tool to incubate design concepts in game studies (Lazarou, 2011). According to Lazarou (2011), CHAT provides a clear framework for producing interactive games to learn science. Moreover, CHAT can be used to evaluate the motives, goals, and needs of all students in the school environment and provide educators comprehensive principles for designing teaching and learning (Lazarou, 2011).

Cognitive Load Theory (CLT)

Description. CLT, developed by John Sweller in the 1980s, was expanded in the 1990s by researchers around the world. According to Sweller (1988), "learning happens best under conditions that are aligned with human cognitive architecture" (para. 1). Based on Miller's (1956) information processing research, "short term memory is limited in the number of elements that can be contained simultaneously; the process of memorization may be simply the formation of chunks, or groups of items that go together until there are few enough chunks so that we can recall all items" (p. 94). Moreover, the contents of long-term memory are "sophisticated structures that permit us to perceive, think, and solve problems, rather than a group of rote learned facts" (Sweller, 1988, para. 1). These two structures, known as schemas, are "what permit us to treat multiple elements as a single element that make up the knowledge base and acquired over a lifetime of learning" (Sweller, 1988, para. 1). Thus, Sweller (1988) built a theory that "treats schemas, or combinations of elements, as the cognitive structures that make up an individual's knowledge base" (para. 1).

A critical issue in CLT approaches to education is the relationship between students' learning and development (McGaw, Peterson, & Baker, 2006). Many researchers have compared and contrasted CLT with other techniques and theories to analyze the relationship between cognitive learning and development in education. For example, Gibson's work (Nardi, 2006) on affordances and Norman's work (Nardi, 2006) on cognitive artifacts, situated action models, and distributed cognition all illustrated similar concepts. Seaman and Nelsen (2011) claimed that CLT fundamentally matched John Dewey's idea of cognitive learning pioneered in 1930s. Researchers have indicated that cognitive learning and development are not only interdependent; rather they interact with the environment, cultural, and social context (Seaman & Nelsen, 2011). In the other words, the conceptual patterns of CLT explain humans beings' cognitive learning, and behavior development is built based on people's cognitive resources and attention situated in this social context (McGaw et al., 2006).

Theoretic framework (principles). Kennedy (2011) suggested that Sweller's CLT (2006), Paivio's dual coding theory (1986), and the triarchic model of cognitive load (DeLeeuw

& Mayer, 2008) underpin other research as a comprehensive theory with potential benefits for designing and distributing multimedia-based instruction, especially for students with diverse learning difficulties.

Based on these theories, there are three assumptions of human cognition that help researchers to understand the process when a person constructs knowledge (Mayer, 1996, 2005, 2009): dual channel assumption, limited capacity assumption, and active processing assumption.

Dual channel assumption. "Humans possess two separate channels for processing visual and auditory information" (Mayer, 2009, p. 63). Mayer and Anderson (1991, 1992, 1997) proposed that the human information-processing system contains a verbal channel and a visual channel. These dual information processing channels, visual and verbal, help learners distribute the processing of knowledge (Muthukumar, 2005).

Limited capacity assumption. Based on Mayer (2005), this assumption points out that the dual channels, visual and auditory, can process only limited amount of information at one time. "Humans are limited in the amount of information that they can process in each channel at one time" (Mayear, 2009, p. 63).

Active processing assumption. Based on Mayer (2005), the active processing assumption focuses on the cognitive process that people use to construct a mental representation of their life experiences. "Humans engage in active learning by attending to relevant incoming information, organizing selected information into coherent mental representations, and integrating mental representations with other knowledge" (Mayer, 2009, p. 63).

Active processing assumption can be broadly divided into three cognitive processes that take place while a person engages in cognitive learning in a multimedia environment (Mayer & Moreno, 1998).

Selecting. This cognitive progress mediates the external information through a sensory representation process to internal memory representation (Mayer, 2005; Mayer & Moreno, 2007). This process helps learner to select key words and pictures during instruction.

Organizing. This cognitive process is applied to organizing selected words and organize them into working memory (Mayer, 2005; Mayer & Moreno, 2007).

Integrating: The third cognitive process occurs when the learner builds connections between word-based and visual-based representations. According to Mayer (2001, 2005, 2009), in this manner, learners integrate new knowledge with their prior knowledge.

Cognitive load theory has provided "a framework for investigations into cognitive processes in instructional design" (Paas, Renkl, & Sweller, 2003). CLT considers the structure of information and the cognitive architecture that allows learners to process that information that has been able to generate a unique variety of new and sometimes counterintuitive instructional designs and procedures (Paas et al., 2003).

Universal Design for Learning (UDL)

Description. Multimedia instruction is reported to benefit low-performing students in practicing reading and writing by focusing on the multimedia-based development of ideas and the structure of the sentences and paragraphs (Rose et al., 2005). The concepts inherent in UDL are particularly effective for the delivery of instruction (Rose & Meyer, 2005). UDL underscores the need for multiple representations of information with equal access for all learners and provides an educational framework for all individuals to gain knowledge, skills, and enthusiasm for learning (Meyer & Rose, 2002; Rose & Meyer, 2006; Rose, Meyer, & Hitchcock, 2005). UDL provides a foundation of research-based guidelines for creating flexible and valid computer-based assessments for a wide range of students, including those with learning difficulties (Thompson, Johnstone & Thurlow, 2002). The primary concept of universal design focuses on the content constructs that are being measured and the full spectrum of abilities and disabilities of those who are being assessed (Rose et al., 2008). The application of universal design principles provide a framework for examining content instruction and its level of accessibility to students with or without learning disabilities (Rose et al., 2008). Thus, the application of universal design in multimedia learning in education can help enhance student engagement and persistence, and maintaining high achievement standards for all students through all grade levels (Rose, Meyer, & Hitchcock, 2005; Stahl, 2008).

Theoretical framework (principles). A set of UDL guidelines were developed by David H. Rose, co-founder and chief education officer at the Center for Applied Special Technology (CAST), and Jenna Gravel, a doctoral student at Harvard (CAST, 2011). These principles expressed have received extensive review and comments from professionals at various levels, such as researchers, colleagues at CAST, teachers at the elementary, secondary, and postsecondary levels, and other practitioners (CAST, 2011) (see Appendix E). The principles are as follows:

Principle I. Provide Multiple Means of Representation.

Guideline 1: Provide options for perception.

Guideline 2: Provide options for language and symbols.

Guideline 3: Provide options for comprehension.

Principle II. Provide Multiple Means of Action and Expression.

Guideline 4: Provide options for physical action.

Guideline 5: Provide options for expressive skills and fluency.

Guideline 6: Provide options for executive functions.

Principle III. Provide Multiple Means of Engagement.

Guideline 7: Provide options for recruiting interest.

Guideline 8: Provide options for sustaining effort and persistence.

Guideline 9: Provide options for self-regulation.

Cognitive Theory in Multimedia Learning (CTML)

Description. Many cognitive psychologists have conducted empirical studies regarding how technology-based content may be used to enhance students' cognitive learning and development. Among the major findings is that the use of multimedia educational resources guided by a research-based theory progressively empowers cognitive learning and development in educational settings (Mayer & Moreno, 1998). Further, Muthukumar (2005) argued that the CTML advocated by Mayer (2001) is one of the key theories in the field of cognitive psychology that have helped understand humans' mental reasoning and ability to process incoming new information.

In addition, Kennedy (2011) noted that multimedia instruction has the potential to deliver high-quality instruction to fulfill the cognitive learning needs of students with learning disabilities. Further, CTML (Mayer, 2001, 2005, 2009) provides significant principles and theoretical framework for designing and delivering effective instruction for students with special needs (Kennedy, 2011).

Multimedia-based learning has been increasingly applied in educational settings and has been shaped by rapid technological innovation. According to Muthukumar (2005), multimedia-based resources in the classroom have been utilized in various interactions to transform conventional education in digital ways. As such, multimedia is a combination of various presentation modes (Bagui 1998), such as text, graphics, animation, audio, and video used to address students' differing learning styles and needs (Muthukumar, 2005).

Many researchers indicate that students' learning is gradually improved through computer-based resources compared to traditional instructional approaches. Further, many results have shown that the use of computer technology enhances pedagogical learning in schools setting and higher education levels (Kazmerski & Blasko 1999; Steyn et al., 1999). For instance, Mitchem et al. (2009) reported that technology such as Internet access, DVDs, and videotapes, along with television and videogames have increased people's interests for retrieving information and enhanced their comprehensive ability.. According to Muthukumar (2005), the efficiency of technology mediated in learning environments has improved students' level of engagement and shown positive results with regard to achieving students' learning objectives (Muthukumar, 2005).

Theoretic framework (principles). CTML has several implications for the development of multimedia-based content, including the power to enhance pedagogical teaching and students' engaging. Mayer (2005) argued that knowing students' learning styles and needs helps in understanding how the learning environment should be organized and how to design effective instructional resources. Grounded in the model of cognitive load, and the three assumptions of the CTML, Mayer (2009) outlined 10 principles for designing instructional resources that effectively enhance students' learning.

Multiple representation principle. This principle advocates that a multimedia presentation should include at least two different forms of visual representation, such as pictures and text, rather than only pictures or text alone because people learn better from words and pictures than from words alone when (Fletcher & Tobias, 2005; Moreno & Mayer, 1999). Therefore, in future design of online instructions, the content should include graphics and animation in addition to the written text.

Split-attention principle. The second principle claims that a multimedia presentation should avoid replicating relevant content (Clark & Mayer, 2009). For instance, when offering auditory information, it should not be replicated with on-screen text. According to Clark and Mayer (2003), multimedia materials should place printed words next to the corresponding pictures to convey relevant meanings for further explanation and descriptios for users. In future design of online tutorials, content should be conveyed using graphics and animation instead of on-screen text only to reducing cognitive load (Sweller, 2004; Sweller et al., 1998).

Modality principle. Since working memory consists of at least two information processing channels, auditory and visiual, Clark and Mayer (2003) argued that students learn better when a multimedia explanation presents verbal information as auditory speech rather than visually as on-screen text. The idea of this principle is to expand effective working memory capacity and reduce excessive cognitive load (Low & Sweller, 2005; Sweller, 2004; Sweller, et al., 1998).

Redundancy principle. Many multimedia-based scenarios include all the various kinds of visual materials, such as animations, video, or graphics simultaneously with text and audio. The redundancy principle states that multimedia-based presentations should avoid presenting the same information in multiple forms (Sweller, 1988, 1994, 2004) because extraneous presentations burden the cognitive abilities of the working memory and, therefore, hurt learning (Clark & Mayer 2003).

Coherence principle. According to the fifth principle, learning is enhanced when irrelevant or extraneous information is excluded within a multimedia presentation. Thus, the instructional content should contain few rather than many extraneous words and pictures to result in better learning results (Moreno & Mayer, 2000).

Personalization principle. Since learners have different understandings of the same information, the fourth principle states that instructional materials should be designed taking individual differences into consideration. Therefore, if multimedia presentations are presented in a conversational rather than a formal style, it would better fit learners' diverse learning differences (Mayer, 2005).

Spatial contiguity principle. This principle states that students learn better when on-screen text and visual materials are physically integrated rather than separated (Astleitner &

Wiesner, 2004). Multimedia-based presentations should present corresponding words and pictures contiguously, placing text nearby or inserting it into images (Bozarth, 2010).

Temporal contiguity principle. This principle holds that students learn better when verbal and visual materials are temporally synchronized rather than separated in time (Astleitner & Wiesner, 2004).

Pretraining principles. The principle indicates that people learn better from a narrated animation when they already know the information and characteristics of essential components. According to Kennedy et al. (2011), students' learning is enhanced when instructional messages contain an orienting message to introduce the forthcoming content.

Segmenting principle. The principle states that people learn better when a narrated animation is presented in learner-paced segments than as a continuous unit (Astleitner & Wiesner, 2004). Thus, learning is enhanced when multimedia presentations are divided into short bursts (5-7 minutes) as opposed to longer modules (Kennedy et al., 2011).

According to the CTML proposed by Moreno and Mayer (1997), these 10 principles make effective use of educational technology in teaching and learning. The better these principles are understood, the better the chances of developing successful multimedia programs that meet students' expectations. The multimedia presentations not only empower educators in teaching but also assist learners.

If researchers take students' cognitive perspectives and learning conditions into account they are more likely to inspire students' learning interests and meet their expectations (Mayer & Moreno, 1998). In other words, use of new instructional technology must be theoretically guided by underlying research theory, which can provide instructional designers with a summary of cognitive factors and target students' need when developing multimedia-based learning environments (Astleitner & Wiesner, 2004).

Stephen Kosslyn's Eight Psychological Principles

Description. Researchers in diverse disciplines have advocated that graphic designs convey more powerful storytelling than narrative words. In terms of visual display, Volkwein (2010) argued that "effective reporting requires the thoughtful integration of text and graphics" (p. 161). Schultz agreed with Kosslyn's (2007) viewpoints that *"*Every visible or auditory change should convey information*"* (Kosslyn, 2007, as cited by Schultz, 2009, p. 279). Moreover, other researchers have discussed design principles for displaying data in tables and charts (Bers & Seybert, 1999; Sanders & Filkins, 2009, as cited by Volkwein, 2010).

The helpful tips from these authors are based on Kosslyn's work, which emphasizes that "the eye and the mind absorb data and information when constructing visuals in reports and presentations" (Kosslyn, 2006, 2007; Tufte, 2001, 2006, as cited by Volkwein, 2010, p. 161). In other words, Kosslyn's principles provide best practice suggestions for how to incorporate graphic and charts within the document and, thereby, contributing bettr to understanding.

Kosslyn (2007) expanded his viewpoint in more psychological and cognitive processes that "people perceive, comprehend visual displays, organize, and interpret world through eyes and minds" (p. 5). Kosslyn's eight psychological principles are organized into three sets, which play different roles in fulfilling different learning goals (Kosslyn, 2007). Research indicates that a good graphic is worth more than a thousand words because any good graphic entails that learners "connect with their audience, direct the reader's attention through display, and promote understanding and memory" (Kosslyn, 2007, p. 6).

Theoretic framework (principles). The eight psychological principles posited by Kosslyn (2007, pp. 1-11) are as follows,

Principle of relevance. Communication is most effective when neither too much nor too little information is presented.

Principle of appropriate knowledge. Communication requires prior knowledge of pertinent concepts, jargon, and symbols.

Principle of salience. Attention is drawn to large perceptible differences.

Principle of distinguishability. Two properties must differ by a large enough proportion; otherwise, they will not be distinguished.

Principle of perceptual organization. People automatically group elements into units, which they then attend to and remember.

Principle of compatibility. A message is easy to understand if its form is compatible with its meaning.

Principle of informative changes. People expect changes in properties to carry information.

Principle of capacity limitations. People have a limited capacity to retain and to process information. As a result, they will not understand a message if it requires too much information to be retained or processed.

Wickens et al.'s 13 Principles of Display Design

Description. Comprehensive methods and knowledge lead to better systematic design in broad spectrums. "Human strengths and limitations" (Wickens et al., 1999) are key elements that designers and other professional, in diverse fields, should take into consideration. Wickens et al. (1999) advocates for 13 display design principles and provide real-world design examples showing readers how these principles are based on understanding of human beings' psychological, biological, and physical characteristics that apply from the conceptualization to the implementation level in their daily life.

Theoretic framework (principles). In terms of display design principles, Wickens et al. (1999) has divided their 13 principles into 4 distinct categories: "(1) Perceptual Principles, (2) Mental Model Principles, (3) Principle based on Attention, and (4) Human Memory. The thirteen display principles are as follows" (pp. 186-191),

Perceptual Principles.

1. Make displays legible (or audible)
2. Avoid absolute judgment limits
3. Top-down processing
4. Redundancy gain
5. Discriminability.

Mental Model Principles

6. Principle of pictorial realism
7. Principle of the moving part

***Principle Based on Attention*.**

8. Minimizing information access cost

9. Proximity compatibility principle

10. Principle of multiple resource

Memory Principles

11. Replace memory with visual information: knowledge in the world

12. Principle of predictive aiding

13. Principle of consistency

Learning Disabilities. Psychological, biological, and social elements are embodied in human factors engineering (Wickens et al., 1999). Many researchers have argued that those key elements could be considered in designs for learners with special needs. For example, the Association for the Advancement of Medical Instrumentation (AAMI) have been conducted many studies and developed design standards that take into consideration human factors issues (Gardner-Bonneau, 2007). The AAMI Human Engineering Committee is developing specific human factors guidelines that emphasize taking "human factors and human performance standards" into consideration for the design of medical devices for subjects with specific age-related and disabilities (Gardner-Bonneau, 2007, p. 3).

The display design principles proposed by Wickens et al. (1999) contain information on broad topics, such as long-term memory, situation awareness, stress effects on performance, cognitive engineering, and computer-mediated communications that can be expanded in designing online instruction for student with learning disabilities.

Design Principles

As described in Chapter Three, the design principles derived from the literature review went through an iterative process structured so as to minimize duplication. When analyzed through this process, it became evident that some principles generalize across more than one theory. The following review of the final 40 principles included in the study aligns each principle with the theory(s) it represents.

1. In learning, the learner interacts with the environment and environment interacts with the learner (Deway, 1933; Mishra & Girod, 2006; Vogotsky, 1978). This principle included the theories of CHAT and HCI.
2. Mediated actions-in-activities while teaching common content at the same time results in more effective learning than when presented with time differences (McGaw, Peterson, & Baker, 2006; Pantic et al., 2005). This principle includes the theories of CHAT, HCI, and UDL.
3. Human activity is realized though actions oriented toward goals while the goals are becoming routinized operations (Lazarou, 2011; Vygotsky, 1978). This principle includes the theory of CHAT.
4. Online navigation should include several modes of access (Hede, 2002; Muthukmar, 2005). This principle includes the theoriesof CTML, CTL, and UDL.
5. Online navigation options should be kept simple (Hede, 2002; Muthukmar, 2005). This principle includes the theories of CTML, CTL, and UDL.
6. Multimedia design features need to be examined in terms of how they interact with each other and their relative contribution to cognitive overload (Muthukumar, 2005; Sajadi, 2010). This principle includes the theories of CTML, CTL, and UDL.
7. In designing multimedia, instructional emphasis needs to be placed on the mix of modes of instruction to meet individual differences (Muthukmar, 2005; Norman, 1993). This principle includes the theories of CTML, CTL, and UDL.

8. The time limitation of working memory must be considered in designing displays (Kosslyn, 1985; Norman, 1988; Posner, 1978). This principle includes the theories of CTML, CTL, UDL, and display principles.
9. Unnecessary information should be kept to a minimum to avoid cognitive overload (Mayer, Bove, Bryman et al., 1996; Tempelman-Kluit, 2006). This principle includes the theories of CTML, CTL, UDL, and display principles.
10. Developers need to understand students' cognitive reasoning when developing online instructional resources to guide learners' quest for learning (Kalyuga, Ayres, Chandler, & Sweller, 2003; Muthukmar, 2005). This principle includes the theories of CTML, CTL, UDL, Kosslyn's 8 psychological principles, and display principles.
11. Developers need to understand students' affective reasoning when developing online instructional resources to guide learners' quest for learning (Kalyuga, Ayres, Chandler, & Sweller, 2003; Muthukmar, 2005). This principle includes the theories of CTML, CTL, UDL, Kosslyn's 8 psychological, and display principles.
12. Multimedia-designed instruction allows the learner to build verbal and visual models while also building connections between them (Mayer & Anderson, 1991; Mayer & Moreno, 1998). This principle include the theories of CTML, CTL, UDL, and display principles.
13. Students should be provided opportunities to see the connection between the knowledge they are taught and everyday life (Hedegaard & Chaiklin, 2005; Lazarou, 2011; Seaman & Nelsen, 2011). This principle includes the theories of CHAT, HCI, CTML, UDL, and display principles.

14. Cultural factors impact activities and require that interactions be contextualized (Hedegaard & Chaiklin, 2005; McGaw, Peterson, & Baker, 2006; Pantic et al., 2005). This principle includes the theories of CHAT, HCI, CTML, UDL, and display principles.
15. Activities should be designed to provide a rich context for learning and lend themselves to sustained inquiry and revisions of ideas (Cole, 1997; Mishra, & Girod, 2006; Papwert, 1991; Vygotsky, 1978; Willet, 1992). This principle includes the theories of CHAT, HCI, and CTML.
16. Concurrent narration and animation results in higher performance than content presented on screen through text and animation (Kosslyn, 2007; Mayer & Anderson, 1991; Moreno & Mayer, 1999). This principle includes the theories of CHAT, HCI, CTML, and display principles.
17. The design structure of an activity should include motives, actions, and responses to cultural needs derived from examining the conditions of the learners' environment (Lazarou, 2011; Seaman & Nelsen, 2011). This principle includes the theories of CHAT, HCI, UDL, and display principles.
18. When viewing or listening conditions are less than desirable. the message is more likely to be interpreted correctly when it is expressed more than once and in alternate forms (Kosslyn, 2007; Wickens et al., 1999). This principle includes the theories of CHAT, HCI, CTML, UDL, and display principles.
19. Simultaneous media presentations should be kept simple (Hede, 2002; Muthukmar, 2005;). This principle includes the theories of CTML, UDL, Kosslyn's 8 principles, and display principles.

20. Narrative presented auditorily and aligned with animation results in better learning outcomes than when text only is aligned with animation (Mayer & Anderson, 1991; Mayer & Moreno, 1998). This principle includes the theories of CHAT, HCI, CTML, UDL, and display principles.
21. Visual displays should be designed in a manner that is consistent with other displays that the student may perceive concurrently (Kosslyn, 1985; Norman, 1988; Posner, 1978; Wickens et al., 1999). This principle includes the theories of CHAT, HCI, CTML, UDL, and display principles.
22. Affective signals for online learners are essential in maximizing e-learning. (Pantic et al., 2005; Pelachaud et al., 2002). This principle includes the theories of CTML, UDL, and display principles.
23. Social contexts for online learners are essential in maximizing e learning (Pantic, et al., 2005; Pelachaud et al., 2002). This principle includes the theories of CHAT, CTML, UDL, and display principles.
24. The motivational value of multimedia (both video and audio) needs to be considered in instructional design because they support learning and help to reduce fear of failure. (Astleitner & Wiesner, 2004; Cennamo, 1993; Tang & Isaacs, 2003). This principle includes the theories of CHAT, CLT, CTML, UDL, and display principles.
25. Visual and auditory stimuli impact instruction in multimedia learning and require a level of engagement plus a balance between textual, pictorial, and verbal representations (Mayer, 1997; Muthukmar, 2005). This principle includes the theories of CTML, UDL, and display principles.

26. Knowing students' prior knowledge is central to the design of online instruction for struggling learners (Blackhurst, 2005; Kosslyn, 2007; Mayer & Moreno, 1998). This principle includes the theories of CTML, UDL, Kosslyn's 8 principles, and display principles.
27. Learners must move new knowledge from long-term memory to working memory to apply it to real-life situations (Clark & Mayer, 2003; Muthukmar, 2005). This principle includes the theories of CHAT, CTML, and UDL.
28. "Chunking" content in short-term memory so that it relates to long-term memory schemata is important in designing online instruction (Clark & Mayer, 2003; Miller, 1956; Tempelman-Kluit, 2006). This principle includes the theories of CTML, UDL, and display principles.
29. Multiple means of expression are central to meeting the varied needs of learners (Hede, 2002; Muthukmar, 2005; Rose, 2006). This principle includes the theories of CTML, UDL, and display principles.
30. Online instruction is most effective when using two modes of instruction rather than one (e.g., listening to an audio presentation while also viewing an animated representation on the same content) (Mayer & Moreno, 1998; Okolo, 2000). This principle includes the theories of CLT, CTML, and UDL.
31. Multiple representations of information should be provided instead of a single representation (Hede, 2002; Muthukmar, 2005; Rose, 2006). This principle includes the theories of CTML, UDL, and Kosslyn's work.
32. To optimize multimedia-based learning environments, factors such as attention, engagement, goal setting, monitoring, and action control must be addressed (Astleitner &

Wiesner, 2004; Hede & Hede, 2002; Muthukumar, 2005. This principle includes the theories of HCI, CTML, and UDL.

33. Students learn better when the summarization does not include the same wording as the original instruction or additional detail (Mayer, Bove, Bryman et al., 1996; Mayer & Moreno, 1998). This principle includes the theories of CHAT, HCI, CTML, UDL, and display principles.
34. Design should minimize working memory load, which combines short-term and long-term memory, and instead utilize the greater capacity of long-term memory (Clark & Mayer, 2003; Ericsson & Kintsch, 1995; Tempelman-Kluit, 2006). This principle includes the theories of CHAT, HCI, CTML, UDL, and display principles.
35. Requiring the learner to mentally integrate disparate sources of information interferes with learning (Chandler & Sweller, 1992; Moreno & Mayer, 1999). This principle includes the theories of CHAT, CTML, UDL, and display principles.
36. By providing time between each segment of learning for reflection, the learner is allowed time to process information before proceeding (Bruning, Schraw, & Ronning, 2003; Tempelman-Kluit, 2006). This principle includes the theories of CTML, UDL, display principles, and display.
37. The presentation of narration increases long-term and short-term memory capacity (Savoji, Hassanabadi, Fasihour, 2011; Tempelman-Kluit, 2006). This principle includes the theories of CLT, CTML, UDL, and display principles.
38. When incorporating displays, the display should look like a pictorial image of what it represents (Mayer & Moreno, 1998; Wickens et al., 1999). This principle includes the theories of CTML, UDL, and Kosslyn’s work and display principles.

39. Computer-mediated activity and design need to be understood within the relevant instruction (Gay & Hembri, 2004; Tempelman-Kluit, 2006). This principle includes the theories of CHAT, CTML, UDL, and display principles.
40. Multiple means of engagement are critical to creating conditions that stimulate engagement in learning (Kosslyn, 2997; Rose, 2006). This principle includes the theories of CTML, UDL, Kosslyn's psychological principles, and display principles.

CHAPTER THREE

Method

A significant change in education has been the emergence of digitalization and Internet technologies that have spawned a major industry. The e-learning industry is achieving capacity for meeting the needs of K-12 education much, like the traditional publishing industry over the past century. This new e-learning industry goes beyond the traditional publishing of curriculum resources. Online instruction is now marketed directly to schools with schools acquiring online resources much like they used to adopt text book series. The difference is in the delivery and the design of online resources. Commercial elearning firms now carry out instructional design and development much like the role of publishers in the design and production of textbooks. One difference is that there appears to be more in-house curriculum development occurring within this industry in addition to the technology design and delivery. Albeit, there is still evidence of the collaborative model with the content being developed by contributing authors continues.

The evolving elearning industry model is more inclusive of what it delivers e.g., content, design, development, technology creation and curriculum integration with the online instructional program marketed on a subscription basis. The emphasis on instruction beyond curriculum and/or curriculum guidelines adds a major dimension to the industry as does the subscription process. A subscription typically includes on-going technical support for delivery and varied supports for teachers, students and administrators in addition to the content and instruction. Students engage in instruction by interacting with software via various computerized devices through visual displays e.g., the monitor. The content and the design are largely embedded in the software with teachers facilitating student engagement in the online instructional process and offering supplemental instruction.

What has not been clear is the extent to which the designs employed are driven by research and/or theory that is extant in the multimedia design and learning science literature. This is particularly true in reference to the development of online resources to meet the needs of students with disabilities. One common element across online instructional environments that differentiates online instruction from instruction that has characterized K-12 in the past is the role that visual displays assume in the delivery of instruction and information. This is not to minimize the importance of the teacher, but currently in the evolvement on online instruction the monitor is a constant if not the only constant in online instructional environments.

This study involved a comprehensive review of the literature on multimedia design to identify the theoretical and research support for instructional design principles related to multimedia theories that are viewed as applicable to online instruction. The intent was to identify specific design principles that offer implications for the design of online instruction. The focus was on verifying the relative importance of these principles to online instructional designs applicable to K-12 education. Particular attention was given to the applications of design principles to all learners with special emphasis given to students with learning disabilities.

Research Questions

1. What are the underlying design principles, derived from the literature on multimedia theory, that apply to the design and development of online instruction?
2. How do experts in multimedia theory and experts in design/development of online instruction for all students compare in their perceptions of whether design principles derived from a review of the multimedia literature apply to online instruction for all students at the K-12 level?

3. How do experts in multimedia theory and experts in design/development of online instruction for students with learning disabilities compare in their perceptions of whether design principles derived from a review of the multimedia literature apply to online instruction for students with learning disabilities at the K-12 level?
4. How do experts in multimedia theory, experts in design/development of online instruction for all students, and experts in design/development of online instruction for students with learning disabilities compare in their perceptions of whether design principles derived from a review of the multimedia literature apply to online instruction for all students at the K-12 level?

Procedures

In contrast to the design and development of traditional instructional and curriculum resources the process of developing digital resources for use in online instruction is relatively new. Online courses in postsecondary education began to emerge in the late 1990s. In contrast to postsecondary education the evolvement of online instruction in K-12 education received less attention until around 2005. The first state level virtual school was implemented in Michigan, which became the first state to require online learning for high school graduation (iNACOL, 2010). In 2008, Alabama added a high school graduation distance/online learning requirement (iNACOL, 2010). A number of professional personnel preparation programs in higher education, with a stated mission of preparing specialists in educational media, have evolved in recent years. The population of individuals that can be characterized as possessing expertise and experience in design and development of online instruction at the K-12 level is small compared to the field of curriculum development of the past. With the growing demand for online instruction and the burgeoning K-12 enrollment in virtual schools and schools in general offering online instruction the demand for individuals with the needed skills and expertise in design and development exceeds the supply. This limited the availability of individuals from which to derive a sample of experts for this study.

Two sets of procedures were adhered to in conducting the study. The first involved the identification of theory based principles from the literature and the engagement of experts in the verification process. The second procedure involved the engagement of panels of experts in determining the relative importance placed on the individual principles and their perceived application to online instruction for all learners including students with learning disabilities.

Set 1. Procedures for the Identification and Framing of Theory Based Principles.

This process included six steps. The steps were carried out sequentially with the outcome being finalization of the identified principles for inclusion in Q-Methodology for analysis.

Step 1. Literature Review.

A systematic literature review was conducted to identify theories of multimedia and associated design principles relevant to online instruction. Three professors with expertise in multimedia theory, design, and online development were consulted in determining the primary theories to guide the literature search. The review was an iterative process in that periodic consultations with these experts were conducted as the review progressed. When a theory based reference was identified in the literature as potentially containing a design principle with a high probability of being applicable to online instruction, the reference was summarized and cited. These examples and citations were then compiled and subjected to an iterative review. Following feedback from this process the references were reviewed again by the researcher for completeness and the need to expand the review to additional theories. This iterative process was repeated until a core of principles was identified as meriting more in depth examination through Step 2.

Step 2. Confirmations of principles.

The confirmation of principles entailed an expanded search to locate research studies addressing the identified theories and associated principles. A minimum of two studies per principle were required for a principle to be considered for inclusion in the initial list of principles for consideration in the study. Citations were prepared for the research studies identified relative to each principle. The citations were retained in an archival file.

Step 3. Iterative Review.

At the completion of reviewing each principle and identifying supporting sources of research for each preliminary principle, 50 principles had been compiled and were subjected to an iterative review. This resulted in duplications being identified and eight preliminary principles were eliminated,

Step 4. Framing of Principle.

Because the original principles varied greatly in length, language format and detail, each principle was restated in similar language and length consistent with the format for Q-Methodology. At this stage the principles were separated from the citations and retained as a single list of principles. The original principles and citations were coded and retained for archival purposes.

Step 5. Iterative review.

Forty-two principles were included in this review. Two were eliminated due to being very similar to others. In the process of this iterative review additional attention was given to the coverage of theories and two additional theories were recommended for review. This review resulted in three additional principles being added to the pool of forty, bringing the total to forty three.

Step 6. The finalization of principles for inclusion in the Q-Methodology.

The final selection resulted in forty principles being included. Once the final principles were selected they were randomized for inclusion in the Q-Sort Tool.

***Set 2. Procedures for Determining the Relative Importance of the Individual Principles*.**

The study employed the Q methodology developed by William Stephenson in the 1930s. The Q-methodology provided an approach to exploring correlations between persons' viewpoints toward an issue or a topic (Brown, 1996). The Set 1 procedures were conducted in readiness for applying Q-Methodology . This involved developing a list of design principles as statements using different sources (Brown, 1996; Dennis, 1986; Valenta & Wigger,1997). In terms of this study, the literature review process described in Step 1 of the previously described set of procedures was conducted to identify principles associated with multimedia theories applicable to the design of online instruction.

Step 1. Selection of Q-Sample of participants (P-Set). Three panels of experts were selected as the Q-Sample of participants. A nomination process was employed in selecting invitees to serve on the panels. Individuals knowledgeable of experts in the respective fields from which expert participants were sought were requested to nominate prospective expert judges. Nominees identified as having done collaborative work with a theorist whose principles had been identified were eliminated from the pool of experts.

The three panels of experts included the following:

Panel 1. Experts in multimedia theory included individuals knowledgeable of and experienced in the application of design theory to online instruction.

Panel 2. Experts in design/development of online instruction for all students included individuals knowledgeable of and experienced in the application of design theory to the design of online instruction for all K-12 learners.

Panel 3. Experts in design/development of online instruction for students with learning disabilities in K-12 education included individuals knowledgeable of and experienced in the application of design theory to the design of online instruction for K-12 learners with learning disabilities.

Step 2. Selection of participants to serve on the expert panels. Because of the relative newness of online instruction for K-12 education, the population of candidates for expert panels, while not known, was fairly small. Nominations were sought from highly experienced individuals in multimedia theory and online instruction in K-12 education. A letter of invitation was sent to each nominee (See Appendix B). The letter described the rationale for the study and the task involved. Invitees were requested to respond to the invitation even if they were unable to participate. Those declining received a response as well as those accepting. Those declining were acknowledged and a willingness to share the results was shared. Those accepting received a letter with a link to the Q-Sort Tool, and detailed instructions. See Appendix. They were also advised that the Q-Sort Tool and responses were being managed by a third party. The researcher did not have access to the responses of individual respondents. Follow up reminders were sent twice, one week apart.

Step 3. Development of a Q-Sort Tool. An online Q-Sort Tool was designed and developed to meet the specific needs of this study. The tool was designed to personalize access to the tool. When a respondent opened the link provided in the instructions, their name appeared. If they were not able to complete the Q-Sort in one setting they could click the link at any time and return to where they last responded. They could repeat this as often as necessary. Use of the tool in carrying out the Q-Sort process involved three steps.

<u>Step 1.</u> The forty statements appeared at the top of the page. Below were three columns. The respondent could hover the curser over a statement and the font size of the statement would enlarge to enhance reading the statement. The task was to drag and drop each statement into one of the three columns e.g., low importance, neutral and high importance (Fig. 1). The respondent was informed that this was a preliminary sort to create readiness for the final Q-Sort that would occur in Step 2. No more than fifteen statements could be placed into single column in Step 1. If the respondent included too many in a column the statement would turn red. The respondent could either move the statement to another column or move a different statement from the same column to a different column. Once the forty statements were distributed across the three

columns the respondent was allowed to review their sort before moving to Step 2.

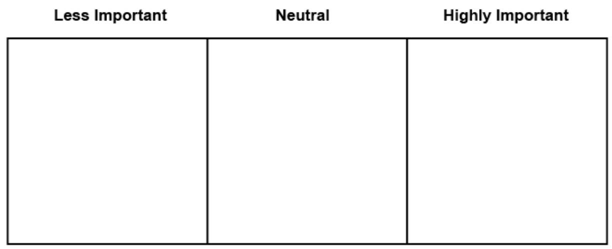


Figure 1. *Step 1 Preliminary sort*

Step 2: The respondent was presented with a display of their distribution of the statements across the three columns. The display of their sort across the three columns appeared across the top of the monitor display. This step is the actual Q-sorting process. Each principle was rated on the strength of their agreement or disagreement with the principle in the design of online instruction in K-12 education from their perspective. A statement identifying their expertise group was tailored to each respondent. The respondent was asked to rate each principle from their perspective on a Q-sort table (Fig. 2). The Q-Sort table shows a screen that includes a quasi-normal distribution labeled from Strongly Disagree at left to Strongly Agree at right and a typical grid rating scale across the top that ranges from –4 to +4 (Brown, 1980; McKeown & Thomas, 1988). Figure 2 displays the grid used for this study. The respondent was restricted in the sorting of the statements to the number of available boxes under each rating. For example, -3 has four boxes. No more than four principles may be rated as -3. This requirement applied to all ratings of individual principles. They were reminded that all of the principles had been derived from the literature. Placing a principle in a "disagree" column is not a negative rating. If they placed a principle in the -4 column on "Strongly Disagree" they are expressing a very strong personal view that the principle, in their judgment, was not as important as other ratings.

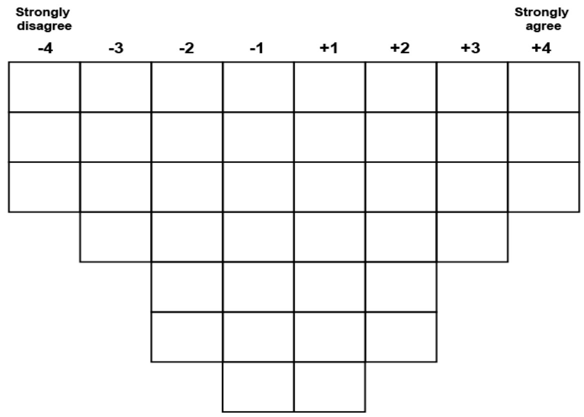


Figure 2. *Q-sort distribution in rating each principle*

Respondents were instructed to follow the same drag and drop procedure in this step as they did in Step 1.

1. The Q-Sort table allowed the respondent to drag and drop each individual principle on the table to the agreement level where they wanted the statement rated. They were allowed to change their ratings at any time until they clicked the submit button in Step 3.
2. If they exceeded the allowable number of principles rated under a value such as 3+, the last principle they placed there appeared in red. They had to shift that principle to another rating or move one of the principles they had already placed under the rating to another rating.

Respondents were informed that due to the number of principles being rated in the center ratings that the list may extend below the bottom of the screen, however they are still recorded. Experts were asked to respond to each principle on the Q-sort table from their perspective as follows.

1. Experts in multimedia theory rated the principles (items) on their relative representation of the theoretical source.

2. Experts in online instruction for K-12 students with learning disabilities rated the principles in their relative importance to the design of online instruction for students with learning disabilities.
3. Experts in instructional design of online instruction for K-12 education rated the principles in their relative importance to the design of online instruction for all learners.

Step 3: This was the confirmation and submission step. When the respondent finished the sorting process in Step 2, they reviewed their ratings to be certain they were satisfied with their sorting. They were free to change ratings by the drag and drop process. However, the restriction on the number of principles per rating remained restricted to the quasi normal distribution. Once they finished the Q-sorting placement process and were satisfied with their ratings, they pressed the submit button at the top-right of the screen. "Your Q-Sorting process was complete" appeared. They automatically received a note of receipt. A note stating that the results of their ratings had automatically been sent to a third party for analysis was sent to each respondent.

Data Analysis

According to the literature, there are several programs designed specifically to handle the type of data collection and analyses in Q Methodology (Brown, 1986). In this study, the researcher used SPSS (software package used for statistical analysis) for the data analyses. The analyses for this study involved two stages. The first stage involved the calculation of descriptive statistics. The descriptive statistics included calculating the mean score and standard deviation on the rating of each expert panel for the individual principles and the aggregate of the three panels for each of the principles in ANOVA (one way).

The second stage of the analyses involved conducting a Factor Analysis, including the calculation of correlations among the three panels of experts (Brown, 1986). The primary feature of the Factor Analysis focused on the correlation and analysis of similarities among individual principles (Rozalia, 2008). This statistical technique was be used to analyze interrelationships among a large number of variables (40 design principles) and to explain these variables in terms of their common underlying characters (factors). In other words, Factor Analysis can be used to evaluate a large number of variables that explain the pattern of correlations within a set of observed variables that reveals each individual's affiliation to several typological factors (Rozalia, 2008).

CHAPTER FOUR

Results

Descriptive Statistics

Forty design principles, having implications for online instruction, were derived from the literature review. Their verification and relative importance to online instruction for all K-12 learners including students with learning disabilities was determined through an expert review process. Descriptive statistics were collected and analyzed on the relationship of responses across the expert groups. The descriptive analysis was followed by factor analysis to determine the interrelationships among the principles.

The three groups of experts included the following:

- Group 1: Experts in multimedia theory included individuals knowledgeable of and experienced in the application of design theory to online instruction.
- Group 2: Experts in design/development of online instruction for all students included individuals knowledgeable of and experienced in the application of design theory to the design of online instruction for all K-12 learners.
- Group 3: Experts in design/development of online instruction for students with learning disabilities in K-12 education included individuals knowledgeable of and experienced in the application of design theory to the design of online instruction for K12 learners with learning disabilities.

Because the population of individuals knowledgeable of and experienced in the application of design principles to online instruction is relatively small due to the newness of online instruction as an evolving field a nomination process was employed. The nomination process was combined with a preliminary contact strategy to refine the selection and insure the integrity of the participation process. This involved obtaining nominations from varied sources, and providing nominees with relevant information about the study that allowed them to determine the appropriateness of their participation prior to the instrument being shared with them.

The process included a description of the study without a copy of the instrument being sent to any one nominated. Individuals responding with an indication that they were prepared to participate were sent a follow up letter containing the instrument and instructions. The individuals became the participants and received the instrument and all instructions.

All analyses were based on 43 final participants. Results will be reported in two stages. Stage 1 includes the descriptive statistics on the responses of the expert groups. Stage 2 reports the results derived from the Q-Sort process that included a quasi-normal distribution labeled from Strongly Disagree at left to Strongly Agree at right. A typical grid rating scale ranges from –4 to +4 (Brown, 1980; McKeown & Thomas, 1988). Factor Analysis results will also be reported

Stage 1 Descriptive Statistics.

Group 1 Multimedia experts: Twenty-nine individuals were introduced to the study and received a description of the study without the instrument and provided an opportunity to indicate if they felt they were appropriate to participate. Sixteen responded yes. Each of the sixteen received a copy of the instructions and the Q-Sort instrument. Twelve returned the completed Q-Sort instrument prior to the deadline for analysis. One response was received late.

Group 2 All K-12 experts: Seventeen individuals were introduced to the study and received a description of the study without the instrument and provided an opportunity to indicate if they felt they were appropriate to participate. Fourteen responded yes. Each of the fourteen received a copy of the instructions and the Q-Sort instrument. All fourteen returned the completed Q-Sort instrument prior to the deadline for analysis.

Group 3 K-12 experts in learning disabilities: Thirty one individuals were introduced to the study and received a description of the study without the instrument and provided an opportunity to indicate if they felt they were appropriate to participate. Twenty-four responded yes. Each of the twenty-four received a copy of the instructions and the Q-Sort instrument. One person responded after receiving the instrument that accepting a new professional position and moving would prevent participation. This reduced the potential participant list for this group of experts to twenty-three. Seventeen returned the completed Q-Sort instrument prior to the deadline for analysis.

Table 1.1 illustrates the response rate for each group and the overall response rate. The response rate for participants was calculated on the number responding that they felt prepared and willing to respond to the Q-Sort instrument and the completed Q-Sort instrument prior to analysis. See Table 1.2 for a summary of the response calculations. The return rate for Group 1 was 75 %, for Group 2 was 100 %, and for Group 3 was 73.9%. The response rate for the total group was 81.1%.

Table 1.1 Response rate for participants

Statistics
GROUP

N	Valid	43
	Missing	0

Group	Contact	Potential Participants	Completed Responses	Percent response
Group #1	29	16	12	75
Group #2	17	14	14	100
Group #3	31	23	17	73.9
Total	77	53	43	81.1

Table 1.2 Expert group information on sample (N= 43).

GROUP

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Multimedia	12	27.9	27.9	27.9
	K-12 all	14	32.6	32.6	60.5
	K-12 LD	17	39.5	39.5	100.0
	Total	43	100.0	100.0	

It should be noted as previously described in Chapter one that all principles were judged to be applicable to online instruction. That was a requirement for a principle to be included among the principles. Thus, receiving a minus response is not negative in the context of not being applicable to online instruction. The minus and plus values are derived from the use of a quasi-normal curve that forced a distribution of responses by each judge causing them to distribute their rankings. This eliminated the possibility that a judge will rank all principles high or the same on the Q-sort. The theoretical mean in this context would be zero.

Table 2.1 reports the relative importance of each of the forty design principles as judged by the combined responses of the three groups of experts on their perspective that the forty principles are applicable to the design of online instruction. The Means and Standard Deviations are reported for the combined responses of the judges to each principle. For a list of the principles and the theory from which each principle was derived (See Appendix D). The principles with the largest Mean value rated by the judges on the plus side for strongly agree were in Principle 5 (M = 1.40, SD = 2.05), Principle 9 (M = 1.70, SD = 2.12), principle 13 (M = 2.19, SD =1.68), Principle 28 (M = 1.84, SD = 2.19), Principle 31 (M = 1.40, SD = 2.47), and Principle 32 (M = 1.40, SD = 1.87). These top six principles are listed as follows,

5. Navigation options should be kept simple.
9. Unnecessary information should be kept to a minimum to avoid cognitive over load.
13. Students should be provided opportunities to see the connection between the knowledge they are taught and everyday life.
28. “Chunking” content in short term memory so that it relates to long-term memory schemata is important in designing online instruction.
31. Multiple representations of information should be provided instead of a single

representation.

32. To optimize multimedia-based learning environments factors such as attention, engagement, goal setting, monitoring and action control need to be addressed.

In contrast, the principles with the largest mean value among the principles rated by the judges on the minus side of least agree were Principle 17 (*M* = -1.21, *SD* = 1.97), Principle 22 (*M* = -1.44, *SD* = 2.16), Principle 33 (*M* = -1.37, *SD* = 2.38), Principle 38 (*M* = -1.98, *SD* = 1.85), and Principle 39 (*M* = -1.26, *SD* = 2.18). These top five principles were as follows,

17. The design structure of an activity should include motives, actions, and responses to cultural needs derived from examining the conditions of the learners' environment.
22. Affective signals for online learners are essential in maximizing e- learning.
33. Students learn better when the summarization does not include the same wording as original instruction or additional detail.
38. When incorporating displays, the display should look like a pictorial image of what it represents.
39. Computer mediated activity and design need to be understood within the relevant instruction.

Table 2.1 All groups

Descriptive Statistics

	N	Mean	Std. Deviation
Principle 1	43	-.51	2.658
Principle 2	43	-.93	2.272
Principle 3	43	-.84	2.246
Principle 4	43	-.86	2.494
Principle 5	43	1.40	2.049
Principle 6	43	1.00	2.093
Principle 7	43	.19	2.130
Principle 8	43	.12	2.174
Principle 9	43	1.70	2.122
Principle 10	43	.28	1.968
Principle 11	43	-1.02	2.365
Principle 12	43	.49	2.208
Principle 13	43	2.19	1.680
Principle 14	43	-.95	2.126
Principle 15	43	1.30	2.053
Principle 16	43	-.60	2.173
Principle 17	43	-1.21	1.971
Principle 18	43	-.53	1.804
Principle 19	43	.56	2.004
Principle 20	43	-.30	2.605
Principle 21	43	-.40	2.311
Principle 22	43	-1.44	2.164
Principle 23	43	-.74	2.431
Principle 24	43	-.19	2.107
Principle 25	43	.67	2.067
Principle 26	43	.70	2.366
Principle 27	43	.07	1.944
Principle 28	43	1.84	2.192
Principle 29	43	.21	2.242
Principle 30	43	-.02	2.425
Principle 31	43	1.40	2.470
Principle 32	43	1.40	1.866
Principle 33	43	-1.37	2.381
Principle 34	43	-.88	2.402
Principle 35	43	-.98	2.345
Principle 36	43	1.21	2.231
Principle 37	43	-.95	1.838
Principle 38	43	-1.98	1.845
Principle 39	43	-1.26	1.827
Principle 40	43	1.26	2.183
Valid N (listwise)	43		

Table 2.2 reports the Mean and Standard Deviation for of each design principle relative the perceptions of the multimedia experts. The principles with the largest Mean value among the principles rated by the judges on the plus side for strongly agree were Principle 5 (*M* = 2.33, *SD* = 1.61), Principle 13 (*M* =2.33, *SD* =2.35), Principle 28 (*M* =2.0, *SD* =2.00), Principle 36 (*M* =1.25 *SD* =2.34), and Principle 40 (*M* =1.67, *SD* =2.02). These five principles are listed as follows,

5. Navigation options should be kept simple.
13. Students should be provided opportunities to see the connection between the knowledge they are taught and everyday life.
28. "Chunking" content in short term memory so that it relates to long-term memory schemata is important in designing online instruction.
36. By providing time between each segment of learning, for reflection, the learner is allowed time to process information before proceeding.
40. Multiple means of engagement are critical to creating conditions that stimulate engagement in learning.

In contrast, the principles with the largest Mean value among the principles rated by the judges on the minus side of least agree were in Principle 17 (*M* = -1.42, *SD* =1.38), Principle 23 (*M* = -1.42, *SD* =1.83), Principle 33 (*M* = -1.50, *SD* =2.07), Principle 38 (*M* = -1.83, *SD* =2.17), and the Principle 39 (*M* = -1.67, *SD* =1.92). These top three principles are listed as follows,

17. The design structure of an activity should include motives, actions, and responses to cultural needs derived from examining the conditions of the learners' environment.
23. Social contexts for online learners are essential in maximizing e- learning.
33. Students learn better when the summarization does not include the same wording as

original instruction or additional detail.

38. When incorporating displays, the display should look like a pictorial image of what it represents.
39. Computer mediated activity and design need to be understood within the relevant instruction.

Table 2.2
Group 1 = Multimedia

Descriptive Statistics[a]

	N	Mean	Std. Deviation
Principle 1	12	-1.17	2.329
Principle 2	12	-1.00	2.412
Principle 3	12	-.42	2.392
Principle 4	12	-1.17	2.725
Principle 5	12	2.33	1.614
Principle 6	12	1.00	2.089
Principle 7	12	-.75	2.006
Principle 8	12	.83	2.250
Principle 9	12	1.08	2.234
Principle 10	12	.25	2.050
Principle 11	12	-.33	2.605
Principle 12	12	.33	2.498
Principle 13	12	2.33	2.348
Principle 14	12	-.75	2.006
Principle 15	12	.92	2.429
Principle 16	12	-.58	2.392
Principle 17	12	-1.42	1.379
Principle 18	12	-.17	1.899
Principle 19	12	.75	1.357
Principle 20	12	.17	2.949
Principle 21	12	.42	2.712
Principle 22	12	-.75	2.454
Principle 23	12	-1.42	1.832
Principle 24	12	-.67	2.270
Principle 25	12	-.33	1.923
Principle 26	12	.17	2.855
Principle 27	12	.50	1.977
Principle 28	12	2.00	2.000
Principle 29	12	.33	2.348
Principle 30	12	-.50	2.236
Principle 31	12	1.17	2.552
Principle 32	12	.50	1.732
Principle 33	12	-1.50	2.067
Principle 34	12	-.17	2.406
Principle 35	12	-.50	2.680
Principle 36	12	1.25	2.340
Principle 37	12	-.92	1.929
Principle 38	12	-1.83	2.167
Principle 39	12	-1.67	1.923
Principle 40	12	1.67	2.015
Valid N (listwise)	12		

Table 2.3 reports the Mean and Standard Deviation for each design principle relative the perceptions of Group 2 experts in online instruction for all K-12 learners. The principles with the largest Mean value among the principles rated by the judges on the plus side for strongly agree were Principle 9 (*M* =2.14, *SD* =1.70), Principle 13 (*M* =2.36, *SD* =1.15), Principle 28 (*M* =1.50, *SD* =2.62), Principle 32 (*M* =1.86, *SD* =1.88), and Principle 40 (*M* =1.71, *SD* =2.43). These top five principles are listed as follows,

9. Unnecessary information should be kept to a minimum to avoid cognitive over load.
13. Students should be provided opportunities to see the connection between the knowledge they are taught and everyday life.
28. "Chunking" content in short term memory so that it relates to long-term memory schemata is important in designing online instruction.
32. To optimize multimedia-based learning environments factors such as attention, engagement, goal setting, monitoring and action control need to be addressed.
40. Multiple means of engagement are critical to creating conditions that stimulate engagement in learning.

In contrast, the principles with the largest mean value among the principles rated by the judges on the minus side of least agree were in Principle 2 (*M* = -1.64, *SD* =1.91), Principle 33 (*M* = -2.21, *SD* =2.12), Principle 37 (*M* = -1.79, *SD* =1.76), Principle 38 (*M* = -2.50, *SD* =1.40), and the Principle 39 (*M* = -1.57, *SD* =1.74). These five principles are listed as follows,

2. Mediated actions-in-activities, while teaching common content at the same time, results in more effective learning than when presented with time differences.
33. Students learn better when the summarization does not include the same wording as original instruction or additional detail.

37. The presentation of narration increases effective long term and short-term memory capacity.
38. When incorporating displays, the display should look like a pictorial image of what it represents.
39. Computer mediated activity and design need to be understood within the relevant instruction.

Table 2.3 Group = All K-12 Learners

Descriptive Statistics[a]

	N	Mean	Std. Deviation
Principle 1	14	.43	2.681
Principle 2	14	-1.64	1.906
Principle 3	14	-.71	2.400
Principle 4	14	-.36	2.170
Principle 5	14	.93	2.200
Principle 6	14	.86	1.956
Principle 7	14	1.29	1.899
Principle 8	14	-.07	2.464
Principle 9	14	2.14	1.703
Principle 10	14	-.07	1.940
Principle 11	14	-.71	2.268
Principle 12	14	.86	1.657
Principle 13	14	2.36	1.151
Principle 14	14	-.86	2.248
Principle 15	14	1.21	1.888
Principle 16	14	-1.00	2.219
Principle 17	14	-.36	2.098
Principle 18	14	-1.07	1.940
Principle 19	14	-.14	2.381
Principle 20	14	-.79	2.806
Principle 21	14	-1.00	1.922
Principle 22	14	-1.21	2.517
Principle 23	14	.43	2.344
Principle 24	14	.29	2.016
Principle 25	14	.79	1.805
Principle 26	14	.79	1.762
Principle 27	14	.36	1.823
Principle 28	14	1.50	2.624
Principle 29	14	.79	2.155
Principle 30	14	-.29	2.758
Principle 31	14	1.21	2.665
Principle 32	14	1.86	1.875
Principle 33	14	-2.21	2.119
Principle 34	14	-.86	2.507
Principle 35	14	-1.29	2.234
Principle 36	14	.71	2.400
Principle 37	14	-1.79	1.762
Principle 38	14	-2.50	1.401
Principle 39	14	-1.57	1.742
Principle 40	14	1.71	2.431
Valid N (listwise)	14		

Table 2.4 reports the Mean and Standard Deviation for each design principle relative to the perceptions of Group 3 experts in online instruction for students with learning disabilities. The principles with the largest Mean value among the principles rated by the experts on the plus side for strongly agree were Principle 9 (*M* = 1.76, *SD* =2.36), Principle 13 (*M* = 1.94, *SD* =1.56), Principle 15 (*M* = 1.65, *SD* =1.97), Principle 28 (*M* = 2.00, *SD* =2.03), Principle 31 (*M* = 1.71, *SD* =2.37), and Principle 32 (*M* = 1.65, *SD* =1.84). These six principles are listed as follows,

9. Unnecessary information should be kept to a minimum to avoid cognitive over load.
13. Students should be provided opportunities to see the connection between the knowledge they are taught and everyday life.
15. Activities should be designed to provide a rich context for learning and lend themselves to sustained inquiry and revisions of ideas.
28. "Chunking" content in short term memory so that it relates to long-term memory schemata is important in designing online instruction.
31. Multiple representations of information should be provided instead of a single representation.
32. To optimize multimedia-based learning environments factors such as attention, engagement, goal setting, monitoring and action control need to be addressed.

In contrast, the principles with the largest Mean value among the principles rated by the judges on the minus side of least agree were Principle 11 (*M* = -1.76, *SD* =2.20), Principle 17 (*M* = -1.76, *SD* =2.08), Principle 22 (*M* = -2.12, *SD* =1.45), Principle 34 (*M* = -1.41, *SD* =2.32), Principle 38 (*M* = -1.65, *SD* =1.94). These five principles are listed as follows,

11. Developers need to understand the students' affective reasoning when developing

online instructional resources to guide the learners' quest for learning.

17. The design structure of an activity should include motives, actions, and responses to cultural needs derived from examining the conditions of the learners' environment.
22. Affective signals for online learners are essential in maximizing e- learning.
34. Design should minimize working memory load which combines short term and long-term memory, instead utilize the greater capacity of long-term memory.
38. When incorporating displays, the display should look like a pictorial image of what it represents.

Table 2.4 *Group 3 = K-12 Learning Disabilities*

Descriptive Statistics[a]

	N	Mean	Std. Deviation
Principle 1	17	-.82	2.789
Principle 2	17	-.29	2.392
Principle 3	17	-1.24	2.078
Principle 4	17	-1.06	2.657
Principle 5	17	1.12	2.088
Principle 6	17	1.12	2.315
Principle 7	17	-.06	2.106
Principle 8	17	-.24	1.855
Principle 9	17	1.76	2.359
Principle 10	17	.59	2.002
Principle 11	17	-1.76	2.195
Principle 12	17	.29	2.469
Principle 13	17	1.94	1.560
Principle 14	17	-1.18	2.215
Principle 15	17	1.65	1.967
Principle 16	17	-.29	2.054
Principle 17	17	-1.76	2.078
Principle 18	17	-.35	1.618
Principle 19	17	1.00	2.000
Principle 20	17	-.24	2.251
Principle 21	17	-.47	2.267
Principle 22	17	-2.12	1.453
Principle 23	17	-1.24	2.635
Principle 24	17	-.24	2.107
Principle 25	17	1.29	2.201
Principle 26	17	1.00	2.500
Principle 27	17	-.47	2.004
Principle 28	17	2.00	2.031
Principle 29	17	-.35	2.234
Principle 30	17	.53	2.294
Principle 31	17	1.71	2.365
Principle 32	17	1.65	1.835
Principle 33	17	-.59	2.647
Principle 34	17	-1.41	2.320
Principle 35	17	-1.06	2.277
Principle 36	17	1.59	2.063
Principle 37	17	-.29	1.649
Principle 38	17	-1.65	1.935
Principle 39	17	-.71	1.795
Principle 40	17	.59	2.033
Valid N (listwise)	17		

Table 2.5 is an Analysis of Variance. An online Q-sort Task was conducted to compare the ratings of experts in multimedia theory, experts in design/development of online instruction for all students, and experts in design/development for students with learning disabilities in their perceptions of whether design principles derived from a review of the multimedia literature apply to online instruction for students with learning disabilities at the K-12 level. Part of the result from the Q-sort Tool among the three expert groups using a one-way ANOVA are presented in Table 2.5. Among of the 40 design principles, the result showed in bold was the Principle 7, which had the *p value* = .039 at the $p < .05$ significant level. The result indicated that there were two expert groups had the most different perspectives in Principle 7 (See Appendix F, for the full ANOVA result).

Table 2.5 Analysis of Variance (ANOVA)

		Sum of Squares	df	Mean Square	F	Sig.
	Between Groups	19.178	2	9.589	1.382	.263
Principle 1	Within Groups	277.566	40	6.939		
	Total	296.744	42			
	Between Groups	14.047	2	7.024	1.386	.262
Principle 2	Within Groups	202.744	40	5.069		
	Total	216.791	42			
	Between Groups	5.028	2	2.514	.486	.619
Principle 3	Within Groups	206.833	40	5.171		
	Total	211.860	42			
	Between Groups	5.341	2	2.670	.418	.662
Principle 4	Within Groups	255.822	40	6.396		
	Total	261.163	42			
	Between Groups	14.919	2	7.460	1.849	.171
Principle 5	Within Groups	161.360	40	4.034		
	Total	176.279	42			
	Between Groups	.521	2	.261	.057	.945
Principle 6	Within Groups	183.479	40	4.587		
	Total	184.000	42			
	Between Groups	28.463	2	14.232	3.513	.039
Principle 7	Within Groups	162.048	40	4.051		
	Total	190.512	42			

The results in Table 2.5 showed the two groups had a significant difference in their perspectives on design Principle 7. The Post-Hoc Test (See Table 2.6) results indicate that the two expert groups with significant differences in their perspectives on principle 7 were experts in multimedia and experts in all K-12 learners.

Table 2.6 showed part of the result on the Post –Hoc Test (screenshot). The result showed that only Principle 7 had the *p value* = .042 between Group 1 Multimedia and Group 2 All K-12 Learners at the $p < .05$ significant level. The result indicated that these two groups had the most different perspectives in Principle 7(See Appendix F, for the full result of the Post –Hoc Test).

Table 2.6 Post –Hoc Test

Bonferroni

Dependent Variable	(I) GROUP	(J) GROUP	Mean Difference (I-J)	Std. Error	Sig.
Principle 1	Multimedia	K-12 all	-1.595	1.036	.395
		K-12 LD	-.343	.993	1.000
	K-12 all	Multimedia	1.595	1.036	.395
		K-12 LD	1.252	.951	.586
	K-12 LD	Multimedia	.343	.993	1.000
		K-12 all	-1.252	.951	.586
Principle 2	Multimedia	K-12 all	.643	.886	1.000
		K-12 LD	-.706	.849	1.000
	K-12 all	Multimedia	-.643	.886	1.000
		K-12 LD	-1.349	.813	.314
	K-12 LD	Multimedia	.706	.849	1.000
		K-12 all	1.349	.813	.314
Principle 3	Multimedia	K-12 all	.298	.895	1.000
		K-12 LD	.819	.857	1.000
	K-12 all	Multimedia	-.298	.895	1.000
		K-12 LD	.521	.821	1.000
	K-12 LD	Multimedia	-.819	.857	1.000
		K-12 all	-.521	.821	1.000
Principle 4	Multimedia	K-12 all	-.810	.995	1.000
		K-12 LD	-.108	.954	1.000
	K-12 all	Multimedia	.810	.995	1.000
		K-12 LD	.702	.913	1.000
	K-12 LD	Multimedia	.108	.954	1.000
		K-12 all	-.702	.913	1.000
Principle 5	Multimedia	K-12 all	1.405	.790	.249
		K-12 LD	1.216	.757	.349
	K-12 all	Multimedia	-1.405	.790	.249
		K-12 LD	-.189	.725	1.000
	K-12 LD	Multimedia	-1.216	.757	.349
		K-12 all	.189	.725	1.000
Principle 6	Multimedia	K-12 all	.143	.843	1.000
		K-12 LD	-.118	.808	1.000
	K-12 all	Multimedia	-.143	.843	1.000
		K-12 LD	-.261	.773	1.000
	K-12 LD	Multimedia	.118	.808	1.000
		K-12 all	.261	.773	1.000
Principle 7	Multimedia	K-12 all	-2.036*	.792	.042
		K-12 LD	-.691	.759	1.000
	K-12 all	Multimedia	2.036*	.792	.042
		K-12 LD	1.345	.726	.215
	K-12 LD	Multimedia	.691	.759	1.000
		K-12 all	-1.345	.726	.215

A correlation analysis was conducted to determine the relationship among the principles based on the ratings of the experts. Table 2.7 displays the interrelationships among the principles based on correlation coefficients. The Pearson correlation coefficient (r) was employed as the measure of correlation. (See Appendix F, for the correlation data on each comparison.) The Pearson is a measure of the degree of linear relationship between two variables. The correlation coefficient may take on any value between plus and minus one which defines the direction of the relationship, either positive or negative. The absolute value of the correlation coefficient measures the strength of the relationship. A correlation coefficient of r =.50 indicates a stronger degree of linear relationship than one of r =.40. In the other words, a correlation coefficient of r = -.50 showed a greater degree of relationship than one of r = .40. Thus, a correlation coefficient of zero (r =0.0) indicates the absence of a linear relationship and correlation coefficients of r = +1.0 and r = -1.0 indicate a perfect linear relationship.

The results displayed in Table 2.7 (See Appendix F) is the full result of correlation. The Table 2.7 shows the strength of the relationship between principles. The analysis of the correlation matrix indicates that few of the observed relationships were very strong. There were three with the most positive correlation coefficients between principle Principle 14 and Principle 17 with (r =.554), Principle 8 and Principle 9 with (r =.545), and Principle 29 and Principle 40 with (r =.529).

The description of the Principles 14 and 17 are as follows,

Principle 14. Cultural factors impact activities and require that interactions be contextualized.

Principle 17. The design structure of an activity should include motives, actions, and responses to cultural needs derived from examining the conditions of the learners' environment.

The positive correlation means that as X increases, so does Y. Therefore, this result indicated that experts who strongly agree with Principle 14 would also highly agree with Principle 17. Experts who addressed that cultural factors are very important will take it into consideration in designing online instruction.

In contrast, there were three negative correlations coefficient between principles, which were Principle 5 and Principle 27 with ($r = -.503$), Principle 20 and Principle 22 with ($r = -.480$), and Principle 14 and Principle 20 with ($r = -.462$).

For example in Principle 5 and Principle 27 are defined as follows:

Principle 5. Navigation options should be kept simple.

Principle 27. Learners must move new knowledge from long-term memory to working memory to apply it to real life applications.

The negative correlation means that as X decreases, Y doesn't. Therefore, this result indicates that experts who strongly disagree with Principle 5, would highly agree with Principle 27.

Stage 2 Factor Analysis.

Factor analysis can be viewed as a method that attempts to identify underlying variables, or specific grouping of factors, which explains the pattern of correlations within a set of observed variables. Furthermore, factor analysis is often used as a statistical method for data reduction to identify the number and nature of common factors needed to account for and explains most of the variance observed in a much larger number of manifest variables (Fabrigar, et al., 1999, as cited by (Hayton, Allen, & Scarpello, 2004). As a conclusion of technique aspect of Q factor analysis mentioned in the Chapter three, there is evidence that both specifying too few factors and specifying too many factors are substantial errors that affect the final results (Hayton et al., 2004). Therefore, selecting both too few or too many factors have significant consequences for the reduction and interpretation of information in a data set. The following tables illustrate the factor reduction and retention processes from the rough stage to the final result.

In this study, the results of initial factor analysis presented the Q- sort data in Table 3.1. There are 14 underlying factors based on Kaiser's rule, also known as K1 rule (Kaiser, 1960), which retains factors with eigenvalues greater than 1.

Table 3.1 Initial Factor Analysis

Total Variance Explained									
Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
Principle 1	4.62	11.56	11.56	4.62	11.56	11.56	3.40	8.50	8.50
Principle 2	4.13	10.32	21.88	4.13	10.32	21.88	2.78	6.95	15.45
Principle 3	3.33	8.33	30.20	3.33	8.33	30.20	2.49	6.21	21.66
Principle 4	2.72	6.79	37.00	2.72	6.79	37.00	2.45	6.12	27.77
Principle 5	2.47	6.18	43.17	2.47	6.18	43.17	2.33	5.82	33.59
Principle 6	2.21	5.52	48.69	2.21	5.52	48.69	2.33	5.81	39.40
Principle 7	2.15	5.37	54.05	2.15	5.37	54.05	2.16	5.39	44.79
Principle 8	2.09	5.22	59.27	2.09	5.22	59.27	2.15	5.38	50.17
Principle 9	1.59	3.97	63.24	1.59	3.97	63.24	2.08	5.21	55.38
Principle 10	1.46	3.64	66.88	1.46	3.64	66.88	1.98	4.94	60.32
Principle 11	1.34	3.36	70.24	1.34	3.36	70.24	1.96	4.90	65.22
Principle 12	1.29	3.23	73.47	1.29	3.23	73.47	1.91	4.76	69.99
Principle 13	1.25	3.12	76.59	1.25	3.12	76.59	1.90	4.74	74.73
Principle 14	1.11	2.77	79.36	1.11	2.77	79.36	1.85	4.63	79.36
Principle 15	0.95	2.38	81.73						
Principle 16	0.87	2.19	83.92						
Principle 17	0.79	1.98	85.89						
Principle 18	0.72	1.81	87.71						
Principle 19	0.66	1.66	89.36						
Principle 20	0.64	1.61	90.97						
Principle 21	0.54	1.35	92.33						
Principle 22	0.49	1.22	93.54						
Principle 23	0.40	1.01	94.55						
Principle 24	0.38	0.95	95.51						
Principle 25	0.33	0.83	96.33						
Principle 26	0.27	0.67	97.00						
Principle 27	0.23	0.57	97.57						
Principle 28	0.21	0.51	98.08						
Principle 29	0.20	0.50	98.58						
Principle 30	0.16	0.40	98.98						
Principle 31	0.13	0.33	99.31						
Principle 32	0.08	0.21	99.52						
Principle 33	0.06	0.14	99.66						
Principle 34	0.05	0.13	99.79						
Principle 35	0.03	0.08	99.88						
Principle 36	0.02	0.06	99.93						
Principle 37	0.02	0.04	99.97						
Principle 38	0.01	0.02	99.99						
Principle 39	0.00	0.01	100.00						
Principle 40	0.00	0.00	100.00						

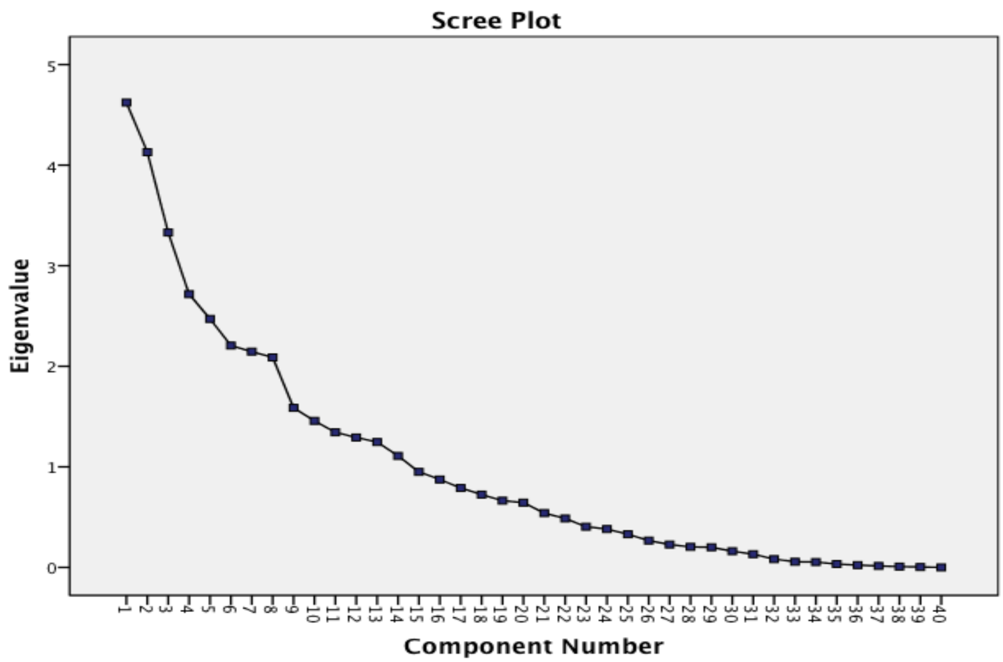
Note: Initial Eigenvalue. (Kaiser's (K1) criterion, eigenvalue greater than 1.
Extraction Method: Principal Component Analysis.

Base on the criteria of Kaiser's rule (K1), the forty design principles are categorized in fourteen different factors based on the similar correlation among the individuals. However, research has reported that K1 criterion tended to overestimate the number of factors (Horn, 1965) because the K1 rule always draws distinctions between factors with eigenvalues just above and just below 1 (Fabrigar et al., 1999).

Another common used method for determining the number of factors of retention is Cattell's (1966) Scree Test, which involved an examination of a plot of the eigenvalues for breaks or discontinuities.

In this study, the results of Scree Test presented the Q- sort data in Figure 1. There were approximately eight underlying factors in the scree test based on Cattell's (1966) criteria. However, there were several uncertain breaks and two or more discontinue points accounted as major factors before the last steep cliff in the scree plot. These uncertain break points may lead to problems especially when the research has complex factor structures (Hayton et al., 2004).

Figure 1 Cattell's Scree Test



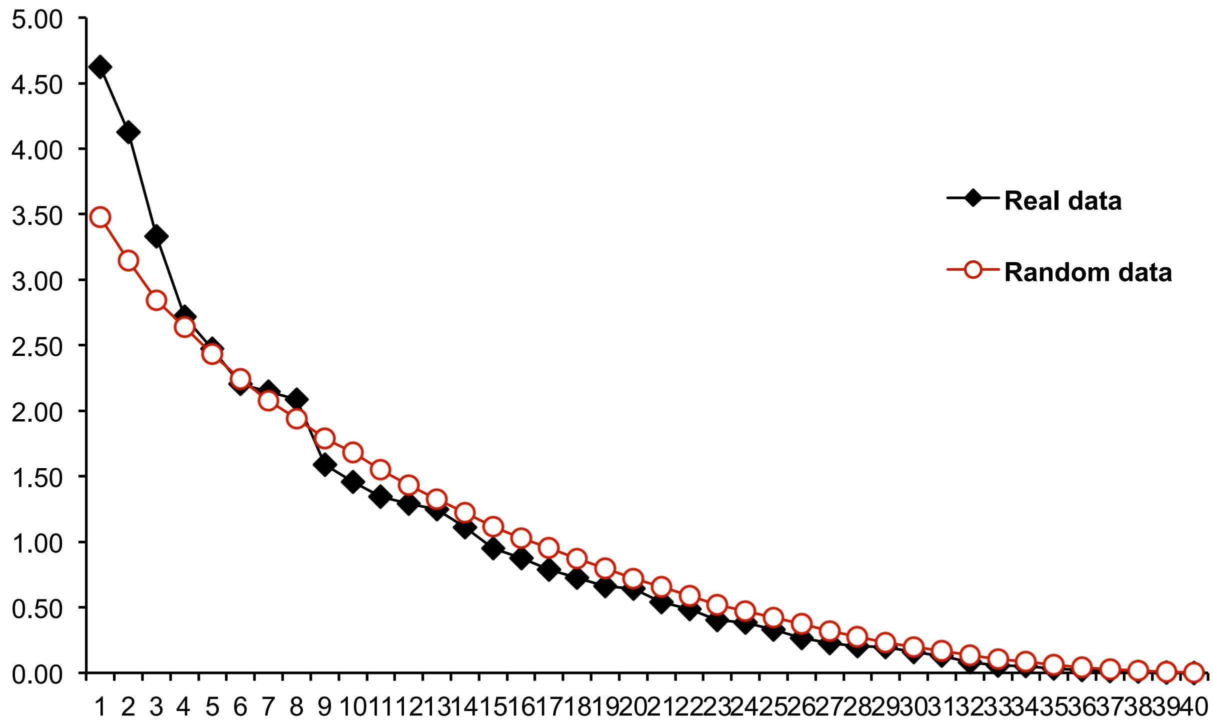
According to research, the third factor retention method is Parallel Analysis, also known as PA (Horn, 1965). PA attempts to overcome a primary limitation of the K1 criterion, which overestimates the retention of the factors (Hayton et al., 2004). In this study, the results of parallel analysis showed the Q- sort data in Table 3.2 and Figure 2. Research indicated the "rationale underlying PA is that the components from real data with a valid underlying factor structure should have larger average eigenvalues than parallel components derived from random data having the same sample size and number of variables" (Ford et al., 1986; Lautenschlager, 1989, as cited by Hayton et al., 2004, p.194).

The average eigenvalues from the random correlation matrices were then compared to the eigenvalues from the real data correlation matrix. For example, the first observed eigenvalue was compared to the first random eigenvalue; the second observed eigenvalue was compared to the second random eigenvalue, and so on (see Table 3.2). After running fifty times of the random correlation data set, the Table 3.2 showed the component from real data had larger average eigenvalues than the parallel component derived from random data at the first five rows. From the sixth row, the parallel component derived from random data had larger eigenvalues than the component from real data.

Table 3.2 Parallel Analysis

Component	Eigenvalue	
	Random Data	Real Data
Principle 1	3.48	4.62
Principle 2	3.14	4.13
Principle 3	2.84	3.33
Principle 4	2.64	2.72
Principle 5	2.43	2.47
Principle 6	2.24	2.21
Principle 7	2.08	2.15
Principle 8	1.94	2.09
Principle 9	1.79	1.59
Principle 10	1.68	1.46
Principle 11	1.55	1.34
Principle 12	1.43	1.29
Principle 13	1.33	1.25
Principle 14	1.22	1.11
Principle 15	1.12	0.95
Principle 16	1.03	0.87
Principle 17	0.95	0.79
Principle 18	0.87	0.72
Principle 19	0.80	0.66
Principle 20	0.72	0.64
Principle 21	0.66	0.54
Principle 22	0.59	0.49
Principle 23	0.52	0.40
Principle 24	0.47	0.38
Principle 25	0.42	0.33
Principle 26	0.37	0.27
Principle 27	0.32	0.23
Principle 28	0.27	0.20
Principle 29	0.23	0.20
Principle 30	0.20	0.16
Principle 31	0.17	0.13
Principle 32	0.13	0.08
Principle 33	0.11	0.06
Principle 34	0.08	0.05
Principle 35	0.06	0.03
Principle 36	0.04	0.02
Principle 37	0.03	0.01
Principle 38	0.02	0.01
Principle 39	0.01	0.00
Principle 40	0.00	0.00

Figure 2. Parallel Analysis



In Figure 3, the line from real data set was above the line derived from the random data set showing 5 break points at the cross point. Comparing the result of Table 1.2 and Figure 2, factors corresponding to actual eigenvalues that are greater than the parallel average random eigenvalues should be retained. Moreover, "actual eigenvalues less than or equal to the parallel average random eigenvalues are considered due to sampling error" (Glorfeld, 1995; Horn, 1965; Zwick & Velicer, 1986, as cited by Hayton et al., 2004, p.194). Thus, there were five factors showed in the Table 1.2 and Figure 2 based on Parallel Analysis' criteria.

A number of studies have showed that the results came from parallel analysis outperformed the Kaiser's (K1) rule (1970) and Cattell's Scree Test (1966) in terms of the factor retention methods (Linn, 1968; Zwick & Velicer, 1986; Fabrigar et al., 1999, as cited by Hayton et al., 2004, p.195). Therefore, there were 5 underlying factors derived from the average eigenvalues of the random correlation matrices compared to the eigenvalues from the real data correlation matrix (See Table 3.3 Factor Analysis).

The Table 3.3 represented by those on Factor 1 (11.557 % of Variance in Extraction Sums of Squared Loadings) and Factor 2 (10.322 % of Variance in Extraction Sums of Squared Loadings) contained the larger factor group from 40 principles. In contrast, Factor 4 and Factor5 were represented by less percentage of the variance.

Table 3.3 Factor Analysis

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4.623	11.557	11.557	4.623	11.557	11.557	4.319	10.799	10.799
2	4.129	10.322	21.879	4.129	10.322	21.879	3.479	8.698	19.497
3	3.330	8.325	30.204	3.330	8.325	30.204	3.453	8.632	28.129
4	2.717	6.793	36.997	2.717	6.793	36.997	3.161	7.902	36.031
5	2.471	6.177	43.174	2.471	6.177	43.174	2.857	7.144	43.174
6	2.206	5.515	48.689						
7	2.146	5.365	54.054						
8	2.088	5.219	59.273						
9	1.587	3.967	63.240						
10	1.457	3.643	66.882						
11	1.343	3.358	70.240						
12	1.292	3.230	73.471						
13	1.247	3.117	76.588						
14	1.108	2.771	79.359						
15	.950	2.375	81.734						
16	.874	2.185	83.919						
17	.790	1.975	85.894						
18	.724	1.811	87.705						
19	.664	1.660	89.364						
20	.644	1.610	90.974						
21	.540	1.351	92.325						
22	.487	1.217	93.542						
23	.404	1.011	94.553						
24	.382	.954	95.507						
25	.330	.825	96.332						
26	.267	.667	96.999						
27	.227	.569	97.568						
28	.205	.511	98.079						
29	.200	.500	98.579						
30	.161	.403	98.983						
31	.132	.329	99.312						
32	.082	.206	99.518						
33	.056	.141	99.658						
34	.053	.133	99.791						
35	.034	.084	99.876						
36	.023	.057	99.933						
37	.015	.037	99.970						
38	.008	.021	99.990						
39	.004	.010	100.000						
40	6.286E-006	1.571E-005	100.000						

Extraction Method: Principal Component Analysis.

Given the evidence and strong recommendations regarding the accuracy of parallel analysis compared to other factor retention methods, researcher used 5 retained factors to conduct the final factor analysis. The five categories among the forty design principles were identified. The Table 3.4 is part of the Factor Loading. (See the Appendix F for the full result)

Table 3.4 Factor Loading

Rotated Component Matrix[a]

	Component				
	Factor1	Factor 2	Factor 3	Factor 4	Factor 5
Principle 1	0.43	0.36	0.23	-0.12	0.37
Principle 2	-0.25	0.02	-0.50	0.17	0.33
Principle 3	0.45	-0.15	0.10	0.13	-0.01
Principle 4	0.03	-0.08	-0.53	0.14	0.02
Principle 5	0.09	0.15	-0.65	0.00	-0.53
Principle 6	0.06	0.31	0.30	0.16	0.00
Principle 7	0.02	-0.53	0.05	-0.02	-0.15
Principle 8	0.04	0.63	0.11	-0.26	-0.14

Note: Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.

Table 3.4 is part of the factors extraction of the final 40 principles (See Appendences F, for the full result). Factor loadings equal to or greater than .3 (absolute value) were shown in bold in Table 1.4. For example, that Principle 17 correlated very highly with the Factor 1 (factor loading is .66), but not with any of the other factors. Similarly the Design Principle 19 (factor loading is - .64), correlated highly with the Factor 5, but apart from Principle 12 to Principle 18, their correlations with Factors 5 were less than .4. In other words, the higher the factor loading score, the more highly the design principle was correlated to the Factors.

Table 3.5 Strong factor loading in Factor 1.

Rotated Component Matrixa					
	Component				
	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
Principle 1	**0.43**	0.36	0.23	-0.12	0.37
Principle 3	**0.45**	-0.15	0.10	0.13	-0.01
Principle 14	**0.73**	0.01	-0.12	0.23	0.06
Principle 17	**0.66**	-0.07	-0.02	-0.13	0.21
Principle 20	**-0.68**	0.01	-0.04	-0.27	0.08
Principle 22	**0.62**	0.18	0.11	0.04	0.02
Principle 30	**-0.52**	-0.09	-0.18	-0.22	0.27
Principle 31	**-0.38**	-0.27	-0.25	0.29	-0.10
Principle 32	**-0.56**	-0.07	0.01	-0.05	0.20
Principle 33	**-0.36**	0.00	0.04	0.32	0.01
Principle 38	**0.19**	0.03	0.09	0.16	0.08

Table 3.6 Strong factor loading in Factor 2.

Rotated Component Matrixa					
	Component				
	Factor 1	**Factor 2**	Factor 3	Factor 4	Factor 5
Principle 6	0.06	**0.31**	0.30	0.16	0.00
Principle 7	0.02	**-0.53**	0.05	-0.02	-0.15
Principle 8	0.04	**0.63**	0.11	-0.26	-0.14
Principle 9	0.12	**0.55**	0.29	-0.18	-0.15
Principle 21	0.16	**0.42**	-0.38	-0.01	0.23
Principle 23	0.30	**-0.54**	0.24	0.15	-0.42
Principle 28	0.23	**0.39**	-0.07	0.04	-0.15
Principle 29	-0.53	**-0.57**	-0.41	0.25	-0.17
Principle 36	0.01	**-0.45**	0.10	0.05	-0.17
Principle 40	0.22	**-0.59**	-0.19	0.04	0.04

Table 3.7 Strong factor loading in Factor 3.

Rotated Component Matrixa					
	Component				
	Factor 1	Factor 2	**Factor 3**	Factor 4	Factor 5
Principle 2	-0.25	0.02	**-0.50**	0.17	0.33
Principle 4	0.03	-0.08	**-0.53**	0.14	0.02
Principle 5	0.09	0.15	**-0.65**	0.00	-0.53
Principle 10	0.04	-0.06	**0.55**	0.12	-0.15
Principle 18	-0.19	0.04	**-0.20**	0.03	0.04
Principle 26	0.05	0.07	**0.48**	0.15	0.10
Principle 27	0.11	0.21	**0.69**	-0.08	0.09
Principle 37	-0.26	0.10	**-0.47**	-0.34	0.16

Table 3.8 Strong factor loading in Factor 4.

Rotated Component Matrixa					
	Component				
	Factor 1	Factor 2	Factor 3	**Factor 4**	Factor 5
Principle 12	0.24	-0.03	0.08	**0.36**	0.16
Principle 13	-0.09	-0.21	0.21	**0.62**	-0.26
Principle 15	-0.10	-0.06	0.04	**0.78**	0.19
Principle 16	-0.43	-0.19	-0.16	**-0.56**	0.11
Principle 24	-0.22	-0.46	0.24	**-0.47**	0.18
Principle 34	-0.03	0.27	0.27	**-0.39**	-0.31
Principle 35	-0.29	0.17	0.16	**-0.56**	-0.01

Table 3.9 Strong factor loading in Factor 5.

Rotated Component Matrixa					
	Component				
	Factor 1	Factor 2	Factor 3	Factor 4	**Factor 5**
Principle 11	0.29	-0.03	0.27	-0.31	**-0.62**
Principle 19	-0.14	0.32	-0.29	0.03	**-0.64**
Principle 25	0.07	0.03	-0.01	-0.23	**0.41**
Principle 39	0.22	0.21	-0.19	0.17	**0.69**

According to the research, the WLS factor solutions were inspected to identify the salient items associated with the common factors (Rhode et al., 2012). Although a factor loading equal to or greater than .30 is usually considered to meet the minimum level in the literature (Tabachnick & Fidell, 2001), a more conservative value of .40 was used in the present study to highlight practical importance of the principles (Hair et al., 1998; Backhaus et al., 2003). In this study, research used .35 to inspect the factor loading in five Factors because some of the principles only had the highest factor loading in .31. The particular result showed in Principle 38 with highest factor loading .19 in Factor 1(See Table 3.5) and the Principle 18 with factor loading -.20 in Factor 3 (See Table 3.7).

These factors loading showed the clear structure and strong correlation in different Factors (See Table 3.5 to Table 3.9). The distinguishing statements of design principles categorized in Tables 3.5 showed those principles had similar characteristics in Factor 1. In contrast, in Table 3.9, there are only four design principles categorized in Factor 5. According to the result, each Factor represented a unique concept of designing online instruction at k-12 level education.

Based on unique characteristic categorized in five different Factors, the labeling of the factors was facilitated by domain experts.

These factors were identified as the following:

Factor 1: Learner variability

Factor 2: Cognitive strategies

Factor 3: Prerequisites for teaching/learning

Factor 4: Context for learning

Factor 5: Media presentation

CHAPTER FIVE

Discussion

The significance of this study relates to the observation that the rapid growth of online instruction emerged without the benefit of a systematic research initiative building from theory and related research. The context for this development included the unprecedented growth in K-12 education through the creation of virtual schools and the evolvement of an e-learning commercial industry generating in excess of $56 billion in revenue from marketing online resources and services.

The goal of this study was to identify and verify design principles based on theory and judged to be applicable, by panels of experts, to online instruction. Identification and verification of theory- and research-based design principles was undertaken in response to a review of the multimedia theory literature centered on the important role of the monitor as a display in the presentation of online instruction. While advances in technology have contributed to significant increases in accessibility to education at all levels, the instructional designs that are employed in creating online instruction lack the theoretical and research base to ensure that there is a concerted effort to maximize the quality of online instruction for all learners, including students with learning disabilities

Forty design principles were derived from a literature review and verification process involving three groups of experts selected nationally. The expert groups included the following:

- Experts in multimedia theory and the application of design theory to online instruction
- Experts in design/development of online instruction for all students in K-12 education

- Experts in design/development of online instruction for students with learning disabilities in K-12 education

Basic Findings of Expert Groups

Based on the employment of Q-methodology, data were collected on the perceived importance of each principle relative to the other principles as judged by each group of experts. The Q-sort required the experts to rate the design principles on a quasi-normal curve; thus, the reason for plus and minus ratings. The normal curve model prevented experts from rating large numbers of principles the same or clustering their ratings around a particular rating (e.g., +4). Because the criteria for including a principle in the final list of principles stipulated that it must be theory-based and supported by research, all design principles had been determined to be applicable to online instruction. Thus, a minus rating was not negative. Rather, it meant that a principle, compared to the other principles, was judged to be less important. In this model the theoretical mean would be zero.

The mean and standard deviation of the ratings by experts were calculated for the combined ratings by experts and independently for each group of experts (i.e., multimedia experts, all K-12 all student experts, and the learning disabilities experts). While data are reported in Chapter Four on all 40 design principles, this discussion addresses only the five principles with the highest mean values as judged by each expert group. In examining the five principles that received the highest plus mean ratings among the 40 design principles judged by the total group of experts and by the three independent groups of experts, two principles rated among the five highest by each group:

28. "Chunking" content in short-term memory so that it relates to long-term memory schemata is important in designing online instruction.

13. Students should be provided opportunities to see the connection between the knowledge they are taught and everyday life.

Two other principles were in the five highest rated by three groups of experts:

9. Unnecessary information should be kept to a minimum to avoid cognitive over load.

32. To optimize multimedia-based learning environments factors such as attention, engagement, goal setting, and monitoring and action control need to be addressed.

The groups rating #9 high were the combined group, the K-12 all group, and the learning disabilities group. Principle 32 was also rated high by the combined group, the K-12 all group and the learning disabilities group.

Three principles were rated among the five highest by two groups of experts:

31. Multiple representations of information should be provided instead of a single representation.

40. Multiple means of engagement are critical to creating conditions that stimulate engagement in learning.

5. Navigation options should be kept simple.

Principle 31 was rated high by the combined group and the learning disabilities group. Principle 40 was rated high by multimedia and the K-12 all group. Finally, principle #5 was rated high by the combined group and the multimedia group.

In reviewing the highly ranked design principles where consensus was evident within and across expert groups in the plus category, it was apparent that the highest rated principles were related to content and the structuring of content. Examples include two principles for which there was consensus across all groups (i.e., #28 on chunking of content and #13 ensuring that students see the connection between what they are taught and everyday life).

This theme continues with the ranking of principles by three groups (e.g., #9 avoid cognitive overload, #33 maximizing factors that increase attention and engagement). While two expert groups agreed on three principles as their highest ranked principle, only #31 on multiple representations of information appeared to directly relate to content in the context of information. These are all principles that teachers can apply in creating online instruction and certainly can be made routine by developers of online instruction for dissemination to schools.

In examining the high mean ratings of principles, it is also important to consider the principles receiving minus ratings. All of the principles met the criteria for inclusion in the study as being applicable to online instruction by being based on theory and research. In the context of the quasi-normal distribution model employed in the Q-sort, minus ratings were essential to the model. Principles with a relatively high mean among those rated minus are also important to the process of making design decisions in the development of online instruction.

The following discusses the means for the principles receiving minus ratings based on the quasi-normal curve model for the Q-sort.

In examining the five principles with the highest minus mean ratings for the total group and for the three independent groups, one principle among the five highest was rated by each group:

38. When incorporating displays, the display should look like a pictorial image of what it represents.

Three principles were in the five highest rated by three groups:

17. The design structure of an activity should include motives, actions, and responses to cultural needs derived from examining the conditions of the learners' environment.
33. Students learn better when the summarization does not include the same wording as original instruction or additional detail.
39. Computer mediated activity and design need to be understood within the relevant instruction.

The groups rating principle #17 high were the combined group, the multimedia group, and the learning disabilities group. Principle 33 was rated high by the combined group, multimedia group, and the K-12 all group. Finally, principle 39 was rated high by the combined group, the multimedia ,and the K-12 all group.

Two groups ranked Principle #22 among the highest five. These groups were the combined group and the learning disabilities group.

22. Affective signals for online learners are essential in maximizing e- learning.

It should be noted that the descriptor the experts were responding to when ranking a principle in a minus column was a level of disagreement with the principle. In examining the design principles highly ranked in the minus group, there did not seem to be a theme. However, there was a pattern in that the design principles on which expert groups tended to agree in their high rankings appeared to be rather specific. Examples include #38 on pictorial image, #33 on students learning better when the original language is not used in summarization, #39 on understanding mediated activity, and #22 on affective signals.

Because the original principles varied greatly in length, language, format, and detail, each principle was restated during the verification process into similar language and length consistent with the format for Q-methodology. They were reviewed again to ensure adherence to the intent of the originally worded principle. Attention was also given to minimizing the number of elements in a statement of principle. But this was not feasible in all cases without altering the principle, which was not allowed. Thus, there remains some variability in length and inclusiveness among the principles, but that is essential to ensuring the integrity of the design principle statements.

In follow-up to the analysis based on the ratings by the three independent groups of experts, an ANOVA was conducted to compare the responses of the three groups of experts on the 40 design principles. The ANOVA results were supported by the post-hoc test analysis, indicating that there was a significant difference between any combination of expert groups on only one principle out of the 40: Principle #7 (i.e., "In designing multimedia instruction, emphasis needs to be placed on the mix of varying modes of instruction to meet individual differences.") The difference was in the responses of the multimedia and K-12 all-learner expert groups. The mean value of the responses by the multimedia expert group to Principle #7 was -.75 and +1.29 for the K-12 all learner expert group. This is the only principle where there was a significant difference and it involved the multimedia experts on a multimedia principle. While the response of experts in learning disabilities did not impact this result, it is important to note that the mean was -.06, indicating that their perspective was a little closer to that of the multimedia expert group than to the K-2 all-student expert group. In sum, the results of the ANOVA indicated that there was high agreement across the expert groups in their ratings on 39 of the 40 design principles.

Pearson correlations were calculated to determine the strength of the relationship among the principles. There were only three sets of principles with significant positive correlation coefficients: between Principle #14 and Principle #17 with (*r* = .554), Principle #8 and Principle #9 with (*r* = .545), and between Principle #29 and Principle #40 with (r = .529). This indicates that the principles were largely independent of each other.

A factor analysis was conducted to determine if principles tended to group around common themes. The factor loading criteria for the identification of principles sharing common factors required a factor solution value equal to or exceeding .30. The factor analysis resulted in five factors being identified. Thirty-eight of the 40 principles met the criterion of .30 and were aligned with one of the 5 factors. The two principles not meeting the .30 criterion were #18 and #38:

18. The learner interacts on the environment and the environment interacts on the learner.

38. When incorporating displays, the display should look like a pictorial image of what it represents.

The process employed in identifying labels to be applied to each of the five factors entailed reviewing the data on the principles aligned with each factor and their respective contributions to other factors. Each principle aligned with a factor was reviewed by two people to independently generate ideas on appropriate labels for the five factors that reflected a theme representative of the intent of the aligned principles. Each suggestion was explored, and consensus was reached on labels for each factor.

Factor 1: Learner variability

The most common implication observed across the principles aligned with Factor 1 was a focus on characterizing the learner. The principles mostly addressed attributes that contributed to variability of learners needing to be accommodated in the design of online instruction. Examples include cultural differences, orientation toward goals, affect, student need for multiple representations of experiences, motives, and contextualization.

Factor 2: Cognitive strategies

In Factor 2, the most common theme was a focus on specific strategies or features that contribute to designs that impact cognitive processes resulting in better learning. Examples include avoiding cognitive overload, working memory, varying modes of instruction, chunking content to benefit short-term memory, long-term memory schemata, and reflection.

Factor 3: Prerequisite for teaching/learning

In Factor 3, there was an emphasis on conditions essential to enhancing teaching and learning. Examples include mediated actions in activities, cognitive reasoning, building on prior knowledge, working memory, moving from long-term memory to working memory, and effective approaches to navigation.

Factor 4: Context for learning

In reviewing the principles meeting the minimum loading criteria for consideration in labeling Factor 4, there was an emphasis on the presentation of online instruction. Examples include visual and verbal connections, minimizing working memory load, use of video and audio, context for sustaining inquiry, revisions of ideas, connecting knowledge and everyday life, and use of text and animation.

Factor 5 Media presentation

Only four principles were aligned with this factor that met the minimum loading criteria. This was the least number of principles loading on any of the five factors. In reviewing the four factors, an emphasis was noted on mediation from a multimedia perspective. Examples included references to textual, pictorial and verbal representations, mediated activity, engagement, media presentation and quest for learning.

While there was some difference in the between ratings of the 40 design principles, there were no significant differences between the ratings by K-12 all-student experts and the learning disability experts. If the design principles are adhered to by teachers and developers of online instruction, this is encouraging. This illustrates that the design principles supported for application in online instruction for students with disabilities will likely apply to all students. The design principles were also found to be largely independent of each other, adding strength to their merit as guidelines.

Recommendations for Future Research and Development

Research on he effectiveness of online instruction based on the design principles individually and collectively needs to be conducted to measure the impact of the design principles on learner outcomes. The design principles applied development of online instruction.

The study also needs to be replicated with additional disability groups representing the comparison group. In doing so, particular attention should be given to students with sensory disabilities and students with attention deficit disorders. While the study has yielded data from experts in the areas of multimedia and K-12 for all experts, the Q-sort would need to be completed by experts in the additional areas of disabilities studied.

Further, research needs to be conducted to identify the design principles and development skills applicable to the creation of online instruction that are taught in academic programs preparing professional for roles in the design and/or development of online instruction in K-12 education. The 40 design principles selected from 7 theories represented a sample of principles.

The study should be replicated with a more comprehensive set of principles representing the seven theories as well as additional theories.

Guidelines for the applications of the design principle in the development of online instructional resources also are in need of being developed and verified. Rubrics to assess the presence of the design principles in existing and evolving online instruction should also be developed and researched.

Limitations

- Only three participating experts represented the commercial e-learning industry.
- The number of theories studied was limited to seven.
- The design principles were not inclusive of all principles associated with the identified theories.
- The population of individual professionals with the preparation and experience to serve as experts in a study of this nature is not known. This limits access to sampling.

APPENDIX A

Instruction for the Q-Sorting Process

Group 1: Multimedia Design Perspective Version

Your Task: Your task is to use the Q-Sort Tool in attachment B to rate each design principle on the strength of your agreement or disagreement with the design principle in the design of online instruction in K-12 education from the perspective of your knowledge of multimedia. Detailed instructions on the use of the tool are provided in the following instructions. There are three steps in the Q-Sort process. Step 1 is a general preliminary sort, Step 2 is the actual Q-Sort, and Step 3 is confirmation of your rating and the final submission. In Step 3 you are allowed to make changes if necessary before submitting you final version.

Background on the principles in the Q-Sort

A comprehensive review of the theoretical literature was conducted to identify design principles, supported by theory and research, with potential for application to online instruction in K-12 education. At the conclusion of reviewing seven theories and supporting research, 40 principles were selected. Each principle was subjected to review prior to being included in the Q-Sort process. For purposes of the Q-Sort process each principle appears as a brief descriptive statement in random order**.**

Example:

> Multimedia design features need to be examined in how they interact with each other and their relative contribution to cognitive over load.

The Three Step Q-Sort Procedure

Open the Q-Sort tool (Attachment B)

Attachment B provides you a link to the Q-Sort Tool. Open the link and the tool will appear. Take a quick look at the tool but do not begin. **You can click this link at any time from any computer to re-enter the tool. Your current location is saved automatically as you work.** We recommend that you use the Q-Sort Tool on the largest screen you have available, in a full-size browser window.

Review the instructions in this document (Attachment A) before proceeding with Step 1 of the Q-Sort process. These are the instructions you are reading now.

Step 1: This is a *preliminary* sort. When you open the Q-Sort Tool you will see a display of unsorted principles at the top of the screen and three columns at the bottom of the screen. In this Step your task is to sort each principle from the unsorted grouping into one of the three boxes i.e., Less Important, Neutral, and Highly Important. Do not place more than 15 principles in any one box. See Figure 1.

The drag and drop procedure is very standard. Click, drag, and move the principles. As you hover your cursor over the principle the font will enlarge. When you have dragged the statement to where you want and release, it will stay there. If you want to move it again, move it again. If you have exceeded the allowable number of principles permitted in a box, the principle will become red and you will need to move it to another box or move a different one in the same box to another box. ,

The purpose of this step is to familiarize yourself with the principles and your relative perspective on each. This step provides readiness for the actual Q-Sort process in Step 2. Step 1 is not intended as part of the data analysis. However, we have found that completing Step 1 saves time in completing Step 2.

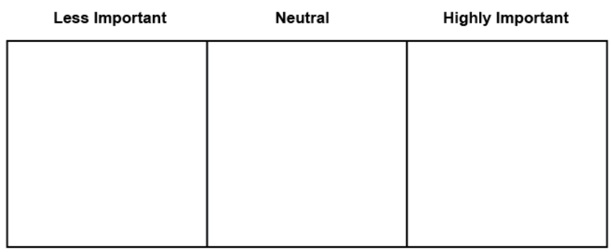


Figure 2. Step 1 Preliminary sort

<u>**Step 2:**</u> This is the ***actual Q-sorting process***. Rate each principle on the strength of your agreement or disagreement with the principle in the design of online instruction in K-12 education from the perspective your knowledge of multimedia. You are asked to rate each principle from your perspective on a Q-sort table (Fig. 2). The Q-Sort table shows a screen that includes a quasi-normal distribution labeled from Strongly Disagree at left to Strongly Agree at right and a typical grid rating scale across the top that ranges from –4 to +4 (Brown, 1980; McKeown & Thomas, 1988). Figure 2 displays the grid used for this investigation. You are restricted in your sorting to the number of available boxes under each rating. For example, -3 has four boxes. No more than four principles may be rated as -3. This requirement applies to all ratings of individual principles. **Please note that all of the principles have been derived from the literature. Placing a principle in a disagree column is not a negative rating. If you place a principle in the -4 column on "Strongly Disagree" you are expressing a very strong personal view that the principle, in your judgment, is not important.**

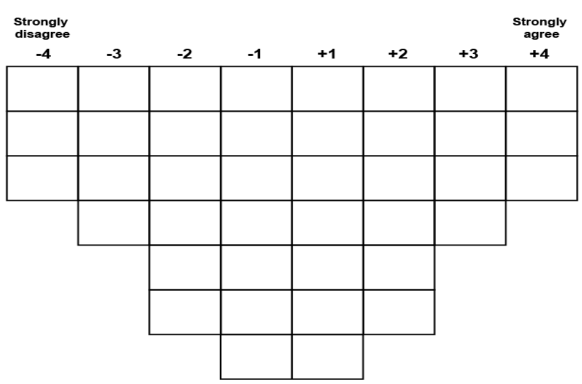


Figure 3. Q-sort distribution in rating each principle

Follow the same drag and drop procedure in this step as you did in Step 1.

3. The Q-Sort table allows you to drag and drop each individual principle on the table to the agreement level where you want them rated. You may change your ratings at any time until you click the submit button **in Step 3.**

4. If you exceed the allowable number of principles rated under a value such as 3+, the last principle you placed there will appear in red. You either must shift that principle to another rating or one of the principles you have already placed under the rating to another rating.

   Due to the number of principles being rated the middle ratings may extend below the bottom of the screen. They are still recorded.

Step 3: This is the *confirmation and submission* step. When you finish the sorting process in Step 2, review your ratings to be certain you are satisfied with your sorting. You are free to change ratings by the drag and drop process. However, the restriction on the number of principles per rating remains restricted to the quasi normal distribution.

1. Once you finish the Q-sorting placement and are satisfied with your ratings, press the submit button at the top-right of the screen. Your Q-Sorting process is now complete.
2. Please note that the results of your rating are automatically sent to a third party for analysis.

Thanks you for sharing your perspectives and for your time. You will receive a copy of the results.

Respectfully,

Chi-Hsun Chiu and Ed Meyen

Instruction for the Q-Sorting Process

Group 2: Design Perspective for all K-12 Learners

Your Task: Your task is to use the Q-Sort Tool in attachment B to rate each design principle on the strength of your agreement or disagreement with the design principle being applied in the design of online instruction for all K-12 learners. Detailed instructions on the use of the tool are provided in the following instructions. There are three steps in the Q-Sort process. Step 1 is a general preliminary sort, Step 2 is the actual Q-Sort, and Step 3 is confirmation of your rating and the final submission. In Step 3 you are allowed to make changes if necessary before submitting you final version.

Background on the principles in the Q-Sort

A comprehensive review of the theoretical literature was conducted to identify design principles, supported by theory and research, with potential for application to online instruction in K-12 education. At the conclusion of reviewing seven theories and supporting research, 40 principles were selected. Each principle was subjected to review prior to being included in the Q-Sort process. For purposes of the Q-Sort process each principle appears as a brief descriptive statement in random order.

Example:

> Multimedia design features need to be examined in how they interact with each other and their relative contribution to cognitive over load.

The Three Step Q-Sort Procedure

Open the Q-Sort tool (Attachment B)

Attachment B provides you a link to the Q-Sort Tool. Open the link and the tool will appear. Take a quick look at the tool but do not begin. **You can click this link at any time from any computer to re-enter the tool. Your current location is saved automatically as you work.** We recommend that you use the Q-Sort Tool on the largest screen you have available, in a full-size browser window.

Review the instructions in this document (Attachment A) before proceeding with Step 1 of the Q-Sort process. These are the instructions you are reading now.

Step 1: This is a *preliminary* sort. When you open the Q-Sort Tool you will see a display of unsorted principles at the top of the screen and three columns at the bottom of the screen. In this Step your task is to sort each principle from the unsorted grouping into one of the three boxes i.e., Less Important, Neutral, and Highly Important. Do not place more than 15 principles in any one box. See Figure 1.

The drag and drop procedure is very standard. Click, drag, and move the principles. As you hover your cursor over the principle the font will enlarge. When you have dragged the statement to where you want and release, it will stay there. If you want to move it again, move it again. If you have exceeded the allowable number of principles permitted in a box, the principle will become red and you will need to move it to another box or move a different one in the same box to another box. ,

The purpose of this step is to familiarize yourself with the principles and your relative perspective on each. This step provides readiness for the actual Q-Sort process in Step 2. Step 1 is not intended as part of the data analysis. However, we have found that completing Step 1 saves time in completing Step 2.

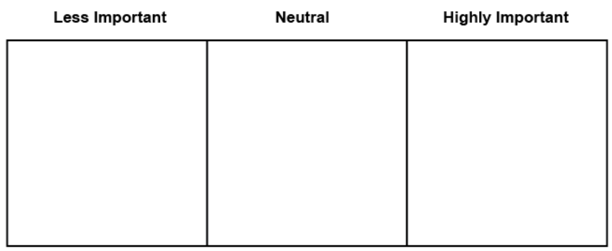


Figure 4. Step 1 Preliminary sort

Step 2: This is the ***actual Q-sorting process***. Rate each principle on the strength of your agreement or disagreement with the design principle being applied in the design of online instruction for all K-12 learners. You are asked to rate each principle from your perspective on a Q-sort table (Fig. 2). The Q-Sort table shows a screen that includes a quasi-normal distribution labeled from Strongly Disagree at left to Strongly Agree at right and a typical grid rating scale across the top that ranges from –4 to +4 (Brown, 1980; McKeown & Thomas, 1988). Figure 2 displays the grid used for this investigation. You are restricted in your sorting to the number of available boxes under each rating. For example, -3 has four boxes. No more than four principles may be rated as -3. This requirement applies to all ratings of individual principles. **Please note that all of the principles have been derived from the literature. Placing a principle in a disagree column is not a negative rating. If you place a principle in the -4 column on "Strongly Disagree" you are expressing a very strong personal view that the principle, in your judgment, is not important.**

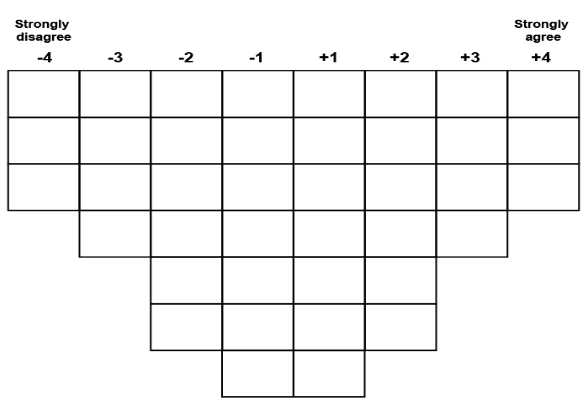


Figure 5. Q-sort distribution in rating each principle

Follow the same drag and drop procedure in this step as you did in Step 1.

5. The Q-Sort table allows you to drag and drop each individual principle on the table to the agreement level where you want them rated. You may change your ratings at any time until you click the submit button **in Step 3.**

6. If you exceed the allowable number of principles rated under a value such as 3+, the last principle you placed there will appear in red. You either must shift that principle to another rating or one of the principles you have already placed under the rating to another rating.

   Due to the number of principles being rated the middle ratings may extend below the bottom of the screen. They are still recorded.

Step 3: This is the *confirmation and submission* step. When you finish the sorting process in Step 2, review your ratings to be certain you are satisfied with your sorting. You are free to change ratings by the drag and drop process. However, the restriction on the number of principles per rating remains restricted to the quasi normal distribution.

3. Once you finish the Q-sorting placement and are satisfied with your ratings, press the submit button at the top-right of the screen. Your Q-Sorting process is now complete.
4. Please note that the results of your rating are automatically sent to a third party for analysis.

Thanks you for sharing your perspectives and for your time. You will receive a copy of the results.

Respectfully,

Chi-Hsun Chiu and Ed Meyen

Instruction for the Q-Sorting Process

Group 3: Design Perspective for K-12 Learners with Learning Disabilities

Your Task: Your task is to use the Q-Sort Tool in attachment B to rate each design principle on the strength of your agreement or disagreement with the design principle being applied in the design of online instruction for K-12 learners with learning disabilities. Detailed instructions on the use of the tool are provided in the following instructions. There are three steps in the Q-Sort process. Step 1 is a general preliminary sort, Step 2 is the actual Q-Sort, and Step 3 is confirmation of your rating and the final submission. In Step 3 you are allowed to make changes if necessary before submitting you final version.

Background on the principles in the Q-Sort

A comprehensive review of the theoretical literature was conducted to identify design principles, supported by theory and research, with potential for application to online instruction in K-12 education. At the conclusion of reviewing seven theories and supporting research, 40 principles were selected. Each principle was subjected to review prior to being included in the Q-Sort process. For purposes of the Q-Sort process each principle appears as a brief descriptive statement in random order**.**

Example:

> Multimedia design features need to be examined in how they interact with each other and their relative contribution to cognitive over load.

The Three Step Q-Sort Procedure

Open the Q-Sort tool (Attachment B)

Attachment B provides you a link to the Q-Sort Tool. Open the link and the tool will appear. Take a quick look at the tool but do not begin. **You can click this link at any time from any computer to re-enter the tool. Your current location is saved automatically as you work.** We recommend that you use the Q-Sort Tool on the largest screen you have available, in a full-size browser window.

Review the instructions in this document (Attachment A) before proceeding with Step 1 of the Q-Sort process. These are the instructions you are reading now.

Step 1: This is a *preliminary* sort. When you open the Q-Sort Tool you will see a display of unsorted principles at the top of the screen and three columns at the bottom of the screen. In this Step your task is to sort each principle from the unsorted grouping into one of the three boxes i.e., Less Important, Neutral, and Highly Important. Do not place more than 15 principles in any one box. See Figure 1.

The drag and drop procedure is very standard. Click, drag, and move the principles. As you hover your cursor over the principle the font will enlarge. When you have dragged the statement to where you want and release, it will stay there. If you want to move it again, move it again. If you have exceeded the allowable number of principles permitted in a box, the principle will become red and you will need to move it to another box or move a different one in the same box to another box. ,

The purpose of this step is to familiarize yourself with the principles and your relative perspective on each. This step provides readiness for the actual Q-Sort process in Step 2. Step 1 is not intended as part of the data analysis. However, we have found that completing Step 1 saves time in completing Step 2.

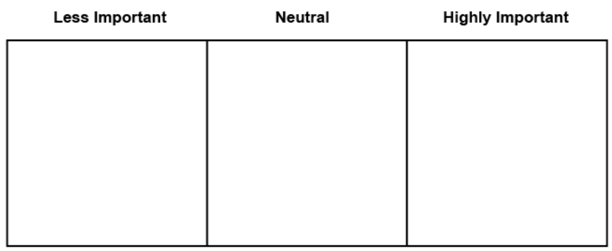


Figure 6. Step 1 Preliminary sort

<u>**Step 2:**</u> This is the ***actual Q-sorting process***. Rate each design principle on the strength of your agreement or disagreement with the principle being applied in the design of online instruction for K-12 learners with learning disabilities. You are asked to rate each principle from your perspective on a Q-sort table (Fig. 2). The Q-Sort table shows a screen that includes a quasi-normal distribution labeled from Strongly Disagree at left to Strongly Agree at right and a typical grid rating scale across the top that ranges from –4 to +4 (Brown, 1980; McKeown & Thomas, 1988). Figure 2 displays the grid used for this investigation. You are restricted in your sorting to the number of available boxes under each rating. For example, -3 has four boxes. No more than four principles may be rated as -3. This requirement applies to all ratings of individual principles. **Please note that all of the principles have been derived from the literature. Placing a principle in a disagree column is not a negative rating. If you place a principle in the -4 column on "Strongly Disagree" you are expressing a very strong personal view that the principle, in your judgment, is not important.**

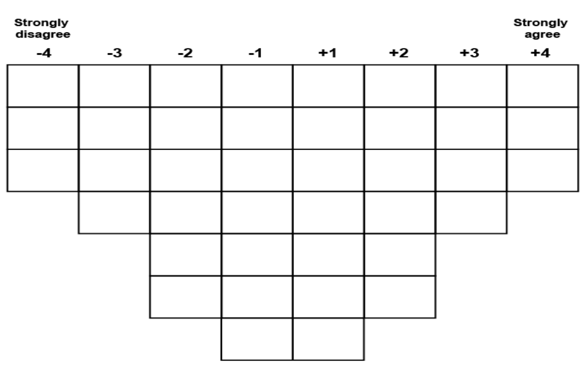


Figure 7. Q-sort distribution in rating each principle

Follow the same drag and drop procedure in this step as you did in Step 1.

7. The Q-Sort table allows you to drag and drop each individual principle on the table to the agreement level where you want them rated. You may change your ratings at any time until you click the submit button **in Step 3.**

8. If you exceed the allowable number of principles rated under a value such as 3+, the last principle you placed there will appear in red. You either must shift that principle to another rating or one of the principles you have already placed under the rating to another rating.

   Due to the number of principles being rated the middle ratings may extend below the bottom of the screen. They are still recorded.

Step 3: This is the *confirmation and submission* step. When you finish the sorting process in Step 2, review your ratings to be certain you are satisfied with your sorting. You are free to change ratings by the drag and drop process. However, the restriction on the number of principles per rating remains restricted to the quasi normal distribution.

5. Once you finish the Q-sorting placement and are satisfied with your ratings, press the submit button at the top-right of the screen. Your Q-Sorting process is now complete.
6. Please note that the results of your rating are automatically sent to a third party for analysis.

Thanks you for sharing your perspectives and for your time. You will receive a copy of the results.

Respectfully,

Chi-Hsun Chiu and Ed Meyen

APPENDIX B

Research Invitation Letter

I am working with Chi Hsun a GRA in the eLearning Design Lab on a research project in the area of theory based designs for online instruction. I would appreciate it very much if you could help by responding to an online Q-Sort task. The rationale for this study is as follows:

The rate of growth in online instruction in K-12 education is unparalleled. Yet, little is known about the theoretical or research base of the designs being employed in the development of e-learning resources. This is especially true in online instruction for struggling learners, such as students with learning disabilities.

As a member of a research team for the National Center on Online Learning for Students with Disabilities at the University of Kansas I am working with Chi Hsun Chiu, in conducting a pilot study investigating theory based design principles applicable to online instruction. Approximately forty principles have been identified and validated. We are now at the stage of seeking input from experts with varied backgrounds related to online designs. **We are inviting you to participate as a member of the expert group related to the design of online instruction for all students.** Each person receiving this invitation has been personally recommended as possessing the expertise essential to responding to this research instrument.

We have opted to use Q-methodology as a process to subject the identified principles to examination by groups of experts. The process entails each reviewer sorting the principles as to the importance they place on each principle from the perspective of their expertise. This task is followed by a Q-sort task is carried out online.It involves a drag and drop procedure to record your rating of each principle.

While the time required to complete the process may vary our experience is that most reviewers complete the task in about 20 minutes. The Q-sort analysis process will be conducted by a third party. All responses will be held in confidence. Data will be reported only in the aggregate. Each participant will receive a copy of the results of the completed study.

We appreciate the consideration you will give to this invitation and hope that you will elect to participate. Attached are the instructions and the Q-Sort Tool. When you open the link your personalized Q-Sort will come up.

We are looking at a deadline on _____. If you elect not to participate, we fully understand and would also appreciate knowing that you will not be participating.

Respectfully,

Ed Meyen and Chi-Hsun Chiu

APPENDIX C

Research Follow-Up Letter

We truly appreciate your agreeing to participate in the study investigating theory based design principles applicable to online instruction. The target group we are asking you to respond to is the **instrument on multimedia design for all learners.** As you recall we are using a Q-sort methodology. Chi-Hsun and I are nearing a critical stage in our study. Our goal is **Monday, Feburary the 18th**. We are sensitive to your time but hope that this time line will work for you.

Attachment A is your Q-sort instructions.

Attachment B is your link to the Q-Sort Tool.

http://elearndesign.org/qsortA/?id=16

Respectfully,

Chi-Hsun Chiu and Ed Meyen

APPENDIX D

Theory Based Principles Applicable to Online Instrument
Final Version

1. In learning the learner interacts on the environment and environment interacts on the learner.
2. Mediated actions-in-activities, while teaching common content at the same time, results in more effective learning than when presented with time differences.
3. Human activity is realized though actions oriented toward goals while the goals are becoming routinized operations.
4. Navigation should include several modes of access.
5. Navigation options should be kept simple.
6. Multimedia design features need to be examined in how they interact with each other and their relative contribution to cognitive over load.
7. In designing multimedia instructional emphasis needs to be placed on the mix of varying modes of instruction to meet individual differences.
8. The time limitation of working memory must be considered in designing displays.
9. Unnecessary information should be kept to a minimum to avoid cognitive over load.
10. Developers need to understand the students' cognitive reasoning when developing online instructional resources to guide the learners' quest for learning.

11. Developers need to understand the students' affective reasoning when developing online instructional resources to guide the learners' quest for learning.

12. Multimedia designed instruction allows the learner to build verbal and visual models while also building connections between them.
13. Students should be provided opportunities to see the connection between the knowledge they are taught and everyday life.
14. Cultural factors impact activities and require that interactions be contextualized.
15. Activities should be designed to provide a rich context for learning and lend themselves to sustained inquiry and revisions of ideas.
16. Concurrent narration and animation results in higher performance than content presented on-screen through text and animation.
17. The design structure of an activity should include motives, actions, and responses to cultural needs derived from examining the conditions of the learners' environment.
18. When viewing or listening conditions are less than desirable the message is more likely to be interpreted correctly when the message is expressed more than once and in alternate forms.
19. Simultaneous media presentations should be kept simple.
20. Narrative presented auditorily and aligned with animation, results in better learning. outcomes than when text only is aligned with animation.
21. Visual displays should be designed in a manner that is consistent with other displays that the student may perceive concurrently.
22. Affective signals for online learners are essential in maximizing e- learning.
23. Social contexts for online learners are essential in maximizing e- learning.
24. The motivational value of multimedia e.g., both video and audio, needs to be considered in instructional design because they support learning and help to reduce fear of failure.

25. Visual and auditory stimuli impact instruction in multimedia learning and require a level of engagement plus a balance between textual, pictorial, and verbal representations.
26. Knowing the prior knowledge of students is central to the design of online instruction for struggling learners.
27. Learners must move new knowledge from long-term memory to working memory to apply it to real life applications.
28. "Chunking" content in short term memory so that it relates to long-term memory schemata is important in designing online instruction.
29. Multiple means of expression are central to meeting the varied needs of learners.
30. Online instruction is most effective when using two modes of instruction rather than one e.g., listening to an audio presentation while also viewing an animated representation on the same content.
31. Multiple representations of information should be provided instead of a single representation.
32. To optimize multimedia-based learning environments factors such as attention, engagement, goal setting, monitoring and action control need to be addressed.
33. Students learn better when the summarization does not include the same wording as original instruction or additional detail.
34. Design should minimize working memory load which combines short term and long term memory, instead utilize the greater capacity of long-term memory.
35. Requiring the learner to mentally integrate disparate sources of information interferes with learning.

36. By providing time between each segment of learning, for reflection, the learner is allowed time to process information before proceeding.
37. The presentation of narration increases effective long term and short term memory capacity.
38. When incorporating displays, the display should look like a pictorial image of what it represents.
39. Computer mediated activity and design need to be understood within the relevant instruction.
40. Multiple means of engagement are critical to creating conditions that stimulate engagement in learning.

APPENDIX E

All Figures

Figure 1. Step 1 Preliminary sort

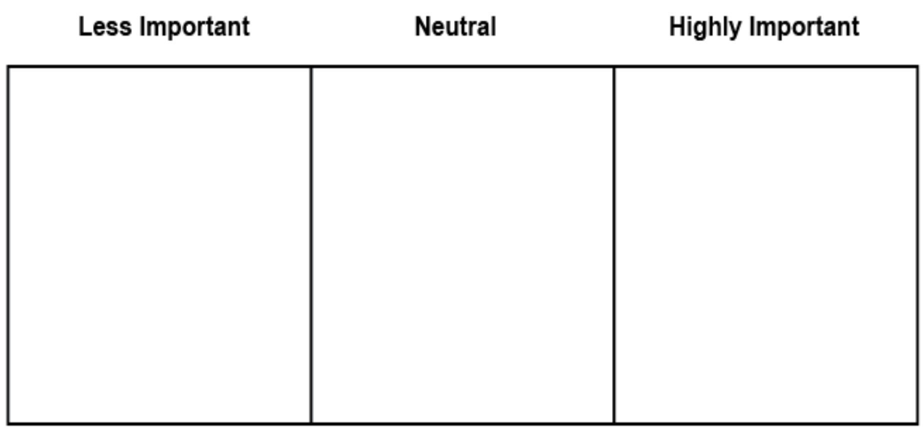


Figure 2. Q-sort distribution in rating each principle

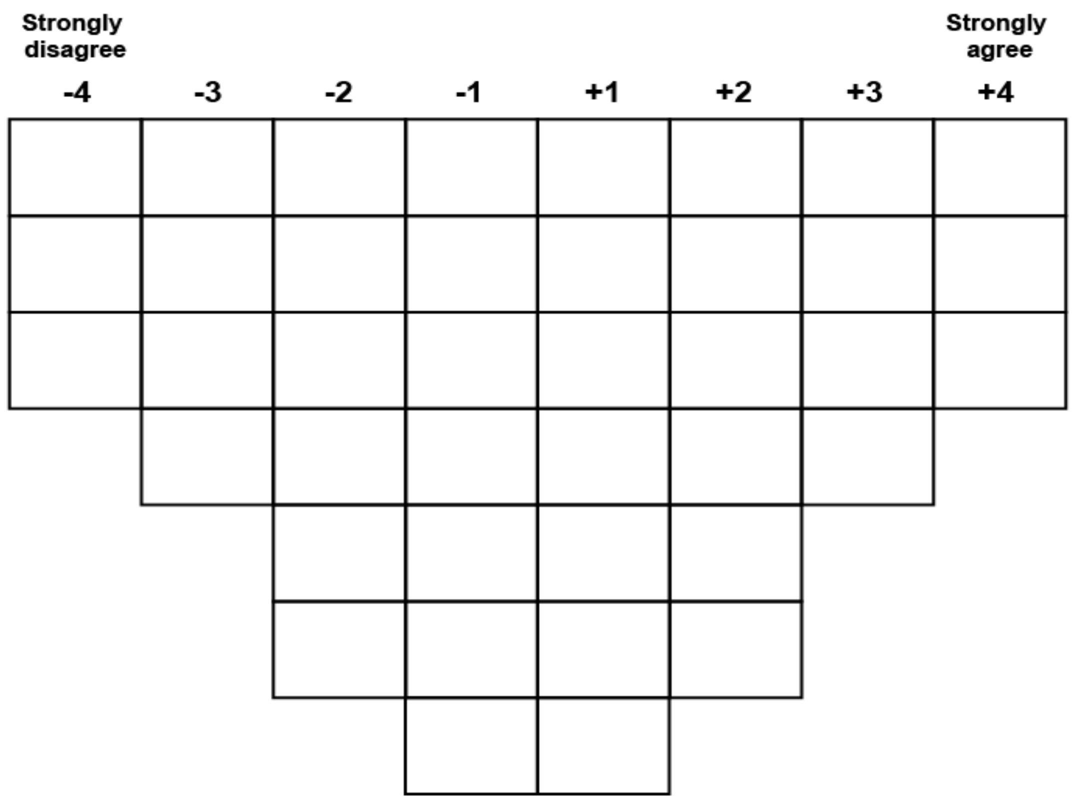


Figure 3. Cattell's Scree Test

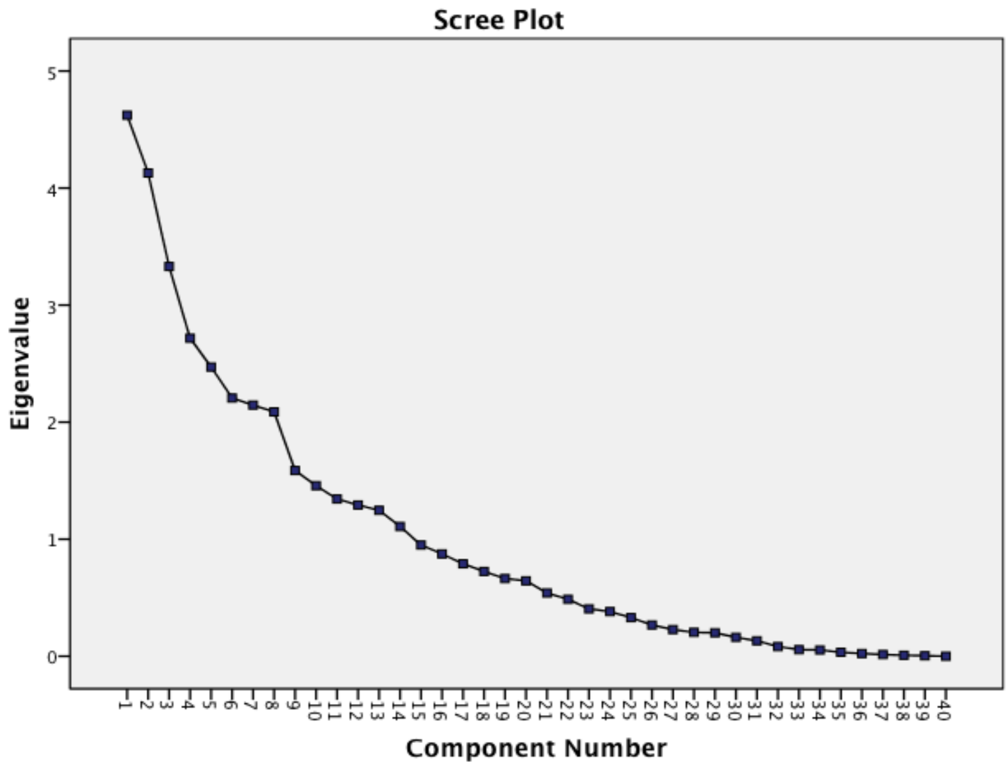


Figure 4. Parallel Analysis

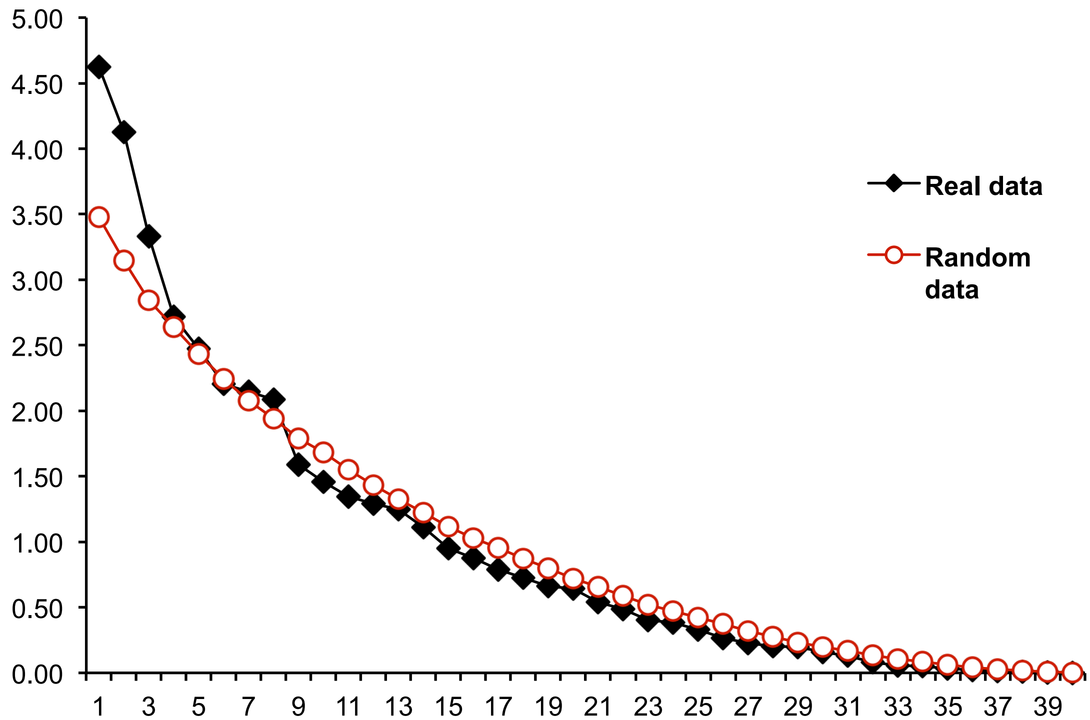
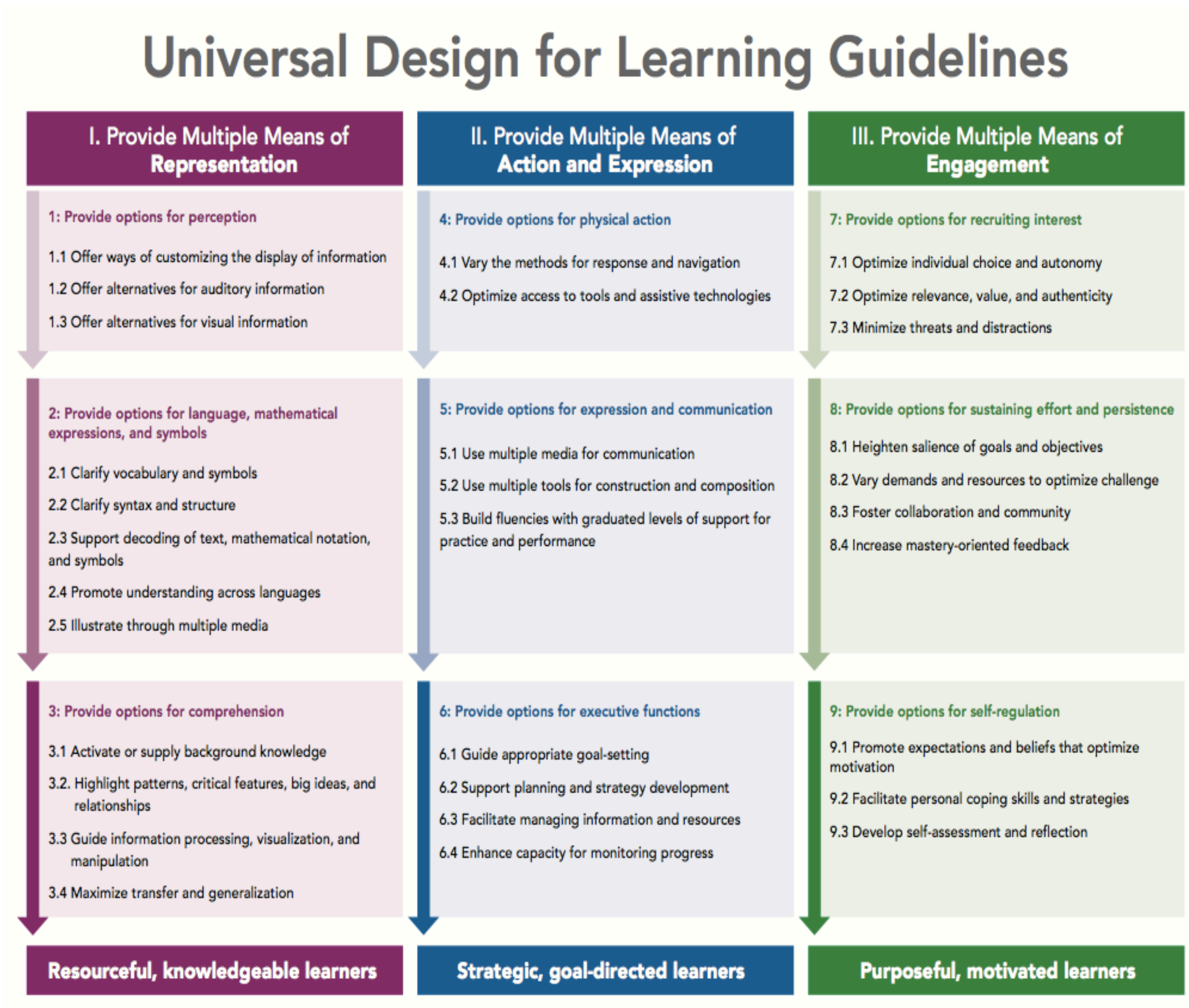


Figure 5. UDL Principles



Note: CAST (2011). *Universal Design for Learning Guidelines version 2.0.* Wakefield, MA: Author.

APPENDIX F

ALL Tables

Table 1.1 Response rate for participants

Group	Contact	Potential Participants	Completed Responses	Percent response
Group #1	29	16	12	75
Group #2	17	14	14	100
Group #3	31	23	17	73.9
Total	77	53	43	81.1

Statistics
GROUP

N	Valid	43
	Missing	0

Table 2.1 All groups

Descriptive Statistics

	N	Mean	Std. Deviation
Principle 1	43	-.51	2.658
Principle 2	43	-.93	2.272
Principle 3	43	-.84	2.246
Principle 4	43	-.86	2.494
Principle 5	43	1.40	2.049
Principle 6	43	1.00	2.093
Principle 7	43	.19	2.130
Principle 8	43	.12	2.174
Principle 9	43	1.70	2.122
Principle 10	43	.28	1.968
Principle 11	43	-1.02	2.365
Principle 12	43	.49	2.208
Principle 13	43	2.19	1.680
Principle 14	43	-.95	2.126
Principle 15	43	1.30	2.053
Principle 16	43	-.60	2.173
Principle 17	43	-1.21	1.971
Principle 18	43	-.53	1.804
Principle 19	43	.56	2.004
Principle 20	43	-.30	2.605
Principle 21	43	-.40	2.311
Principle 22	43	-1.44	2.164
Principle 23	43	-.74	2.431
Principle 24	43	-.19	2.107
Principle 25	43	.67	2.067
Principle 26	43	.70	2.366
Principle 27	43	.07	1.944
Principle 28	43	1.84	2.192
Principle 29	43	.21	2.242
Principle 30	43	-.02	2.425
Principle 31	43	1.40	2.470
Principle 32	43	1.40	1.866
Principle 33	43	-1.37	2.381
Principle 34	43	-.88	2.402
Principle 35	43	-.98	2.345
Principle 36	43	1.21	2.231
Principle 37	43	-.95	1.838
Principle 38	43	-1.98	1.845
Principle 39	43	-1.26	1.827
Principle 40	43	1.26	2.183
Valid N (listwise)	43		

Table 2.2 Group 1 = Multimedia

Descriptive Statistics[a]

	N	Mean	Std. Deviation
Principle 1	12	-1.17	2.329
Principle 2	12	-1.00	2.412
Principle 3	12	-.42	2.392
Principle 4	12	-1.17	2.725
Principle 5	12	2.33	1.614
Principle 6	12	1.00	2.089
Principle 7	12	-.75	2.006
Principle 8	12	.83	2.250
Principle 9	12	1.08	2.234
Principle 10	12	.25	2.050
Principle 11	12	-.33	2.605
Principle 12	12	.33	2.498
Principle 13	12	2.33	2.348
Principle 14	12	-.75	2.006
Principle 15	12	.92	2.429
Principle 16	12	-.58	2.392
Principle 17	12	-1.42	1.379
Principle 18	12	-.17	1.899
Principle 19	12	.75	1.357
Principle 20	12	.17	2.949
Principle 21	12	.42	2.712
Principle 22	12	-.75	2.454
Principle 23	12	-1.42	1.832
Principle 24	12	-.67	2.270
Principle 25	12	-.33	1.923
Principle 26	12	.17	2.855
Principle 27	12	.50	1.977
Principle 28	12	2.00	2.000
Principle 29	12	.33	2.348
Principle 30	12	-.50	2.236
Principle 31	12	1.17	2.552
Principle 32	12	.50	1.732
Principle 33	12	-1.50	2.067
Principle 34	12	-.17	2.406
Principle 35	12	-.50	2.680
Principle 36	12	1.25	2.340
Principle 37	12	-.92	1.929
Principle 38	12	-1.83	2.167
Principle 39	12	-1.67	1.923
Principle 40	12	1.67	2.015
Valid N (listwise)	12		

a. GROUP = Multimedia

Table 2.3 Group = All K-12 Learners

Descriptive Statistics[a]

	N	Mean	Std. Deviation
Principle 1	14	.43	2.681
Principle 2	14	-1.64	1.906
Principle 3	14	-.71	2.400
Principle 4	14	-.36	2.170
Principle 5	14	.93	2.200
Principle 6	14	.86	1.956
Principle 7	14	1.29	1.899
Principle 8	14	-.07	2.464
Principle 9	14	2.14	1.703
Principle 10	14	-.07	1.940
Principle 11	14	-.71	2.268
Principle 12	14	.86	1.657
Principle 13	14	2.36	1.151
Principle 14	14	-.86	2.248
Principle 15	14	1.21	1.888
Principle 16	14	-1.00	2.219
Principle 17	14	-.36	2.098
Principle 18	14	-1.07	1.940
Principle 19	14	-.14	2.381
Principle 20	14	-.79	2.806
Principle 21	14	-1.00	1.922
Principle 22	14	-1.21	2.517
Principle 23	14	.43	2.344
Principle 24	14	.29	2.016
Principle 25	14	.79	1.805
Principle 26	14	.79	1.762
Principle 27	14	.36	1.823
Principle 28	14	1.50	2.624
Principle 29	14	.79	2.155
Principle 30	14	-.29	2.758
Principle 31	14	1.21	2.665
Principle 32	14	1.86	1.875
Principle 33	14	-2.21	2.119
Principle 34	14	-.86	2.507
Principle 35	14	-1.29	2.234
Principle 36	14	.71	2.400
Principle 37	14	-1.79	1.762
Principle 38	14	-2.50	1.401
Principle 39	14	-1.57	1.742
Principle 40	14	1.71	2.431
Valid N (listwise)	14		

a. GROUP = K-12 all

Table 2.4 Group 3 = K-12 Learning Disabilities

Descriptive Statistics[a]

	N	Mean	Std. Deviation
Principle 1	17	-.82	2.789
Principle 2	17	-.29	2.392
Principle 3	17	-1.24	2.078
Principle 4	17	-1.06	2.657
Principle 5	17	1.12	2.088
Principle 6	17	1.12	2.315
Principle 7	17	-.06	2.106
Principle 8	17	-.24	1.855
Principle 9	17	1.76	2.359
Principle 10	17	.59	2.002
Principle 11	17	-1.76	2.195
Principle 12	17	.29	2.469
Principle 13	17	1.94	1.560
Principle 14	17	-1.18	2.215
Principle 15	17	1.65	1.967
Principle 16	17	-.29	2.054
Principle 17	17	-1.76	2.078
Principle 18	17	-.35	1.618
Principle 19	17	1.00	2.000
Principle 20	17	-.24	2.251
Principle 21	17	-.47	2.267
Principle 22	17	-2.12	1.453
Principle 23	17	-1.24	2.635
Principle 24	17	-.24	2.107
Principle 25	17	1.29	2.201
Principle 26	17	1.00	2.500
Principle 27	17	-.47	2.004
Principle 28	17	2.00	2.031
Principle 29	17	-.35	2.234
Principle 30	17	.53	2.294
Principle 31	17	1.71	2.365
Principle 32	17	1.65	1.835
Principle 33	17	-.59	2.647
Principle 34	17	-1.41	2.320
Principle 35	17	-1.06	2.277
Principle 36	17	1.59	2.063
Principle 37	17	-.29	1.649
Principle 38	17	-1.65	1.935
Principle 39	17	-.71	1.795
Principle 40	17	.59	2.033
Valid N (listwise)	17		

a. GROUP = K-12 LD

Table 2.5 ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
	Between Groups	19.178	2	9.589	1.382	.263
Principle 1	Within Groups	277.566	40	6.939		
	Total	296.744	42			
	Between Groups	14.047	2	7.024	1.386	.262
Principle 2	Within Groups	202.744	40	5.069		
	Total	216.791	42			
	Between Groups	5.028	2	2.514	.486	.619
Principle 3	Within Groups	206.833	40	5.171		
	Total	211.860	42			
	Between Groups	5.341	2	2.670	.418	.662
Principle 4	Within Groups	255.822	40	6.396		
	Total	261.163	42			
	Between Groups	14.919	2	7.460	1.849	.171
Principle 5	Within Groups	161.360	40	4.034		
	Total	176.279	42			
	Between Groups	.521	2	.261	.057	.945
Principle 6	Within Groups	183.479	40	4.587		
	Total	184.000	42			
	Between Groups	28.463	2	14.232	3.513	.039
Principle 7	Within Groups	162.048	40	4.051		
	Total	190.512	42			
	Between Groups	8.765	2	4.382	.924	.405
Principle 8	Within Groups	189.654	40	4.741		
	Total	198.419	42			
Principle 9	Between Groups	7.380	2	3.690	.812	.451

	Within Groups	181.690	40	4.542		
	Total	189.070	42			
Principle 10	Between Groups	3.355	2	1.677	.421	.659

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Principle 10	Within Groups	159.296	40	3.982		
	Total	162.651	42			
	Between Groups	16.394	2	8.197	1.500	.235
Principle 11	Within Groups	218.583	40	5.465		
	Total	234.977	42			
	Between Groups	2.834	2	1.417	.281	.757
Principle 12	Within Groups	201.910	40	5.048		
	Total	204.744	42			
	Between Groups	1.689	2	.845	.289	.750
Principle 13	Within Groups	116.822	40	2.921		
	Total	118.512	42			
	Between Groups	1.472	2	.736	.156	.856
Principle 14	Within Groups	188.435	40	4.711		
	Total	189.907	42			
	Between Groups	3.914	2	1.957	.452	.640
Principle 15	Within Groups	173.156	40	4.329		
	Total	177.070	42			
	Between Groups	3.833	2	1.916	.394	.677
Principle 16	Within Groups	194.446	40	4.861		
	Total	198.279	42			
Principle 17	Between Groups	15.927	2	7.963	2.164	.128
	Within Groups	147.190	40	3.680		

	Total	163.116	42			
Principle 18	Between Groups	6.220	2	3.110	.953	.394
	Within Groups	130.478	40	3.262		
	Total	136.698	42			
Principle 19	Between Groups	10.640	2	5.320	1.347	.272
	Within Groups	157.964	40	3.949		
	Total	168.605	42			

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Principle 20	Between Groups	5.987	2	2.994	.429	.654
	Within Groups	279.083	40	6.977		
	Total	285.070	42			
Principle 21	Between Groups	13.127	2	6.564	1.243	.299
	Within Groups	211.152	40	5.279		
	Total	224.279	42			
Principle 22	Between Groups	14.233	2	7.116	1.561	.222
	Within Groups	182.372	40	4.559		
	Total	196.605	42			
Principle 23	Between Groups	28.782	2	14.391	2.624	.085
	Within Groups	219.404	40	5.485		
	Total	248.186	42			
Principle 24	Between Groups	5.929	2	2.964	.657	.524
	Within Groups	180.583	40	4.515		
	Total	186.512	42			
Principle 25	Between Groups	18.889	2	9.444	2.353	.108
	Within Groups	160.553	40	4.014		
	Total	179.442	42			

	Between Groups	5.046	2	2.523	.439	.648
Principle 26	Within Groups	230.024	40	5.751		
	Total	235.070	42			
	Between Groups	8.341	2	4.171	1.109	.340
Principle 27	Within Groups	150.450	40	3.761		
	Total	158.791	42			
	Between Groups	2.360	2	1.180	.237	.790
Principle 28	Within Groups	199.500	40	4.988		
	Total	201.860	42			
Principle 29	Between Groups	10.210	2	5.105	1.016	.371

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Principle 29	Within Groups	200.906	40	5.023		
	Total	211.116	42			
	Between Groups	8.884	2	4.442	.746	.481
Principle 30	Within Groups	238.092	40	5.952		
	Total	246.977	42			
	Between Groups	2.726	2	1.363	.215	.807
Principle 31	Within Groups	253.553	40	6.339		
	Total	256.279	42			
	Between Groups	13.682	2	6.841	2.064	.140
Principle 32	Within Groups	132.597	40	3.315		
	Total	146.279	42			
	Between Groups	20.572	2	10.286	1.892	.164
Principle 33	Within Groups	217.475	40	5.437		
	Total	238.047	42			
Principle 34	Between Groups	10.920	2	5.460	.943	.398

	Within Groups	231.499	40	5.787		
	Total	242.419	42			
Principle 35	Between Groups	4.178	2	2.089	.368	.694
	Within Groups	226.798	40	5.670		
	Total	230.977	42			
Principle 36	Between Groups	5.891	2	2.946	.580	.565
	Within Groups	203.225	40	5.081		
	Total	209.116	42			
Principle 37	Between Groups	17.104	2	8.552	2.741	.077
	Within Groups	124.803	40	3.120		
	Total	141.907	42			
Principle 38	Between Groups	5.928	2	2.964	.865	.429
	Within Groups	137.049	40	3.426		
	Total	142.977	42			

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Principle 39	Between Groups	8.561	2	4.281	1.301	.284
	Within Groups	131.625	40	3.291		
	Total	140.186	42			
Principle 40	Between Groups	12.545	2	6.272	1.337	.274
	Within Groups	187.641	40	4.691		
	Total	200.186	42			

Table 2.6 Post Hoc Tests

Multiple Comparisons

Bonferroni

Dependent Variable	(I) GROUP	(J) GROUP	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Principle 1	Multimedia	K-12 all	-1.595	1.036	.395	-4.18	.99
		K-12 LD	-.343	.993	1.000	-2.83	2.14
	K-12 all	Multimedia	1.595	1.036	.395	-.99	4.18
		K-12 LD	1.252	.951	.586	-1.12	3.63
	K-12 LD	Multimedia	.343	.993	1.000	-2.14	2.83
		K-12 all	-1.252	.951	.586	-3.63	1.12
Principle 2	Multimedia	K-12 all	.643	.886	1.000	-1.57	2.86
		K-12 LD	-.706	.849	1.000	-2.83	1.42
	K-12 all	Multimedia	-.643	.886	1.000	-2.86	1.57
		K-12 LD	-1.349	.813	.314	-3.38	.68
	K-12 LD	Multimedia	.706	.849	1.000	-1.42	2.83
		K-12 all	1.349	.813	.314	-.68	3.38
Principle 3	Multimedia	K-12 all	.298	.895	1.000	-1.94	2.53
		K-12 LD	.819	.857	1.000	-1.32	2.96
	K-12 all	Multimedia	-.298	.895	1.000	-2.53	1.94
		K-12 LD	.521	.821	1.000	-1.53	2.57
	K-12 LD	Multimedia	-.819	.857	1.000	-2.96	1.32
		K-12 all	-.521	.821	1.000	-2.57	1.53
Principle 4	Multimedia	K-12 all	-.810	.995	1.000	-3.30	1.68
		K-12 LD	-.108	.954	1.000	-2.49	2.27
	K-12 all	Multimedia	.810	.995	1.000	-1.68	3.30
		K-12 LD	.702	.913	1.000	-1.58	2.98
	K-12 LD	Multimedia	.108	.954	1.000	-2.27	2.49
		K-12 all	-.702	.913	1.000	-2.98	1.58
Principle 5	Multimedia	K-12 all	1.405	.790	.249	-.57	3.38
		K-12 LD	1.216	.757	.349	-.68	3.11

	K-12 all	Multimedia	-1.405	.790	.249	-3.38	.57
		K-12 LD	-.189	.725	1.000	-2.00	1.62
	K-12 LD	Multimedia	-1.216	.757	.349	-3.11	.68
		K-12 all	.189	.725	1.000	-1.62	2.00
Principle 6	Multimedia	K-12 all	.143	.843	1.000	-1.96	2.25
		K-12 LD	-.118	.808	1.000	-2.14	1.90
	K-12 all	Multimedia	-.143	.843	1.000	-2.25	1.96
		K-12 LD	-.261	.773	1.000	-2.19	1.67

Multiple Comparisons

Bonferroni

Dependent Variable	(I) GROUP	(J) GROUP	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
Principle 6	K-12 LD	Multimedia	.118	.808	1.000	-1.90	2.14
		K-12 all	.261	.773	1.000	-1.67	2.19
Principle 7	Multimedia	K-12 all	-2.036	.792	.042	-4.01	-.06
		K-12 LD	-.691	.759	1.000	-2.59	1.21
	K-12 all	Multimedia	2.036	.792	.042	.06	4.01
		K-12 LD	1.345	.726	.215	-.47	3.16
	K-12 LD	Multimedia	.691	.759	1.000	-1.21	2.59
		K-12 all	-1.345	.726	.215	-3.16	.47
Principle 8	Multimedia	K-12 all	.905	.857	.892	-1.24	3.05
		K-12 LD	1.069	.821	.601	-.98	3.12
	K-12 all	Multimedia	-.905	.857	.892	-3.05	1.24
		K-12 LD	.164	.786	1.000	-1.80	2.13
	K-12 LD	Multimedia	-1.069	.821	.601	-3.12	.98
		K-12 all	-.164	.786	1.000	-2.13	1.80
Principle 9	Multimedia	K-12 all	-1.060	.838	.641	-3.15	1.04
		K-12 LD	-.681	.804	1.000	-2.69	1.33
	K-12 all	Multimedia	1.060	.838	.641	-1.04	3.15
		K-12 LD	.378	.769	1.000	-1.54	2.30

	K-12 LD	Multimedia	.681	.804	1.000	-1.33	2.69
		K-12 all	-.378	.769	1.000	-2.30	1.54
	Multimedia	K-12 all	.321	.785	1.000	-1.64	2.28
		K-12 LD	-.338	.752	1.000	-2.22	1.54
Principle 10	K-12 all	Multimedia	-.321	.785	1.000	-2.28	1.64
		K-12 LD	-.660	.720	1.000	-2.46	1.14
	K-12 LD	Multimedia	.338	.752	1.000	-1.54	2.22
		K-12 all	.660	.720	1.000	-1.14	2.46
	Multimedia	K-12 all	.381	.920	1.000	-1.92	2.68
		K-12 LD	1.431	.881	.337	-.77	3.63
Principle 11	K-12 all	Multimedia	-.381	.920	1.000	-2.68	1.92
		K-12 LD	1.050	.844	.661	-1.06	3.16
	K-12 LD	Multimedia	-1.431	.881	.337	-3.63	.77
		K-12 all	-1.050	.844	.661	-3.16	1.06
Principle 12	Multimedia	K-12 all	-.524	.884	1.000	-2.73	1.68
		K-12 LD	.039	.847	1.000	-2.08	2.16

Multiple Comparisons

Bonferroni

Dependent Variable	(I) GROUP	(J) GROUP	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Principle 12	K-12 all	Multimedia	.524	.884	1.000	-1.68	2.73
		K-12 LD	.563	.811	1.000	-1.46	2.59
	K-12 LD	Multimedia	-.039	.847	1.000	-2.16	2.08
		K-12 all	-.563	.811	1.000	-2.59	1.46
	Multimedia	K-12 all	-.024	.672	1.000	-1.70	1.66
		K-12 LD	.392	.644	1.000	-1.22	2.00
Principle 13	K-12 all	Multimedia	.024	.672	1.000	-1.66	1.70
		K-12 LD	.416	.617	1.000	-1.13	1.96
	K-12 LD	Multimedia	-.392	.644	1.000	-2.00	1.22
		K-12 all	-.416	.617	1.000	-1.96	1.13

Principle 14	Multimedia	K-12 all	.107	.854	1.000	-2.03	2.24
		K-12 LD	.426	.818	1.000	-1.62	2.47
	K-12 all	Multimedia	-.107	.854	1.000	-2.24	2.03
		K-12 LD	.319	.783	1.000	-1.64	2.28
	K-12 LD	Multimedia	-.426	.818	1.000	-2.47	1.62
		K-12 all	-.319	.783	1.000	-2.28	1.64
Principle 15	Multimedia	K-12 all	-.298	.819	1.000	-2.34	1.75
		K-12 LD	-.730	.784	1.000	-2.69	1.23
	K-12 all	Multimedia	.298	.819	1.000	-1.75	2.34
		K-12 LD	-.433	.751	1.000	-2.31	1.44
	K-12 LD	Multimedia	.730	.784	1.000	-1.23	2.69
		K-12 all	.433	.751	1.000	-1.44	2.31
Principle 16	Multimedia	K-12 all	.417	.867	1.000	-1.75	2.58
		K-12 LD	-.289	.831	1.000	-2.37	1.79
	K-12 all	Multimedia	-.417	.867	1.000	-2.58	1.75
		K-12 LD	-.706	.796	1.000	-2.69	1.28
	K-12 LD	Multimedia	.289	.831	1.000	-1.79	2.37
		K-12 all	.706	.796	1.000	-1.28	2.69
Principle 17	Multimedia	K-12 all	-1.060	.755	.504	-2.95	.83
		K-12 LD	.348	.723	1.000	-1.46	2.16
	K-12 all	Multimedia	1.060	.755	.504	-.83	2.95
		K-12 LD	1.408	.692	.146	-.32	3.14
	K-12 LD	Multimedia	-.348	.723	1.000	-2.16	1.46
		K-12 all	-1.408	.692	.146	-3.14	.32

Multiple Comparisons

Bonferroni

Dependent Variable	(I) GROUP	(J) GROUP	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Principle 18	Multimedia	K-12 all	.905	.711	.631	-.87	2.68
		K-12 LD	.186	.681	1.000	-1.52	1.89

	K-12 all	Multimedia	-.905	.711	.631	-2.68	.87
		K-12 LD	-.718	.652	.831	-2.35	.91
	K-12 LD	Multimedia	-.186	.681	1.000	-1.89	1.52
		K-12 all	.718	.652	.831	-.91	2.35
Principle 19	Multimedia	K-12 all	.893	.782	.781	-1.06	2.85
		K-12 LD	-.250	.749	1.000	-2.12	1.62
	K-12 all	Multimedia	-.893	.782	.781	-2.85	1.06
		K-12 LD	-1.143	.717	.357	-2.94	.65
	K-12 LD	Multimedia	.250	.749	1.000	-1.62	2.12
		K-12 all	1.143	.717	.357	-.65	2.94
Principle 20	Multimedia	K-12 all	.952	1.039	1.000	-1.64	3.55
		K-12 LD	.402	.996	1.000	-2.09	2.89
	K-12 all	Multimedia	-.952	1.039	1.000	-3.55	1.64
		K-12 LD	-.550	.953	1.000	-2.93	1.83
	K-12 LD	Multimedia	-.402	.996	1.000	-2.89	2.09
		K-12 all	.550	.953	1.000	-1.83	2.93
Principle 21	Multimedia	K-12 all	1.417	.904	.375	-.84	3.68
		K-12 LD	.887	.866	.936	-1.28	3.05
	K-12 all	Multimedia	-1.417	.904	.375	-3.68	.84
		K-12 LD	-.529	.829	1.000	-2.60	1.54
	K-12 LD	Multimedia	-.887	.866	.936	-3.05	1.28
		K-12 all	.529	.829	1.000	-1.54	2.60
Principle 22	Multimedia	K-12 all	.464	.840	1.000	-1.63	2.56
		K-12 LD	1.368	.805	.291	-.64	3.38
	K-12 all	Multimedia	-.464	.840	1.000	-2.56	1.63
		K-12 LD	.903	.771	.744	-1.02	2.83
	K-12 LD	Multimedia	-1.368	.805	.291	-3.38	.64
		K-12 all	-.903	.771	.744	-2.83	1.02
Principle 23	Multimedia	K-12 all	-1.845	.921	.156	-4.15	.46
		K-12 LD	-.181	.883	1.000	-2.39	2.03
	K-12 all	Multimedia	1.845	.921	.156	-.46	4.15
		K-12 LD	1.664	.845	.168	-.45	3.78

Multiple Comparisons

Bonferroni

Dependent Variable	(I) GROUP	(J) GROUP	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
Principle 23	K-12 LD	Multimedia	.181	.883	1.000	-2.03	2.39
		K-12 all	-1.664	.845	.168	-3.78	.45
Principle 24	Multimedia	K-12 all	-.952	.836	.784	-3.04	1.14
		K-12 LD	-.431	.801	1.000	-2.43	1.57
	K-12 all	Multimedia	.952	.836	.784	-1.14	3.04
		K-12 LD	.521	.767	1.000	-1.40	2.44
	K-12 LD	Multimedia	.431	.801	1.000	-1.57	2.43
		K-12 all	-.521	.767	1.000	-2.44	1.40
Principle 25	Multimedia	K-12 all	-1.119	.788	.490	-3.09	.85
		K-12 LD	-1.627	.755	.112	-3.52	.26
	K-12 all	Multimedia	1.119	.788	.490	-.85	3.09
		K-12 LD	-.508	.723	1.000	-2.32	1.30
	K-12 LD	Multimedia	1.627	.755	.112	-.26	3.52
		K-12 all	.508	.723	1.000	-1.30	2.32
Principle 26	Multimedia	K-12 all	-.619	.943	1.000	-2.98	1.74
		K-12 LD	-.833	.904	1.000	-3.09	1.43
	K-12 all	Multimedia	.619	.943	1.000	-1.74	2.98
		K-12 LD	-.214	.865	1.000	-2.38	1.95
	K-12 LD	Multimedia	.833	.904	1.000	-1.43	3.09
		K-12 all	.214	.865	1.000	-1.95	2.38
Principle 27	Multimedia	K-12 all	.143	.763	1.000	-1.76	2.05
		K-12 LD	.971	.731	.576	-.86	2.80
	K-12 all	Multimedia	-.143	.763	1.000	-2.05	1.76
		K-12 LD	.828	.700	.732	-.92	2.58
	K-12 LD	Multimedia	-.971	.731	.576	-2.80	.86
		K-12 all	-.828	.700	.732	-2.58	.92

	Multimedia	K-12 all	.500	.879	1.000	-1.70	2.70
		K-12 LD	.000	.842	1.000	-2.10	2.10
Principle 28	K-12 all	Multimedia	-.500	.879	1.000	-2.70	1.70
		K-12 LD	-.500	.806	1.000	-2.51	1.51
	K-12 LD	Multimedia	.000	.842	1.000	-2.10	2.10
		K-12 all	.500	.806	1.000	-1.51	2.51
Principle 29	Multimedia	K-12 all	-.452	.882	1.000	-2.66	1.75
		K-12 LD	.686	.845	1.000	-1.43	2.80

Multiple Comparisons

Bonferroni

Dependent Variable	(I) GROUP	(J) GROUP	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Principle 29	K-12 all	Multimedia	.452	.882	1.000	-1.75	2.66
		K-12 LD	1.139	.809	.501	-.88	3.16
	K-12 LD	Multimedia	-.686	.845	1.000	-2.80	1.43
		K-12 all	-1.139	.809	.501	-3.16	.88
Principle 30	Multimedia	K-12 all	-.214	.960	1.000	-2.61	2.18
		K-12 LD	-1.029	.920	.809	-3.33	1.27
	K-12 all	Multimedia	.214	.960	1.000	-2.18	2.61
		K-12 LD	-.815	.881	1.000	-3.02	1.39
	K-12 LD	Multimedia	1.029	.920	.809	-1.27	3.33
		K-12 all	.815	.881	1.000	-1.39	3.02
Principle 31	Multimedia	K-12 all	-.048	.990	1.000	-2.52	2.43
		K-12 LD	-.539	.949	1.000	-2.91	1.83
	K-12 all	Multimedia	.048	.990	1.000	-2.43	2.52
		K-12 LD	-.492	.909	1.000	-2.76	1.78
	K-12 LD	Multimedia	.539	.949	1.000	-1.83	2.91
		K-12 all	.492	.909	1.000	-1.78	2.76
Principle 32	Multimedia	K-12 all	-1.357	.716	.196	-3.15	.43
		K-12 LD	-1.147	.686	.308	-2.86	.57

	K-12 all	Multimedia	1.357	.716	.196	-.43	3.15
		K-12 LD	.210	.657	1.000	-1.43	1.85
	K-12 LD	Multimedia	1.147	.686	.308	-.57	2.86
		K-12 all	-.210	.657	1.000	-1.85	1.43
Principle 33	Multimedia	K-12 all	.714	.917	1.000	-1.58	3.01
		K-12 LD	-.912	.879	.918	-3.11	1.29
	K-12 all	Multimedia	-.714	.917	1.000	-3.01	1.58
		K-12 LD	-1.626	.842	.181	-3.73	.48
	K-12 LD	Multimedia	.912	.879	.918	-1.29	3.11
		K-12 all	1.626	.842	.181	-.48	3.73
Principle 34	Multimedia	K-12 all	.690	.946	1.000	-1.67	3.06
		K-12 LD	1.245	.907	.532	-1.02	3.51
	K-12 all	Multimedia	-.690	.946	1.000	-3.06	1.67
		K-12 LD	.555	.868	1.000	-1.61	2.72
	K-12 LD	Multimedia	-1.245	.907	.532	-3.51	1.02
		K-12 all	-.555	.868	1.000	-2.72	1.61

Multiple Comparisons

Bonferroni

Dependent Variable	(I) GROUP	(J) GROUP	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Principle 35	Multimedia	K-12 all	.786	.937	1.000	-1.56	3.13
		K-12 LD	.559	.898	1.000	-1.68	2.80
	K-12 all	Multimedia	-.786	.937	1.000	-3.13	1.56
		K-12 LD	-.227	.859	1.000	-2.37	1.92
	K-12 LD	Multimedia	-.559	.898	1.000	-2.80	1.68
		K-12 all	.227	.859	1.000	-1.92	2.37
Principle 36	Multimedia	K-12 all	.536	.887	1.000	-1.68	2.75
		K-12 LD	-.338	.850	1.000	-2.46	1.79
	K-12 all	Multimedia	-.536	.887	1.000	-2.75	1.68
		K-12 LD	-.874	.813	.867	-2.91	1.16
	K-12 LD	Multimedia	.338	.850	1.000	-1.79	2.46

		K-12 all	.874	.813	.867	-1.16	2.91
	Multimedia	K-12 all	.869	.695	.655	-.87	2.61
		K-12 LD	-.623	.666	1.000	-2.29	1.04
Principle 37	K-12 all	Multimedia	-.869	.695	.655	-2.61	.87
		K-12 LD	-1.492	.637	.073	-3.08	.10
	K-12 LD	Multimedia	.623	.666	1.000	-1.04	2.29
		K-12 all	1.492	.637	.073	-.10	3.08
Principle 38	Multimedia	K-12 all	.667	.728	1.000	-1.15	2.49
		K-12 LD	-.186	.698	1.000	-1.93	1.56
	K-12 all	Multimedia	-.667	.728	1.000	-2.49	1.15
		K-12 LD	-.853	.668	.627	-2.52	.82
	K-12 LD	Multimedia	.186	.698	1.000	-1.56	1.93
		K-12 all	.853	.668	.627	-.82	2.52
Principle 39	Multimedia	K-12 all	-.095	.714	1.000	-1.88	1.69
		K-12 LD	-.961	.684	.503	-2.67	.75
	K-12 all	Multimedia	.095	.714	1.000	-1.69	1.88
		K-12 LD	-.866	.655	.581	-2.50	.77
	K-12 LD	Multimedia	.961	.684	.503	-.75	2.67
		K-12 all	.866	.655	.581	-.77	2.50
Principle 40	Multimedia	K-12 all	-.048	.852	1.000	-2.18	2.08
		K-12 LD	1.078	.817	.582	-.96	3.12
	K-12 all	Multimedia	.048	.852	1.000	-2.08	2.18
		K-12 LD	1.126	.782	.472	-.83	3.08

Multiple Comparisons

Bonferroni

Dependent Variable	(I) GROUP	(J) GROUP	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Principle 40	K-12 LD	Multimedia	-1.078	.817	.582	-3.12	.96
		K-12 all	-1.126	.782	.472	-3.08	.83

*. The mean difference is significant at the 0.05 level.

Table 2.7 Correlations

		P1	P2	P3	P4	P5	P6	P7	P8	P9
Principle 1	Pearson Correlation	1	.002	.066	-.108	-.242	.171	-.147	.241	.381*
	Sig. (2-tailed)		.989	.674	.493	.118	.272	.348	.119	.012
	N	43	43	43	43	43	43	43	43	43
Principle 2	Pearson Correlation	.002	1	-.016	.196	.173	-.140	-.067	-.166	-.430**
	Sig. (2-tailed)	.989		.917	.208	.267	.370	.671	.289	.004
	N	43	43	43	43	43	43	43	43	43
Principle 3	Pearson Correlation	.066	-.016	1	-.166	.022	-.020	-.051	-.184	-.094
	Sig. (2-tailed)	.674	.917		.288	.889	.897	.744	.236	.547
	N	43	43	43	43	43	43	43	43	43
Principle 4	Pearson Correlation	-.108	.196	-.166	1	.157	-.283	.156	-.025	-.005
	Sig. (2-tailed)	.493	.208	.288		.316	.066	.317	.873	.973
	N	43	43	43	43	43	43	43	43	43
Principle 5	Pearson Correlation	-.242	.173	.022	.157	1	-.105	-.165	.203	-.092
	Sig. (2-tailed)	.118	.267	.889	.316		.501	.292	.191	.556
	N	43	43	43	43	43	43	43	43	43
Principle 6	Pearson Correlation	.171	-.140	-.020	-.283	-.105	1	-.144	.105	.059
	Sig. (2-tailed)	.272	.370	.897	.066	.501		.356	.504	.707
	N	43	43	43	43	43	43	43	43	43
Principle 7	Pearson Correlation	-.147	-.067	-.051	.156	-.165	-.144	1	-.303*	-.077
	Sig. (2-tailed)	.348	.671	.744	.317	.292	.356		.048	.624
	N	43	43	43	43	43	43	43	43	43
Principle 8	Pearson Correlation	.241	-.166	-.184	-.025	.203	.105	-.303*	1	.545**

	Sig. (2-tailed)	.119	.289	.236	.873	.191	.504	.048		.000
	N	43	43	43	43	43	43	43	43	43
Principle 9	Pearson Correlation	.381*	-.430**	-.094	-.005	-.092	.059	-.077	.545**	1
	Sig. (2-tailed)	.012	.004	.547	.973	.556	.707	.624	.000	
	N	43	43	43	43	43	43	43	43	43
Principle 10	Pearson Correlation	.046	-.100	.027	-.299	-.276	.035	.141	.092	.146
	Sig. (2-tailed)	.769	.522	.863	.051	.073	.825	.368	.556	.350

Correlations

		P10	P11	P12	P13	P14	P15	P16	P17	P18
Principle 1	Pearson Correlation	.046	-.089	-.021	-.111	.236	-.154	-.108	.388	-.039*
	Sig. (2-tailed)	.769	.570	.892	.477	.128	.323	.489	.010	.806
	N	43	43	43	43	43	43	43	43	43
Principle 2	Pearson Correlation	-.100	-.336	-.031	-.085	-.267	.205	.202	-.151	.195**
	Sig. (2-tailed)	.522	.027	.845	.590	.084	.188	.195	.334	.210
	N	43	43	43	43	43	43	43	43	43
Principle 3	Pearson Correlation	.027	.108	.080	-.027	.173	.134	-.140	-.057	-.013
	Sig. (2-tailed)	.863	.489	.612	.863	.268	.393	.369	.718	.933
	N	43	43	43	43	43	43	43	43	43
Principle 4	Pearson Correlation	-.299	-.165	.108	.090	.183	.196	.042	.142	.022
	Sig. (2-tailed)	.051	.291	.489	.565	.241	.207	.788	.365	.887
	N	43	43	43	43	43	43	43	43	43
Principle 5	Pearson Correlation	-.276	.169	-.107	-.043	.094	-.222	-.111	-.085	.059
	Sig. (2-tailed)	.073	.279	.495	.786	.549	.153	.479	.587	.709
	N	43	43	43	43	43	43	43	43	43

Principle 6	Pearson Correlation	.035	-.024	.185	.020	-.048	.122	-.230	.127	-.120
	Sig. (2-tailed)	.825	.878	.234	.897	.759	.436	.137	.417	.444
	N	43	43	43	43	43	43	43	43	43
Principle 7	Pearson Correlation	.141	.124	-.055	.110	-.007	-.068	.030	.117*	-.320
	Sig. (2-tailed)	.368	.429	.725	.483	.963	.667	.848	.454	.036
	N	43	43	43	43	43	43	43	43	43
Principle 8	Pearson Correlation	.092	.177	-.057	-.058	-.012	-.334	-.005*	-.072	-.099**
	Sig. (2-tailed)	.556	.257	.718	.711	.942	.029	.975	.646	.527
	N	43	43	43	43	43	43	43	43	43
Principle 9	Pearson Correlation	.146*	.136**	-.130	-.091	.183	-.263	-.118	-.072**	-.180
	Sig. (2-tailed)	.350	.384	.405	.563	.241	.089	.451	.644	.248
	N	43	43	43	43	43	43	43	43	43
Principle 10	Pearson Correlation	1	.267	.165	.258	-.043	.096	-.171	-.028	-.239
	Sig. (2-tailed)		.083	.290	.095	.784	.538	.272	.861	.123

Correlations

		P19	P20	P21	P22	P23	P24	P25	P26	P27
Principle 1	Pearson Correlation	-.160	-.291	.148	.229	-.145	.097	-.018	.145	.187*
	Sig. (2-tailed)	.306	.058	.342	.140	.353	.534	.909	.353	.231
	N	43	43	43	43	43	43	43	43	43
Principle 2	Pearson Correlation	.059	.008	.069	-.057	-.335	-.017	.086	-.271	-.346**
	Sig. (2-tailed)	.706	.961	.661	.719	.028	.913	.583	.079	.023
	N	43	43	43	43	43	43	43	43	43
Principle 3	Pearson Correlation	-.148	-.309	.159	.363	.341	.062	-.224	.135	.243

	Sig. (2-tailed)	.345	.044	.307	.017	.025	.693	.148	.388	.117
	N	43	43	43	43	43	43	43	43	43
Principle 4	Pearson Correlation	-.030	.146	.113	-.227	-.104	-.181	.074	-.283	-.380
	Sig. (2-tailed)	.847	.350	.470	.144	.506	.246	.639	.066	.012
	N	43	43	43	43	43	43	43	43	43
Principle 5	Pearson Correlation	.496	-.142	.149	.040	-.011	-.214	-.177	-.265	-.503
	Sig. (2-tailed)	.001	.363	.339	.797	.943	.168	.256	.086	.001
	N	43	43	43	43	43	43	43	43	43
Principle 6	Pearson Correlation	.074	-.114	.079	.053	.014	.054	-.138	.034	.158
	Sig. (2-tailed)	.638	.469	.616	.738	.929	.731	.379	.830	.312
	N	43	43	43	43	43	43	43	43	43
Principle 7	Pearson Correlation	-.025	-.093	-.285	-.250	.248	.109	-.045	.016*	-.158
	Sig. (2-tailed)	.874	.555	.064	.105	.109	.488	.772	.918	.310
	N	43	43	43	43	43	43	43	43	43
Principle 8	Pearson Correlation	.121	-.019	.171	.031	-.456	-.032	.099*	.067	.212**
	Sig. (2-tailed)	.438	.904	.274	.841	.002	.841	.529	.669	.172
	N	43	43	43	43	43	43	43	43	43
Principle 9	Pearson Correlation	.192*	.026**	.096	.012	-.142	-.221	.048	.242**	.219
	Sig. (2-tailed)	.218	.868	.538	.941	.365	.155	.762	.118	.159
	N	43	43	43	43	43	43	43	43	43
Principle 10	Pearson Correlation	.074	-.076	-.425	.024	.000	.231	-.053	.029	.349
	Sig. (2-tailed)	.636	.628	.004	.878	.998	.136	.735	.855	.022

Correlations

	P28	P29	P30	P31	P32	P33	P34	P35	P36

Principle 1	Pearson Correlation	-.006	-.297	-.342	-.338	.003	-.257	-.054	.082	-.391*
	Sig. (2-tailed)	.967	.053	.025	.026	.983	.097	.732	.600	.010
	N	43	43	43	43	43	43	43	43	43
Principle 2	Pearson Correlation	.060	-.003	.208	.165	.117	.243	-.311	-.175	-.059**
	Sig. (2-tailed)	.704	.985	.181	.291	.455	.117	.042	.263	.706
	N	43	43	43	43	43	43	43	43	43
Principle 3	Pearson Correlation	-.028	.182	-.209	-.291	-.209	-.158	-.352	-.118	-.207
	Sig. (2-tailed)	.857	.242	.178	.058	.179	.313	.021	.450	.184
	N	43	43	43	43	43	43	43	43	43
Principle 4	Pearson Correlation	-.100	.242	-.094	.300	-.135	-.111	-.190	-.131	-.211
	Sig. (2-tailed)	.522	.118	.549	.051	.388	.477	.223	.403	.175
	N	43	43	43	43	43	43	43	43	43
Principle 5	Pearson Correlation	.094	.267	-.113	.138	-.023	-.003	-.063	-.081	-.045
	Sig. (2-tailed)	.548	.084	.470	.378	.883	.983	.689	.604	.777
	N	43	43	43	43	43	43	43	43	43
Principle 6	Pearson Correlation	.202	-.203	-.014	-.180	.043	-.110	.104	-.078	-.010
	Sig. (2-tailed)	.193	.192	.929	.249	.786	.483	.506	.621	.948
	N	43	43	43	43	43	43	43	43	43
Principle 7	Pearson Correlation	-.044	.236	.199	.235	-.247	-.019	-.051	-.168*	.067
	Sig. (2-tailed)	.778	.128	.201	.130	.111	.904	.746	.282	.671
	N	43	43	43	43	43	43	43	43	43
Principle 8	Pearson Correlation	.029	-.362	-.126	-.257	-.041	-.125	.152*	.154	-.295**
	Sig. (2-tailed)	.853	.017	.421	.096	.794	.425	.329	.325	.055
	N	43	43	43	43	43	43	43	43	43

Principle 9	Pearson Correlation	.025*	-.302**	-.052	-.267	-.035	-.273	.222	.107**	-.323
	Sig. (2-tailed)	.874	.049	.739	.083	.822	.077	.153	.496	.034
	N	43	43	43	43	43	43	43	43	43
Principle 10	Pearson Correlation	.022	-.148	-.273	-.009	-.134	.048	-.062	-.048	.073
	Sig. (2-tailed)	.890	.342	.076	.957	.390	.759	.691	.760	.641

Correlations

		P37	P38	P39	P40
Principle 1	Pearson Correlation	-.107	-.163	.330	-.170
	Sig. (2-tailed)	.494	.298	.031	.276
	N	43	43	43	43
Principle 2	Pearson Correlation	.222	-.006	.285	-.076
	Sig. (2-tailed)	.153	.969	.064	.630
	N	43	43	43	43
Principle 3	Pearson Correlation	.004	-.041	-.135	.137
	Sig. (2-tailed)	.980	.793	.389	.381
	N	43	43	43	43
Principle 4	Pearson Correlation	.019	-.177	-.008	.068
	Sig. (2-tailed)	.902	.257	.961	.667
	N	43	43	43	43
Principle 5	Pearson Correlation	.229	-.084	-.182	.067
	Sig. (2-tailed)	.140	.591	.242	.668
	N	43	43	43	43
Principle 6	Pearson Correlation	-.173	-.062	.000	-.375
	Sig. (2-tailed)	.266	.695	1.000	.013
	N	43	43	43	43
Principle 7	Pearson Correlation	-.203	-.086	-.140	.281
	Sig. (2-tailed)	.192	.584	.369	.068
	N	43	43	43	43
Principle 8	Pearson Correlation	.011	.029	-.112	-.277

	Sig. (2-tailed)	.947	.854	.474	.072
	N	43	43	43	43
	Pearson Correlation	-.192*	-.010**	-.039	-.317
Principle 9	Sig. (2-tailed)	.218	.948	.805	.038
	N	43	43	43	43
Principle 10	Pearson Correlation	-.201	-.251	-.072	-.084
	Sig. (2-tailed)	.196	.104	.645	.594

Correlations

		P1	P2	P3	P4	P5	P6	P7	P8	P9
Principle 10	N	43	43	43	43	43	43	43	43	43*
Principle 11	Pearson Correlation	-.089	-.336	.108	-.165	.169	-.024	.124	.177	.136
	Sig. (2-tailed)	.570	.027	.489	.291	.279	.878	.429	.257	.384
	N	43	43	43	43	43	43	43	43	43**
Principle 12	Pearson Correlation	-.021	-.031	.080	.108	-.107	.185	-.055	-.057	-.130
	Sig. (2-tailed)	.892	.845	.612	.489	.495	.234	.725	.718	.405
	N	43	43	43	43	43	43	43	43	43
Principle 13	Pearson Correlation	-.111	-.085	-.027	.090	-.043	.020	.110	-.058	-.091
	Sig. (2-tailed)	.477	.590	.863	.565	.786	.897	.483	.711	.563
	N	43	43	43	43	43	43	43	43	43
Principle 14	Pearson Correlation	.236	-.267	.173	.183	.094	-.048	-.007	-.012	.183
	Sig. (2-tailed)	.128	.084	.268	.241	.549	.759	.963	.942	.241
	N	43	43	43	43	43	43	43	43	43
Principle 15	Pearson Correlation	-.154	.205	.134	.196	-.222	.122	-.068	-.334	-.263
	Sig. (2-tailed)	.323	.188	.393	.207	.153	.436	.667	.029	.089
	N	43	43	43	43	43	43	43	43	43

Principle 16	Pearson Correlation	-.108	.202	-.140	.042	-.111	-.230	.030	-.005	-.118
	Sig. (2-tailed)	.489	.195	.369	.788	.479	.137	.848	.975	.451
	N	43	43	43	43	43	43	43	43*	43
Principle 17	Pearson Correlation	.388	-.151	-.057	.142	-.085	.127	.117	-.072	-.072
	Sig. (2-tailed)	.010	.334	.718	.365	.587	.417	.454	.646	.644
	N	43	43	43	43	43	43	43*	43	43**
Principle 18	Pearson Correlation	-.039	.195	-.013	.022	.059	-.120	-.320	-.099	-.180
	Sig. (2-tailed)	.806	.210	.933	.887	.709	.444	.036	.527	.248
	N	43*	43**	43	43	43	43	43	43**	43
Principle 19	Pearson Correlation	-.160	.059	-.148	-.030	.496	.074	-.025	.121	.192
	Sig. (2-tailed)	.306	.706	.345	.847	.001	.638	.874	.438	.218
	N	43	43	43	43	43	43	43	43	43
Principle 20	Pearson Correlation	-.291	.008	-.309	.146	-.142	-.114	-.093	-.019	.026

Correlations

		P10	P11	P12	P13	P14	P15	P16	P17	P18
Principle 10	N	43	43	43	43	43	43	43	43	43*
Principle 11	Pearson Correlation	.267	1	-.025	.049	.000	-.239	-.007	.101	-.009
	Sig. (2-tailed)	.083		.873	.755	.999	.123	.962	.519	.957
	N	43	43	43	43	43	43	43	43	43**
Principle 12	Pearson Correlation	.165	-.025	1	.148	.249	.240	-.329	.139	-.023
	Sig. (2-tailed)	.290	.873		.343	.108	.121	.031	.374	.886
	N	43	43	43	43	43	43	43	43	43
Principle 13	Pearson Correlation	.258	.049	.148	1	.011	.377	-.288	-.081	.081

	Sig. (2-tailed)	.095	.755	.343		.945	.013	.061	.604	.607
	N	43	43	43	43	43	43	43	43	43
Principle 14	Pearson Correlation	-.043	.000	.249	.011	1	.073	-.344	.554	-.142
	Sig. (2-tailed)	.784	.999	.108	.945		.642	.024	.000	.363
	N	43	43	43	43	43	43	43	43	43
Principle 15	Pearson Correlation	.096	-.239	.240	.377	.073	1	-.236	-.113	.006
	Sig. (2-tailed)	.538	.123	.121	.013	.642		.128	.469	.969
	N	43	43	43	43	43	43	43	43	43
Principle 16	Pearson Correlation	-.171	-.007	-.329	-.288	-.344	-.236	1	-.169	.207
	Sig. (2-tailed)	.272	.962	.031	.061	.024	.128		.278	.183
	N	43	43	43	43	43	43	43	43^{*}	43
Principle 17	Pearson Correlation	-.028	.101	.139	-.081	.554	-.113	-.169	1	-.153
	Sig. (2-tailed)	.861	.519	.374	.604	.000	.469	.278		.328
	N	43	43	43	43	43	43	43^{*}	43	43^{**}
Principle 18	Pearson Correlation	-.239	-.009	-.023	.081	-.142	.006	.207	-.153	1
	Sig. (2-tailed)	.123	.957	.886	.607	.363	.969	.183	.328	
	N	43^{*}	43^{**}	43	43	43	43	43	43^{**}	43
Principle 19	Pearson Correlation	.074	.219	-.230	-.067	-.090	-.129	.057	-.211	.117
	Sig. (2-tailed)	.636	.159	.138	.670	.566	.410	.714	.175	.453
	N	43	43	43	43	43	43	43	43	43
Principle 20	Pearson Correlation	-.076	-.133	-.193	-.058	-.462	-.085	.522	-.254	.269

Correlations

		P19	P20	P21	P22	P23	P24	P25	P26	P27
Principle 10	N	43	43	43	43	43	43	43	43	43^{*}

Principle 11	Pearson Correlation	.219	-.133	-.394	.203	.316	.085	-.143	.033	.145
	Sig. (2-tailed)	.159	.397	.009	.192	.039	.587	.361	.835	.352
	N	43	43	43	43	43	43	43	43	43**
Principle 12	Pearson Correlation	-.230	-.193	-.115	-.048	-.090	.025	-.069	.006	.058
	Sig. (2-tailed)	.138	.215	.462	.758	.564	.873	.662	.969	.710
	N	43	43	43	43	43	43	43	43	43
Principle 13	Pearson Correlation	-.067	-.058	-.349	-.154	.291	-.178	-.181	.014	.054
	Sig. (2-tailed)	.670	.714	.022	.325	.058	.253	.245	.927	.730
	N	43	43	43	43	43	43	43	43	43
Principle 14	Pearson Correlation	-.090	-.462	.130	.424	.214	-.216	-.116	.164	-.248
	Sig. (2-tailed)	.566	.002	.407	.005	.168	.164	.460	.294	.108
	N	43	43	43	43	43	43	43	43	43
Principle 15	Pearson Correlation	-.129	-.085	-.024	.058	.103	-.339	-.066	.117	-.035
	Sig. (2-tailed)	.410	.588	.877	.714	.509	.026	.674	.454	.823
	N	43	43	43	43	43	43	43	43	43
Principle 16	Pearson Correlation	.057	.522	-.087	-.301	-.209	.297	.236	-.101	-.080
	Sig. (2-tailed)	.714	.000	.580	.050	.179	.053	.127	.518	.610
	N	43	43	43	43	43	43	43	43*	43
Principle 17	Pearson Correlation	-.211	-.254	.008	.330	.066	.128	.024	-.085	-.052
	Sig. (2-tailed)	.175	.101	.962	.031	.674	.413	.880	.586	.740
	N	43	43	43	43	43	43	43*	43	43**
Principle 18	Pearson Correlation	.117	.269	.074	-.080	-.071	-.114	.003	.017	.058
	Sig. (2-tailed)	.453	.081	.639	.609	.650	.465	.983	.914	.710
	N	43*	43**	43	43	43	43	43	43**	43

Principle 19	Pearson Correlation	1	.038	.085	-.008	-.006	-.324	-.128	-.180	-.181
	Sig. (2-tailed)		.811	.589	.961	.972	.034	.415	.249	.244
	N	43	43	43	43	43	43	43	43	43
Principle 20	Pearson Correlation	.038	1	-.036	-.480	-.360	.055	.313	-.073	.018

Correlations

		P28	P29	P30	P31	P32	P33	P34	P35	P36
Principle 10	N	43	43	43	43	43	43	43	43	43*
Principle 11	Pearson Correlation	.174	-.071	-.303	-.418	-.224	-.209	.189	.129	-.004
	Sig. (2-tailed)	.265	.651	.048	.005	.148	.179	.225	.410	.982
	N	43	43	43	43	43	43	43	43	43**
Principle 12	Pearson Correlation	.189	.114	-.082	-.054	-.273	-.096	-.406	-.103	-.026
	Sig. (2-tailed)	.225	.469	.600	.732	.076	.540	.007	.509	.868
	N	43	43	43	43	43	43	43	43	43
Principle 13	Pearson Correlation	-.069	.236	-.262	.200	-.024	.196	-.171	-.424	.104
	Sig. (2-tailed)	.659	.128	.090	.199	.878	.207	.274	.005	.508
	N	43	43	43	43	43	43	43	43	43
Principle 14	Pearson Correlation	-.100	.193	-.332	-.176	-.401	-.269	-.407	-.120	-.178
	Sig. (2-tailed)	.521	.216	.030	.259	.008	.081	.007	.445	.254
	N	43	43	43	43	43	43	43	43	43
Principle 15	Pearson Correlation	-.005	.079	-.104	.234	.049	.233	-.273	-.427	.059
	Sig. (2-tailed)	.976	.614	.508	.131	.756	.133	.077	.004	.709
	N	43	43	43	43	43	43	43	43	43
Principle 16	Pearson Correlation	-.336	-.076	.404	.090	.148	-.008	.169	.064	.081

	Sig. (2-tailed)	.028	.628	.007	.566	.342	.961	.279	.685	.607
	N	43	43	43	43	43	43	43	43*	43
Principle 17	Pearson Correlation	.080	.021	-.410	-.276	-.262	-.316	-.181	.027	-.168
	Sig. (2-tailed)	.610	.894	.006	.073	.090	.039	.246	.864	.280
	N	43	43	43	43	43	43	43*	43	43**
Principle 18	Pearson Correlation	-.227	.075	-.123	-.016	.291	-.020	-.051	-.200	.058
	Sig. (2-tailed)	.143	.631	.433	.921	.059	.900	.744	.199	.712
	N	43*	43**	43	43	43	43	43	43**	43
Principle 19	Pearson Correlation	.070	.116	-.081	.152	-.092	.020	.130	-.160	-.016
	Sig. (2-tailed)	.656	.457	.608	.332	.556	.901	.407	.306	.918
	N	43	43	43	43	43	43	43	43	43
Principle 20	Pearson Correlation	-.151	-.225	.451	.245	.172	.223	.253	.071	-.026

Correlations

		P37	P38	P39	P40
Principle 10	N	43	43	43	43
Principle 11	Pearson Correlation	-.033	-.338	-.387	-.096
	Sig. (2-tailed)	.836	.027	.010	.542
	N	43	43	43	43
Principle 12	Pearson Correlation	-.012	-.026	.049	-.036
	Sig. (2-tailed)	.941	.867	.753	.817
	N	43	43	43	43
Principle 13	Pearson Correlation	-.280	.091	-.194	.104
	Sig. (2-tailed)	.068	.563	.214	.509
	N	43	43	43	43
Principle 14	Pearson Correlation	-.104	-.110	.273	.120
	Sig. (2-tailed)	.506	.484	.077	.442
	N	43	43	43	43

	Pearson Correlation	-.206	-.065	.199	-.060
Principle 15	Sig. (2-tailed)	.186	.680	.201	.702
	N	43	43	43	43
	Pearson Correlation	.234	-.139	-.232	-.147
Principle 16	Sig. (2-tailed)	.131	.374	.135	.346
	N	43	43	43	43
	Pearson Correlation	-.010	-.313	.249	.096
Principle 17	Sig. (2-tailed)	.947	.041	.107	.541
	N	43	43	43	43
	Pearson Correlation	.166	-.168	.008	-.122
Principle 18	Sig. (2-tailed)	.288	.282	.959	.437
	N	43*	43**	43	43
	Pearson Correlation	-.033	-.120	-.285	-.338
Principle 19	Sig. (2-tailed)	.833	.445	.064	.027
	N	43	43	43	43
Principle 20	Pearson Correlation	-.032	-.098	-.227	-.112

Correlations

		P1	P2	P3	P4	P5	P6	P7	P8	P9
Principle 20	Sig. (2-tailed)	.058	.961	.044	.350	.363	.469	.555	.904	.868*
	N	43	43	43	43	43	43	43	43	43
Principle 21	Pearson Correlation	.148	.069	.159	.113	.149	.079	-.285	.171	.096
	Sig. (2-tailed)	.342	.661	.307	.470	.339	.616	.064	.274	.538**
	N	43	43	43	43	43	43	43	43	43
Principle 22	Pearson Correlation	.229	-.057	.363	-.227	.040	.053	-.250	.031	.012
	Sig. (2-tailed)	.140	.719	.017	.144	.797	.738	.105	.841	.941
	N	43	43	43	43	43	43	43	43	43
Principle 23	Pearson Correlation	-.145	-.335	.341	-.104	-.011	.014	.248	-.456	-.142
	Sig. (2-tailed)	.353	.028	.025	.506	.943	.929	.109	.002	.365

	N	43	43	43	43	43	43	43	43	43
Principle 24	Pearson Correlation	.097	-.017	.062	-.181	-.214	.054	.109	-.032	-.221
	Sig. (2-tailed)	.534	.913	.693	.246	.168	.731	.488	.841	.155
	N	43	43	43	43	43	43	43	43	43
Principle 25	Pearson Correlation	-.018	.086	-.224	.074	-.177	-.138	-.045	.099	.048
	Sig. (2-tailed)	.909	.583	.148	.639	.256	.379	.772	.529	.762
	N	43	43	43	43	43	43	43	43	43
Principle 26	Pearson Correlation	.145	-.271	.135	-.283	-.265	.034	.016	.067	.242
	Sig. (2-tailed)	.353	.079	.388	.066	.086	.830	.918	.669*	.118
	N	43	43	43	43	43	43	43	43	43
Principle 27	Pearson Correlation	.187	-.346	.243	-.380	-.503	.158	-.158	.212	.219
	Sig. (2-tailed)	.231	.023	.117	.012	.001	.312	.310*	.172	.159**
	N	43	43	43	43	43	43	43	43	43
Principle 28	Pearson Correlation	-.006	.060	-.028	-.100	.094	.202	-.044	.029	.025
	Sig. (2-tailed)	.967*	.704**	.857	.522	.548	.193	.778	.853**	.874
	N	43	43	43	43	43	43	43	43	43
Principle 29	Pearson Correlation	-.297	-.003	.182	.242	.267	-.203	.236	-.362	-.302
	Sig. (2-tailed)	.053	.985	.242	.118	.084	.192	.128	.017	.049
	N	43	43	43	43	43	43	43	43	43

Correlations

		P10	P11	P12	P13	P14	P15	P16	P17	P18
Principle 20	Sig. (2-tailed)	.628	.397	.215	.714	.002	.588	.000	.101	.081*
	N	43	43	43	43	43	43	43	43	43
Principle 21	Pearson Correlation	-.425	-.394	-.115	-.349	.130	-.024	-.087	.008	.074

	Sig. (2-tailed)	.004	.009	.462	.022	.407	.877	.580	.962	.639**
	N	43	43	43	43	43	43	43	43	43
Principle 22	Pearson Correlation	.024	.203	-.048	-.154	.424	.058	-.301	.330	-.080
	Sig. (2-tailed)	.878	.192	.758	.325	.005	.714	.050	.031	.609
	N	43	43	43	43	43	43	43	43	43
Principle 23	Pearson Correlation	.000	.316	-.090	.291	.214	.103	-.209	.066	-.071
	Sig. (2-tailed)	.998	.039	.564	.058	.168	.509	.179	.674	.650
	N	43	43	43	43	43	43	43	43	43
Principle 24	Pearson Correlation	.231	.085	.025	-.178	-.216	-.339	.297	.128	-.114
	Sig. (2-tailed)	.136	.587	.873	.253	.164	.026	.053	.413	.465
	N	43	43	43	43	43	43	43	43	43
Principle 25	Pearson Correlation	-.053	-.143	-.069	-.181	-.116	-.066	.236	.024	.003
	Sig. (2-tailed)	.735	.361	.662	.245	.460	.674	.127	.880	.983
	N	43	43	43	43	43	43	43	43	43
Principle 26	Pearson Correlation	.029	.033	.006	.014	.164	.117	-.101	-.085	.017
	Sig. (2-tailed)	.855	.835	.969	.927	.294	.454	.518	.586*	.914
	N	43	43	43	43	43	43	43	43	43
Principle 27	Pearson Correlation	.349	.145	.058	.054	-.248	-.035	-.080	-.052	.058
	Sig. (2-tailed)	.022	.352	.710	.730	.108	.823	.610*	.740	.710**
	N	43	43	43	43	43	43	43	43	43
Principle 28	Pearson Correlation	.022	.174	.189	-.069	-.100	-.005	-.336	.080	-.227
	Sig. (2-tailed)	.890*	.265**	.225	.659	.521	.976	.028	.610**	.143
	N	43	43	43	43	43	43	43	43	43
Principle 29	Pearson Correlation	-.148	-.071	.114	.236	.193	.079	-.076	.021	.075

	Sig. (2-tailed)	.342	.651	.469	.128	.216	.614	.628	.894	.631
	N	43	43	43	43	43	43	43	43	43

Correlations

		P19	P20	P21	P22	P23	P24	P25	P26	P27
Principle 20	Sig. (2-tailed)	.811		.818	.001	.018	.728	.041	.641	.907*
	N	43	43	43	43	43	43	43	43	43
Principle 21	Pearson Correlation	.085	-.036	1	.083	-.316	-.245	-.277	-.066	.096
	Sig. (2-tailed)	.589	.818		.595	.039	.113	.072	.674	.539**
	N	43	43	43	43	43	43	43	43	43
Principle 22	Pearson Correlation	-.008	-.480	.083	1	.226	-.144	-.060	.085	.223
	Sig. (2-tailed)	.961	.001	.595		.146	.358	.704	.588	.151
	N	43	43	43	43	43	43	43	43	43
Principle 23	Pearson Correlation	-.006	-.360	-.316	.226	1	.079	-.229	.126	-.064
	Sig. (2-tailed)	.972	.018	.039	.146		.614	.139	.422	.682
	N	43	43	43	43	43	43	43	43	43
Principle 24	Pearson Correlation	-.324	.055	-.245	-.144	.079	1	.040	-.155	.114
	Sig. (2-tailed)	.034	.728	.113	.358	.614		.797	.322	.468
	N	43	43	43	43	43	43	43	43	43
Principle 25	Pearson Correlation	-.128	.313	-.277	-.060	-.229	.040	1	.091	-.101
	Sig. (2-tailed)	.415	.041	.072	.704	.139	.797		.560	.520
	N	43	43	43	43	43	43	43	43	43
Principle 26	Pearson Correlation	-.180	-.073	-.066	.085	.126	-.155	.091	1	.217
	Sig. (2-tailed)	.249	.641	.674	.588	.422	.322	.560		.162
	N	43	43	43	43	43	43	43	43	43

Principle 27	Pearson Correlation	-.181	.018	.096	.223	-.064	.114	-.101	.217	1
	Sig. (2-tailed)	.244	.907	.539	.151	.682	.468	.520*	.162	
	N	43	43	43	43	43	43	43	43	43
Principle 28	Pearson Correlation	.070	-.151	.043	.075	-.153	-.223	-.212	-.198	-.036
	Sig. (2-tailed)	.656*	.335**	.782	.633	.328	.150	.173	.203**	.817
	N	43	43	43	43	43	43	43	43	43
Principle 29	Pearson Correlation	.116	-.225	-.020	-.020	.344	-.042	-.124	-.163	-.255
	Sig. (2-tailed)	.457	.146	.897	.900	.024	.789	.429	.297	.099
	N	43	43	43	43	43	43	43	43	43

Correlations

		P28	P29	P30	P31	P32	P33	P34	P35	P36
Principle 20	Sig. (2-tailed)	.335	.146	.002	.114	.270	.150	.102	.649	.870*
	N	43	43	43	43	43	43	43	43	43
Principle 21	Pearson Correlation	.043	-.020	.071	-.026	-.035	-.239	.008	.032	-.288
	Sig. (2-tailed)	.782	.897	.653	.868	.825	.122	.957	.836	.061**
	N	43	43	43	43	43	43	43	43	43
Principle 22	Pearson Correlation	.075	-.020	-.347	-.492	-.097	-.305	-.100	-.040	-.143
	Sig. (2-tailed)	.633	.900	.023	.001	.535	.046	.524	.798	.360
	N	43	43	43	43	43	43	43	43	43
Principle 23	Pearson Correlation	-.153	.344	-.253	-.021	-.028	-.139	.011	-.085	.218
	Sig. (2-tailed)	.328	.024	.101	.893	.858	.372	.944	.590	.160
	N	43	43	43	43	43	43	43	43	43
Principle 24	Pearson Correlation	-.223	-.042	-.052	.042	.255	-.052	-.094	.126	.150
	Sig. (2-tailed)	.150	.789	.740	.790	.099	.740	.547	.420	.336

	N	43	43	43	43	43	43	43	43	43
Principle 25	Pearson Correlation	-.212	-.124	.340	-.035	.090	.014	-.088	.046	-.228
	Sig. (2-tailed)	.173	.429	.025	.825	.567	.932	.574	.771	.142
	N	43	43	43	43	43	43	43	43	43
Principle 26	Pearson Correlation	-.198	-.163	.003	-.146	-.139	-.008	-.040	-.003	-.091
	Sig. (2-tailed)	.203	.297	.985	.350	.372	.961	.800	.985*	.560
	N	43	43	43	43	43	43	43	43	43
Principle 27	Pearson Correlation	-.036	-.255	-.217	-.313	.064	-.102	.268	.088	-.135
	Sig. (2-tailed)	.817	.099	.163	.041	.682	.514	.082*	.573	.388**
	N	43	43	43	43	43	43	43	43	43
Principle 28	Pearson Correlation	1	-.274	-.037	-.243	-.252	.171	.148	.228	-.222
	Sig. (2-tailed)		.076**	.816	.117	.104	.274	.342	.142**	.153
	N	43	43	43	43	43	43	43	43	43
Principle 29	Pearson Correlation	-.274	1	-.034	.157	.031	-.262	-.442	-.436	.153
	Sig. (2-tailed)	.076		.828	.316	.844	.090	.003	.003	.328
	N	43	43	43	43	43	43	43	43	43

Correlations

		P37	P38	P39	P40
Principle 20	Sig. (2-tailed)	.840	.534	.144	.476
	N	43	43	43	43
	Pearson Correlation	.105	.041	.297	.129
Principle 21	Sig. (2-tailed)	.501	.793	.053	.409
	N	43	43	43	43
	Pearson Correlation	-.001	.015	.133	-.056
Principle 22	Sig. (2-tailed)	.996	.926	.394	.721
	N	43	43	43	43

Principle 23	Pearson Correlation	-.312	.030	-.371	.248
	Sig. (2-tailed)	.042	.846	.014	.109
	N	43	43	43	43
Principle 24	Pearson Correlation	.101	-.189	-.186	.114
	Sig. (2-tailed)	.521	.226	.233	.466
	N	43	43	43	43
Principle 25	Pearson Correlation	.123	.096	.223	-.224
	Sig. (2-tailed)	.431	.542	.150	.149
	N	43	43	43	43
Principle 26	Pearson Correlation	-.407	.149	-.040	-.068
	Sig. (2-tailed)	.007	.341	.797	.666
	N	43	43	43	43
Principle 27	Pearson Correlation	-.187	.013	-.089	-.173
	Sig. (2-tailed)	.229	.935	.572	.268
	N	43	43	43	43
Principle 28	Pearson Correlation	.374	.001	.043	-.086
	Sig. (2-tailed)	.013*	.995**	.785	.585
	N	43	43	43	43
Principle 29	Pearson Correlation	.009	-.024	-.068	.529
	Sig. (2-tailed)	.954	.877	.665	.000
	N	43	43	43	43

Correlations

		P1	P2	P3	P4	P5	P6	P7	P8	P9
Principle 30	Pearson Correlation	-.342	.208	-.209	-.094	-.113	-.014	.199	-.126	-.052*
	Sig. (2-tailed)	.025	.181	.178	.549	.470	.929	.201	.421	.739
	N	43	43	43	43	43	43	43	43	43
Principle 31	Pearson Correlation	-.338	.165	-.291	.300	.138	-.180	.235	-.257	-.267**
	Sig. (2-tailed)	.026	.291	.058	.051	.378	.249	.130	.096	.083
	N	43	43	43	43	43	43	43	43	43

Principle 32	Pearson Correlation	.003	.117	-.209	-.135	-.023	.043	-.247	-.041	-.035
	Sig. (2-tailed)	.983	.455	.179	.388	.883	.786	.111	.794	.822
	N	43	43	43	43	43	43	43	43	43
Principle 33	Pearson Correlation	-.257	.243	-.158	-.111	-.003	-.110	-.019	-.125	-.273
	Sig. (2-tailed)	.097	.117	.313	.477	.983	.483	.904	.425	.077
	N	43	43	43	43	43	43	43	43	43
Principle 34	Pearson Correlation	-.054	-.311	-.352	-.190	-.063	.104	-.051	.152	.222
	Sig. (2-tailed)	.732	.042	.021	.223	.689	.506	.746	.329	.153
	N	43	43	43	43	43	43	43	43	43
Principle 35	Pearson Correlation	.082	-.175	-.118	-.131	-.081	-.078	-.168	.154	.107
	Sig. (2-tailed)	.600	.263	.450	.403	.604	.621	.282	.325	.496
	N	43	43	43	43	43	43	43	43	43
Principle 36	Pearson Correlation	-.391	-.059	-.207	-.211	-.045	-.010	.067	-.295*	-.323
	Sig. (2-tailed)	.010	.706	.184	.175	.777	.948	.671	.055	.034
	N	43	43	43	43	43	43	43	43	43
Principle 37	Pearson Correlation	-.107	.222	.004	.019	.229	-.173	-.203*	.011	-.192**
	Sig. (2-tailed)	.494	.153	.980	.902	.140	.266	.192	.947	.218
	N	43	43	43	43	43	43	43	43	43
Principle 38	Pearson Correlation	-.163*	-.006**	-.041	-.177	-.084	-.062	-.086	.029**	-.010
	Sig. (2-tailed)	.298	.969	.793	.257	.591	.695	.584	.854	.948
	N	43	43	43	43	43	43	43	43	43
Principle 39	Pearson Correlation	.330	.285	-.135	-.008	-.182	.000	-.140	-.112	-.039
	Sig. (2-tailed)	.031	.064	.389	.961	.242	1.000	.369	.474	.805

Correlations

		P10	P11	P12	P13	P14	P15	P16	P17	P18
Principle 30	Pearson Correlation	-.273	-.303	-.082	-.262	-.332	-.104	.404	-.410	-.123*
	Sig. (2-tailed)	.076	.048	.600	.090	.030	.508	.007	.006	.433
	N	43	43	43	43	43	43	43	43	43
Principle 31	Pearson Correlation	-.009	-.418	-.054	.200	-.176	.234	.090	-.276	-.016**
	Sig. (2-tailed)	.957	.005	.732	.199	.259	.131	.566	.073	.921
	N	43	43	43	43	43	43	43	43	43
Principle 32	Pearson Correlation	-.134	-.224	-.273	-.024	-.401	.049	.148	-.262	.291
	Sig. (2-tailed)	.390	.148	.076	.878	.008	.756	.342	.090	.059
	N	43	43	43	43	43	43	43	43	43
Principle 33	Pearson Correlation	.048	-.209	-.096	.196	-.269	.233	-.008	-.316	-.020
	Sig. (2-tailed)	.759	.179	.540	.207	.081	.133	.961	.039	.900
	N	43	43	43	43	43	43	43	43	43
Principle 34	Pearson Correlation	-.062	.189	-.406	-.171	-.407	-.273	.169	-.181	-.051
	Sig. (2-tailed)	.691	.225	.007	.274	.007	.077	.279	.246	.744
	N	43	43	43	43	43	43	43	43	43
Principle 35	Pearson Correlation	-.048	.129	-.103	-.424	-.120	-.427	.064	.027	-.200
	Sig. (2-tailed)	.760	.410	.509	.005	.445	.004	.685	.864	.199
	N	43	43	43	43	43	43	43	43	43
Principle 36	Pearson Correlation	.073	-.004	-.026	.104	-.178	.059	.081	-.168*	.058
	Sig. (2-tailed)	.641	.982	.868	.508	.254	.709	.607	.280	.712
	N	43	43	43	43	43	43	43	43	43
Principle 37	Pearson Correlation	-.201	-.033	-.012	-.280	-.104	-.206	.234*	-.010	.166**

	Sig. (2-tailed)	.196	.836	.941	.068	.506	.186	.131	.947	.288
	N	43	43	43	43	43	43	43	43	43
Principle 38	Pearson Correlation	-.251*	-.338**	-.026	.091	-.110	-.065	-.139	-.313**	-.168
	Sig. (2-tailed)	.104	.027	.867	.563	.484	.680	.374	.041	.282
	N	43	43	43	43	43	43	43	43	43
Principle 39	Pearson Correlation	-.072	-.387	.049	-.194	.273	.199	-.232	.249	.008
	Sig. (2-tailed)	.645	.010	.753	.214	.077	.201	.135	.107	.959

Correlations

		P19	P20	P21	P22	P23	P24	P25	P26	P27
Principle 30	Pearson Correlation	-.081	.451	.071	-.347	-.253	-.052	.340	.003	-.217*
	Sig. (2-tailed)	.608	.002	.653	.023	.101	.740	.025	.985	.163
	N	43	43	43	43	43	43	43	43	43
Principle 31	Pearson Correlation	.152	.245	-.026	-.492	-.021	.042	-.035	-.146	-.313**
	Sig. (2-tailed)	.332	.114	.868	.001	.893	.790	.825	.350	.041
	N	43	43	43	43	43	43	43	43	43
Principle 32	Pearson Correlation	-.092	.172	-.035	-.097	-.028	.255	.090	-.139	.064
	Sig. (2-tailed)	.556	.270	.825	.535	.858	.099	.567	.372	.682
	N	43	43	43	43	43	43	43	43	43
Principle 33	Pearson Correlation	.020	.223	-.239	-.305	-.139	-.052	.014	-.008	-.102
	Sig. (2-tailed)	.901	.150	.122	.046	.372	.740	.932	.961	.514
	N	43	43	43	43	43	43	43	43	43
Principle 34	Pearson Correlation	.130	.253	.008	-.100	.011	-.094	-.088	-.040	.268
	Sig. (2-tailed)	.407	.102	.957	.524	.944	.547	.574	.800	.082
	N	43	43	43	43	43	43	43	43	43

Principle 35	Pearson Correlation	-.160	.071	.032	-.040	-.085	.126	.046	-.003	.088
	Sig. (2-tailed)	.306	.649	.836	.798	.590	.420	.771	.985	.573
	N	43	43	43	43	43	43	43	43	43
Principle 36	Pearson Correlation	-.016	-.026	-.288	-.143	.218	.150	-.228	-.091*	-.135
	Sig. (2-tailed)	.918	.870	.061	.360	.160	.336	.142	.560	.388
	N	43	43	43	43	43	43	43	43	43
Principle 37	Pearson Correlation	-.033	-.032	.105	-.001	-.312	.101	.123*	-.407	-.187**
	Sig. (2-tailed)	.833	.840	.501	.996	.042	.521	.431	.007	.229
	N	43	43	43	43	43	43	43	43	43
Principle 38	Pearson Correlation	-.120*	-.098**	.041	.015	.030	-.189	.096	.149**	.013
	Sig. (2-tailed)	.445	.534	.793	.926	.846	.226	.542	.341	.935
	N	43	43	43	43	43	43	43	43	43
Principle 39	Pearson Correlation	-.285	-.227	.297	.133	-.371	-.186	.223	-.040	-.089
	Sig. (2-tailed)	.064	.144	.053	.394	.014	.233	.150	.797	.572

Correlations

		P28	P29	P30	P31	P32	P33	P34	P35	P36
Principle 30	Pearson Correlation	-.037	-.034	1	.145	.076	.085	.058	.117	.041*
	Sig. (2-tailed)	.816	.828		.355	.629	.588	.713	.454	.796
	N	43	43	43	43	43	43	43	43	43
Principle 31	Pearson Correlation	-.243	.157	.145	1	.105	.325	.076	-.096	.136**
	Sig. (2-tailed)	.117	.316	.355		.504	.033	.627	.540	.385
	N	43	43	43	43	43	43	43	43	43
Principle 32	Pearson Correlation	-.252	.031	.076	.105	1	.130	.144	-.236	.191

	Sig. (2-tailed)	.104	.844	.629	.504		.405	.359	.127	.219
	N	43	43	43	43	43	43	43	43	43
Principle 33	Pearson Correlation	.171	-.262	.085	.325	.130	1	.049	-.045	.203
	Sig. (2-tailed)	.274	.090	.588	.033	.405		.753	.773	.191
	N	43	43	43	43	43	43	43	43	43
Principle 34	Pearson Correlation	.148	-.442	.058	.076	.144	.049	1	.418	.133
	Sig. (2-tailed)	.342	.003	.713	.627	.359	.753		.005	.395
	N	43	43	43	43	43	43	43	43	43
Principle 35	Pearson Correlation	.228	-.436	.117	-.096	-.236	-.045	.418	1	.076
	Sig. (2-tailed)	.142	.003	.454	.540	.127	.773	.005		.626
	N	43	43	43	43	43	43	43	43	43
Principle 36	Pearson Correlation	-.222	.153	.041	.136	.191	.203	.133	.076*	1
	Sig. (2-tailed)	.153	.328	.796	.385	.219	.191	.395	.626	
	N	43	43	43	43	43	43	43	43	43
Principle 37	Pearson Correlation	.374	.009	.139	-.203	.043	-.034	-.071*	.121	.021**
	Sig. (2-tailed)	.013	.954	.374	.191	.784	.828	.649	.439	.895
	N	43	43	43	43	43	43	43	43	43
Principle 38	Pearson Correlation	.001*	-.024**	.266	.029	-.023	.262	.069	.176**	.323
	Sig. (2-tailed)	.995	.877	.084	.852	.881	.089	.659	.259	.035
	N	43	43	43	43	43	43	43	43	43
Principle 39	Pearson Correlation	.043	-.068	.052	-.146	.135	.005	-.172	-.104	-.121
	Sig. (2-tailed)	.785	.665	.739	.351	.388	.975	.270	.506	.440

Correlations

		P37	P38	P39	P40

Principle 30	Pearson Correlation	.139	.266	.052	.006
	Sig. (2-tailed)	.374	.084	.739	.971
	N	43	43	43	43
Principle 31	Pearson Correlation	-.203	.029	-.146	.047
	Sig. (2-tailed)	.191	.852	.351	.765
	N	43	43	43	43
Principle 32	Pearson Correlation	.043	-.023	.135	-.014
	Sig. (2-tailed)	.784	.881	.388	.930
	N	43	43	43	43
Principle 33	Pearson Correlation	-.034	.262	.005	-.055
	Sig. (2-tailed)	.828	.089	.975	.728
	N	43	43	43	43
Principle 34	Pearson Correlation	-.071	.069	-.172	-.219
	Sig. (2-tailed)	.649	.659	.270	.158
	N	43	43	43	43
Principle 35	Pearson Correlation	.121	.176	-.104	-.080
	Sig. (2-tailed)	.439	.259	.506	.609
	N	43	43	43	43
Principle 36	Pearson Correlation	.021	.323	-.121	.194
	Sig. (2-tailed)	.895	.035	.440	.213
	N	43	43	43	43
Principle 37	Pearson Correlation	1	-.056	.231	-.092
	Sig. (2-tailed)		.719	.137	.557
	N	43	43	43	43
Principle 38	Pearson Correlation	-.056*	1**	-.026	.046
	Sig. (2-tailed)	.719		.866	.771
	N	43	43	43	43
Principle 39	Pearson Correlation	.231	-.026	1	.059
	Sig. (2-tailed)	.137	.866		.709

Correlations

	P1	P2	P3	P4	P5	P6	P7	P8	P9

Principle 39	N	43	43	43	43	43	43	43	43	43*
Principle 40	Pearson Correlation	-.170	-.076	.137	.068	.067	-.375	.281	-.277	-.317
	Sig. (2-tailed)	.276	.630	.381	.667	.668	.013	.068	.072	.038
	N	43	43	43	43	43	43	43	43	43**

Correlations

		P10	P11	P12	P13	P14	P15	P16	P17	P18
Principle 39	N	43	43	43	43	43	43	43	43	43*
Principle 40	Pearson Correlation	-.084	-.096	-.036	.104	.120	-.060	-.147	.096	-.122
	Sig. (2-tailed)	.594	.542	.817	.509	.442	.702	.346	.541	.437
	N	43	43	43	43	43	43	43	43	43**

Correlations

		P19	P20	P21	P22	P23	P24	P25	P26	P27
Principle 39	N	43	43	43	43	43	43	43	43	43*
Principle 40	Pearson Correlation	-.338	-.112	.129	-.056	.248	.114	-.224	-.068	-.173
	Sig. (2-tailed)	.027	.476	.409	.721	.109	.466	.149	.666	.268
	N	43	43	43	43	43	43	43	43	43**

Correlations

		P28	P29	P30	P31	P32	P33	P34	P35	P36
Principle 39	N	43	43	43	43	43	43	43	43	43*
Principle 40	Pearson Correlation	-.086	.529	.006	.047	-.014	-.055	-.219	-.080	.194
	Sig. (2-tailed)	.585	.000	.971	.765	.930	.728	.158	.609	.213
	N	43	43	43	43	43	43	43	43	43**

Correlations

		P37	P38	P39	P40
Principle 39	N	43	43	43	43
	Pearson Correlation	-.092	.046	.059	1
Principle 40	Sig. (2-tailed)	.557	.771	.709	
	N	43	43	43	43

Note: P1= Principle 1

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

Table 3.1 Initial Factor Analysis

Total Variance Explained									
Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
Principle 1	4.62	11.56	11.56	4.62	11.56	11.56	3.40	8.50	8.50
Principle 2	4.13	10.32	21.88	4.13	10.32	21.88	2.78	6.95	15.45
Principle 3	3.33	8.33	30.20	3.33	8.33	30.20	2.49	6.21	21.66
Principle 4	2.72	6.79	37.00	2.72	6.79	37.00	2.45	6.12	27.77
Principle 5	2.47	6.18	43.17	2.47	6.18	43.17	2.33	5.82	33.59
Principle 6	2.21	5.52	48.69	2.21	5.52	48.69	2.33	5.81	39.40
Principle 7	2.15	5.37	54.05	2.15	5.37	54.05	2.16	5.39	44.79
Principle 8	2.09	5.22	59.27	2.09	5.22	59.27	2.15	5.38	50.17
Principle 9	1.59	3.97	63.24	1.59	3.97	63.24	2.08	5.21	55.38
Principle 10	1.46	3.64	66.88	1.46	3.64	66.88	1.98	4.94	60.32
Principle 11	1.34	3.36	70.24	1.34	3.36	70.24	1.96	4.90	65.22
Principle 12	1.29	3.23	73.47	1.29	3.23	73.47	1.91	4.76	69.99
Principle 13	1.25	3.12	76.59	1.25	3.12	76.59	1.90	4.74	74.73
Principle 14	1.11	2.77	79.36	1.11	2.77	79.36	1.85	4.63	79.36
Principle 15	0.95	2.38	81.73						
Principle 16	0.87	2.19	83.92						
Principle 17	0.79	1.98	85.89						
Principle 18	0.72	1.81	87.71						
Principle 19	0.66	1.66	89.36						
Principle 20	0.64	1.61	90.97						
Principle 21	0.54	1.35	92.33						
Principle 22	0.49	1.22	93.54						
Principle 23	0.40	1.01	94.55						
Principle 24	0.38	0.95	95.51						
Principle 25	0.33	0.83	96.33						
Principle 26	0.27	0.67	97.00						
Principle 27	0.23	0.57	97.57						
Principle 28	0.21	0.51	98.08						
Principle 29	0.20	0.50	98.58						
Principle 30	0.16	0.40	98.98						
Principle 31	0.13	0.33	99.31						
Principle 32	0.08	0.21	99.52						
Principle 33	0.06	0.14	99.66						
Principle 34	0.05	0.13	99.79						
Principle 35	0.03	0.08	99.88						
Principle 36	0.02	0.06	99.93						
Principle 37	0.02	0.04	99.97						
Principle 38	0.01	0.02	99.99						
Principle 39	0.00	0.01	100.00						
Principle 40	0.00	0.00	100.00						

Note: Initial Eigenvalue. (Kaiser's (K1) criterion, eigenvalue greater than 1.

Extraction Method: Principal Component Analysis

Table 3.2 Parallel Analysis

Component	Eigenvalue	
	Random Data	Real Data
Principle 1	3.48	4.62
Principle 2	3.14	4.13
Principle 3	2.84	3.33
Principle 4	2.64	2.72
Principle 5	2.43	2.47
Principle 6	2.24	2.21
Principle 7	2.08	2.15
Principle 8	1.94	2.09
Principle 9	1.79	1.59
Principle 10	1.68	1.46
Principle 11	1.55	1.34
Principle 12	1.43	1.29
Principle 13	1.33	1.25
Principle 14	1.22	1.11
Principle 15	1.12	0.95
Principle 16	1.03	0.87
Principle 17	0.95	0.79
Principle 18	0.87	0.72
Principle 19	0.80	0.66
Principle 20	0.72	0.64
Principle 21	0.66	0.54
Principle 22	0.59	0.49
Principle 23	0.52	0.40
Principle 24	0.47	0.38
Principle 25	0.42	0.33
Principle 26	0.37	0.27
Principle 27	0.32	0.23
Principle 28	0.27	0.20
Principle 29	0.23	0.20
Principle 30	0.20	0.16
Principle 31	0.17	0.13
Principle 32	0.13	0.08
Principle 33	0.11	0.06
Principle 34	0.08	0.05
Principle 35	0.06	0.03
Principle 36	0.04	0.02
Principle 37	0.03	0.01
Principle 38	0.02	0.01
Principle 39	0.01	0.00
Principle 40	0.00	0.00

Table 3.3 Factor Analysis

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4.623	11.557	11.557	4.623	11.557	11.557	4.319	10.799	10.799
2	4.129	10.322	21.879	4.129	10.322	21.879	3.479	8.698	19.497
3	3.330	8.325	30.204	3.330	8.325	30.204	3.453	8.632	28.129
4	2.717	6.793	36.997	2.717	6.793	36.997	3.161	7.902	36.031
5	2.471	6.177	43.174	2.471	6.177	43.174	2.857	7.144	43.174
6	2.206	5.515	48.689						
7	2.146	5.365	54.054						
8	2.088	5.219	59.273						
9	1.587	3.967	63.240						
10	1.457	3.643	66.882						
11	1.343	3.358	70.240						
12	1.292	3.230	73.471						
13	1.247	3.117	76.588						
14	1.108	2.771	79.359						
15	.950	2.375	81.734						
16	.874	2.185	83.919						
17	.790	1.975	85.894						
18	.724	1.811	87.705						
19	.664	1.660	89.364						
20	.644	1.610	90.974						
21	.540	1.351	92.325						
22	.487	1.217	93.542						
23	.404	1.011	94.553						
24	.382	.954	95.507						
25	.330	.825	96.332						
26	.267	.667	96.999						
27	.227	.569	97.568						
28	.205	.511	98.079						
29	.200	.500	98.579						
30	.161	.403	98.983						
31	.132	.329	99.312						
32	.082	.206	99.518						
33	.056	.141	99.658						
34	.053	.133	99.791						
35	.034	.084	99.876						
36	.023	.057	99.933						
37	.015	.037	99.970						
38	.008	.021	99.990						
39	.004	.010	100.000						
40	6.286E-006	1.571E-005	100.000						

Extraction Method: Principal Component Analysis.

Table 3.4 Factor Loading

Rotated Component Matrix[a]

	Component				
	Factor1	Factor 2	Factor 3	Factor 4	Factor 5
Principle 1	0.43	0.36	0.23	-0.12	0.37
Principle 2	-0.25	0.02	-0.50	0.17	0.33
Principle 3	0.45	-0.15	0.10	0.13	-0.01
Principle 4	0.03	-0.08	-0.53	0.14	0.02
Principle 5	0.09	0.15	-0.65	0.00	-0.53
Principle 6	0.06	0.31	0.30	0.16	0.00
Principle 7	0.02	-0.53	0.05	-0.02	-0.15
Principle 8	0.04	0.63	0.11	-0.26	-0.14

Note: Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.

Table 3.5 Strong factor loading in Factor 1.

Rotated Component Matrixa					
	Component				
	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
Principle 1	**0.43**	0.36	0.23	-0.12	0.37
Principle 3	**0.45**	-0.15	0.10	0.13	-0.01
Principle 14	**0.73**	0.01	-0.12	0.23	0.06
Principle 17	**0.66**	-0.07	-0.02	-0.13	0.21
Principle 20	**-0.68**	0.01	-0.04	-0.27	0.08
Principle 22	**0.62**	0.18	0.11	0.04	0.02
Principle 30	**-0.52**	-0.09	-0.18	-0.22	0.27
Principle 31	**-0.38**	-0.27	-0.25	0.29	-0.10
Principle 32	**-0.56**	-0.07	0.01	-0.05	0.20
Principle 33	**-0.36**	0.00	0.04	0.32	0.01
Principle 38	**0.19**	0.03	0.09	0.16	0.08

Table 3.6 Strong factor loading in Factor 2.

Rotated Component Matrixa					
	Component				
	Factor 1	**Factor 2**	Factor 3	Factor 4	Factor 5
Principle 6	0.06	**0.31**	0.30	0.16	0.00
Principle 7	0.02	**-0.53**	0.05	-0.02	-0.15
Principle 8	0.04	**0.63**	0.11	-0.26	-0.14
Principle 9	0.12	**0.55**	0.29	-0.18	-0.15
Principle 21	0.16	**0.42**	-0.38	-0.01	0.23
Principle 23	0.30	**-0.54**	0.24	0.15	-0.42
Principle 28	0.23	**0.39**	-0.07	0.04	-0.15
Principle 29	-0.53	**-0.57**	-0.41	0.25	-0.17
Principle 36	0.01	**-0.45**	0.10	0.05	-0.17
Principle 40	0.22	**-0.59**	-0.19	0.04	0.04

Table 3.7 Strong factor loading in Factor 3.

Rotated Component Matrixa					
	Component				
	Factor 1	Factor 2	**Factor 3**	Factor 4	Factor 5
Principle 2	-0.25	0.02	**-0.50**	0.17	0.33
Principle 4	0.03	-0.08	**-0.53**	0.14	0.02
Principle 5	0.09	0.15	**-0.65**	0.00	-0.53
Principle 10	0.04	-0.06	**0.55**	0.12	-0.15
Principle 18	-0.19	0.04	**-0.20**	0.03	0.04
Principle 26	0.05	0.07	**0.48**	0.15	0.10
Principle 27	0.11	0.21	**0.69**	-0.08	0.09
Principle 37	-0.26	0.10	**-0.47**	-0.34	0.16

Table 3.8 Strong factor loading in Factor 4.

Rotated Component Matrixa					
	Component				
	Factor 1	Factor 2	Factor 3	**Factor 4**	Factor 5
Principle 12	0.24	-0.03	0.08	**0.36**	0.16
Principle 13	-0.09	-0.21	0.21	**0.62**	-0.26
Principle 15	-0.10	-0.06	0.04	**0.78**	0.19
Principle 16	-0.43	-0.19	-0.16	**-0.56**	0.11
Principle 24	-0.22	-0.46	0.24	**-0.47**	0.18
Principle 34	-0.03	0.27	0.27	**-0.39**	-0.31
Principle 35	-0.29	0.17	0.16	**-0.56**	-0.01

Table 3.9 Strong factor loading in Factor 5.

Rotated Component Matrixa					
	Component				
	Factor 1	Factor 2	Factor 3	Factor 4	**Factor 5**
Principle 11	0.29	-0.03	0.27	-0.31	**-0.62**
Principle 19	-0.14	0.32	-0.29	0.03	**-0.64**
Principle 25	0.07	0.03	-0.01	-0.23	**0.41**
Principle 39	0.22	0.21	-0.19	0.17	**0.69**

REFERENCE

Astleitner, H. & Wiesner, C. (2004). An Integrated Model of Multimedia Learning and Motivation. Journal of Educational Multimedia and Hypermedia, 13(1), 3-21.

Abedi, J., Leon, S., & Mirocha, J. (2003). Impact of Student Language Background on Content-Based Performance: Analyses of Extant Data *(CSE Technical Report No. 603)*. Los Angeles, CA: University of California: National Center for Research on Evaluation, Standards, and Student Testing.

Association for Educational Communications and Technology (2007). Definition. A. Januszewski, & M. Molenda (Eds.), Educational technology: A definition with commentary (pp. 1–14). New York: Lawrence Erlbaum Associate.

Augustyniak, K., Murphy, J., & Phillips, D. K. (2005). Psychological perspectives in assessing mathematics learning needs. *Journal of Instructional Psychology, 32*(4), 277-286.

Blackhurst, A. E. (2005). Perspectives on applications of technology in the field of learning disabilities. *Learning Disability Quarterly, 28*(2), 175-178.

Badian, N. A. (1983). Dyscalculia and nonverbal disorders of learning. In H. R. Myklebust (Ed.), *Progress* (pp. 235–264). New York: Grune & Stratton.

Berthold, K., Eysink, T.H.S., & Renkl, A. (2009). Assisting self-explanation prompts are more effective than open prompts when learning with multiple representations. *Instructional Science*, *37*(4), 345 – 363

Bellamy D. (1996) Designing educational technology: computer-mediated change. In *Context and Consciousness: Activity Theory and Human-Computer Interaction* (ed. B.Nardi), pp. 123–146. Massachusetts Institute of Technology, Cambridge, MA.

Backhaus, K., Erichson, B., Plinke, W., (2003). Multivariate Analysis method. 10th ed. Berlin: Springer-Verlag.

Bagui, S. (1998). Reasons for increased learning using multimedia. *Journal of educational multimedia and hypermedia*, *7*, 3-18.

Bøttcher, L., & Dammeyer, J. (2012). Disability as a dialectical concept: building on Vygotsky's defectology. *European Journal of Special Needs Education*, *27*(4), 433-446.

Bodker S. (1991) A Human Activity Approach to User Interfaces, Human Computer Interaction, 4(3) 171-195.

Bodker S. (1991) Activity Theory as a challenge to system design. In *Information Systems Research: Contemporary Approaches and Emergent Traditions* (eds H. Nissen, H. Klein & R. Hirschheim), pp. 551–564. Elesevier Science, North Holland, BV.

Bozarth, J. (2010). Nuts and Bolts: Principles of Multimedia Learning. Retrieved March 8, 2013, from http://www.learningsolutionsmag.com/articles/453/

Brown, S. R. (1980). *Political subjectivity: Application of Q methodology in political science.* New Haven, CT: Yale University Press.

Brown, S. R. (1986). Q technique and method: Principles and procedures. *New tools for social scientists: Advances and applications in research methods*, 57-76.

Brown, S. R. (1993). A primer on Q methodology. *Operant subjectivity*, *16*(3/4), 91-138.

Brown, S. R. (1996). Q-methodology and qualitative research. *Qualitative Health Research, 6,* 561-567.

Bruning, R. H., Schraw, G. J., Norby, M. M., & Ronning, R. R. (2003). *Cognitive psychology and instruction* (4th ed.). Columbus, OH: Prentice-Hall.

Cattell, R. B. (1966). The scree test for the number of factors. *Multivariate Behavioral Research, 1,* 245-276.

Carney, R. N., & Levin, J. R. (2002). Picturial illustrations still improve students' learning from text. Educational Psychology Review, 14, 5–26.

Clark, R. C., & Mayer, R. E. (2003). *e-learning and the science of instruction.* San Francisco: Jossey-Bass.

Clark, R.C., Nguyen, F., & Sweller, J. (2006). *Efficiency in learning: evidence-based guidelines to manage cognitive load.* San Francisco: Pfeiffer.

Commission on Instructional technology. (1970). To improve learning: A report to the President and the Congress of the United States. Washington, D.C.: U.S. Government Printing Office.

Crowe, E. (2011). Race to the Top and Teacher Preparation: Analyzing State Strategies for Ensuring Real Accountability and Fostering Program Innovation (pp. 48): Center for American Progress.

Chandler, P., & Sweller, J. (1991). Cognitive load theory and the format of instruction. *Cognition and Instruction,8,* 293-332.

Chandler, P., & Sweller, J. (1992). The split-attention effect as a factor in the design of instruction. *British Journal of Educational Psychology.* **62**: 233–246.

CAST (2011). Universal design forlearning guidelines version 1.0. Wakefield, MA: Author.

Clark, R. & Mayer, R. (2009) *E-Learning and the Science of Instruction*. San Francisco: Pfeiffer.

Collins P., Shukla S. & Redmiles D. (2002) Activity theory and system design: a view from the trenches. *Computer Supported Cooperative Work* 11, 55–80.

Cole, M. (1997). Cultural psychology: A once and future discipline. Cambridge: Harvard University Press.

Cennamo, K. S. (1993). Learning from video. Factors influencing learners' preconceptions and invested mental effort. Educational Technology, Research, and Development, 41, 33e45.

Daniels, H. (2004). Cultural historical activity theory and professional learning, International Journal of Disability, Development and Education, 51 (2), 185-200.

Darling-Hammond, L. (2003). Standards and Assessments: Where We Are and What We Need. Stanford University.

Dennis, K. E. (1986). Q-methodology—Relevance and application to nursing research. *Advances in Nursing Science, 8,* 6-17.

DeLeeuw, K. E., & Mayer, R. E. (2008). A comparison of three measures of cognitive load: Evidence for separable measures of intrinsic, extraneous, and germane load. *Journal of Educational Psychology*, *100*(1), 223.

Dewey, J. (1933). How We Think: A Restatement of the Relation of Reflective Thinking to the Educative Process (Boston, MA: Heath).

Education Week. (2007). Achievement gap. Retrieved January 23, 2013, from http://www.edweek.org/ew/issues/achievement-gap/

Elliott, S. N. Kurz, A. Beddow, P. and Frey, J. (2009) Cognitive Load Theory & Universal Design Principals: Applications to Test Item Development, NASP Section.

Eilam, B., & Poyas, Y. (2008). Learning with multiple representations: Extending multimedia learning beyond the lab. Learning and Instruction, 18(4), 368-378.

Engeström, Y. (2001). Expansive learning at work: Toward an activity theoretical reconceptualisation. *Journal of Education and Work, 14*(1), 133-156.

Ericsson, K. A., & Kintsch, W. (1995). Long-term working memory. *Psychological Review, 102,* 211–245.

Fabrigar, L. R., Wegener, D. T., MacCallum, R. C., & Strahan, E. J. (1999). Evaluating the use of exploratory factor analysis in psychological research. *Psychological Methods, 4,* 272-299.

Fletcher, J. D., & Tobias, S. (2005). The multimedia principle. In R. E. Mayer (Ed.), The Cambridge handbook of multimedia learning, 117– 133. Cambridge, MA: Cambridge University Press.

Ford, J. K., MacCallum, R. C., & Tait, M. (1986). The applications of exploratory factor analysis in applied psychology: A critical review and analysis. *Personnel Psychology, 39,* 291-314.

Gay, G., & Hembrooke, H., (2004): *Activity-Centered Design: An Ecological Approach to Designing Smart Tools and Usable Systems (Acting with Technology).* The MIT Press.

Gardner-Bonneau, D. J. (2007, August). *Human factors issues in home health care.* Presentation to the Committee on Hu- man-Systems Integration, Division of Behavioral and Social Sciences and Education, The National Academies, Woods Hole, MA.

Gindis, B. (2003). Sociocultural Theory and Children with Special Needs. *Vygotsky's educational theory in cultural context*, 200.

Gross-Tsur, V., Manor, O., & Shalev, R. S. (1996). Developmental dyscalculalia: Prevalence and demographic features. *Developmental Medicine and Child Neurology, 38,* 25–33.

Hasselbring, T. S. (1996). Read 180. Available online at http://teacher.scholastic.com/products/readl80

Hair, J. F., Anderson, R.E., Tatham, R. L., et al. (1998). Multivariate Data Analysis. 5th ed. Englewood Cliffs, NJ: Prentice Hall International.

Hayton, J. C., Allen, D. G., & Scarpello, V. (2004). Factor Retention Decisions in Exploratory Factor Analysis: a Tutorial on Parallel Analysis. *Organizational Research Methods, 7*(2), 191-205

Hardman J. (2005) An exploratory case study of computer use in a primary school mathematics classroom: new technology, new pedagogy? *Perspectives in Education* 23, 1–13.

Hedegaard, M. & Chaiklin, S. (2005). *Radical-local teaching and learning*. Århus Universitetsforlag. Kapitel 4-6 , 51-81

Hedegaard, M. & Chaiklin, S. (2005) *Radical-Local Teaching and Learning. A Cultural-Historical Approach.* Denmark, Aarhus University Press.

Hede, A. (2002). An integrated model of multimedia effects on learning. Journal of Educational Multimedia and Hypermedia, 11, 177-191.

Hede, T., and A. Hede (2002). Multimedia effects on learning: Design implications of an integrated model. In S. McNamara and E. Stacey (eds.), Untangling the Web: Establishing Learning Links. Proceedings ASET Conference 2002. Melbourne, 7-10 July. Retrieved Feb 21, 2013, from *http://ascilite.org.au/aset-archives/confs/2002/hede-t.html*

Horn, J. L. (1965). A rationale and test for the number of factors in factor analysis. *Psychometrika, 32,* 179-185.

Hedegaard, M., & Chaiklin, S. (2005). Radical-local teaching and learning. *Århus*

Universitetsforlag. Kapitel, 4-6.

Issroff K. & Scanlon E. (2001) Case studies revisited: what can Activity Theory offer? In European Perspectives on Computer Supported Collaborative Learning, Proceedings of European Conference on Computer Supported Collaborative Learning (eds P. Dillenbourg, A. Eurelings & K. Hakkarainen). University Maastricht, Maastricht, The Netherlands.

iNACOL. (2010). Fast facts about online learning. Washington DC: International Association for K-12 Online Learning (iNACOL).

iNACOL. (2012). Fast facts about online learning. Washington DC: International Association for K-12 Online Learning (iNACOL).

Individuals with Disabilities Education Improvement Act. (2004). Public Law No. 108-446. Washington, DC: U. S. Government Printing Office.

Jitendra, A. K., & Star, J. R. (2011). Meeting the Needs of Students With Learning Disabilities in Inclusive Mathematics Classrooms: The Role of Schema-Based Instruction on Mathematical Problem-Solving. *Theory Into Practice, 50*(1), 12-19. doi: 10.1080/00405841.2011.534912.

Kaiser, H. F. (1960). The application of electronic computers to factor analysis. *Educational and Psychological Measurement, 20,* 141-151.

Kaptelinin, V. & Nardi, B. (2006). *Acting with technology: Activity theory and interaction design.* Cambridge, MA: MIT Press.

Kosc, L. (1974). Developmental dyscalculalia. *Journal of Learning Disabilities, 7,* 164–177.

Kalyuga, S., Ayres, P., Chandler, P., & Sweller, J. (2003). The expertise reversal effect.

Educational Psychologist, 38, 23e31.

Kazmerski, V. A., Blasko, D. G., (1999). Teaching observational research in introductory psychology: computerized and lecture-based methods. Teach Psychol 26(4): 295–298.

Kaptelinin V. (1996), Activity Theory: Implications for Human-Computer Interaction in B. Nardi (Ed.), Context and Consciousness: MIT Press, 103-116.

Kaptilinin, V. (1996). Computer-mediated activity: Functional organs in social and developmental contexts. In B. A. Nardi (Ed.), *Context and consciousness: Activity theory and human computer interaction,* 45-68. Cambridge, MA: MIT Press.

Kaptelinin V. & Nardi B. (2006) *Acting with Technology: Activity Theory and Interaction Design.* MIT Press, Cambridge.

Kosslyn, S. M., (1985) "Graphics and human information processing: A review of five books. Journal of the American Statistical Association 80: 499-512.

Kosslyn, S. M. (2007). *Clear and to the point: 8 psychological principles for compelling PowerPoint presentations*. Oxford Press.

Kuutti, K. (1996). Activity theory as a potential framework for human-computer interaction research. In B. A. Nardi (Ed.), Context and consciousness (pp. 17-44). Cambridge, MA: MIT Press.

Lautenschlager, G. J. (1989). A comparison of alternatives to conducting Monte Carlo analyses for determining parallel analysis criteria. *Multivariate Behavioral Research, 24,* 365-395.

Lim C.P. & Hang D. (2003) An activity theory approach to research of ICT integration in Singapore schools. *Computers and Education* 41, 49–63.

Leont'ev, A. N. (1978). *Activity, consciousness, and personality*. Englewood Cliffs: Prentice-

Hall.

Leont'ev, A. N. (1981). *Problems of the development of the mind*. Moscow: Progress Publishers.

Lazarou, D. (2011). Using cultural-historical activity theory to design and evaluate an educational game in science education. *Journal of Computer Assisted Learning*, *27*, 424-439.

Lewis, R. B. (2005). Classroom technology for students with learning disabilities. In D. Edyburn, K. Higgins, & R. Boone (Eds.), Handbooko f speciale ducationt echnologyr esearcha nd practice(pp. 325-334).

Levie, H. W., & Lentz, R. (1982). Effects of text illustrations: A review of research. Educational Communication and Technology Journal, 30, 195–232.

Levin, J. R., Anglin, G. J., & Carney, R. N. (1987). On empirically validating functions of pictures in prose. In D. M. Willows, & H. A. Houghton (Eds.), The psychology of illustration (Vol. 1, pp. 51–86). New York: Springer.

Laboratory of Comparative Human Cognition. (In Press). Qualitative research: Cultural-historical activity theory. In B. McGaw, P. Peterson, & E. Baker (Eds.), *International Encyclopedia of Education* (pp. 1-13). New York: Elsevier.

Luria, A. R. (1928). The problem of the cultural development of the child. Journal of Genetic Psychology, 35, 493-506.

Low, R., & Sweller, J. (2005). The modality principle in multimedia learning. *The Cambridge handbook of multimedia learning*, *147*, 158.

Mayer, R. E. (1996). Learners as information processors: Legacies and limitations of educational psychology’s second metaphor. *Educ. Psychol.* 31: 151–161.

Mayer, R. E., Bove, W., Bryman, A., Mars, R., & Tapangco, L. (1996). When less is more: Meaningful learning from visual and verbal summaries of science textbook lessons. Journal of Educational Psychology, 88, 64-73.

Mayer, R. E. (1997). Multimedia learning: Are we asking the right questions. Educational Psychology Review, 8, 357-371.

Mayer, R. E. (1997). Multimedia learning: Are we asking the right questions?. *Educational psychologist*, *32*(1), 1-19.

Mayer, R.E. (2001). Multimedia learning. Cambridge, UK: Cambridge University Press.

Mayer, R. E. (2005). Cognitive theory of multimedia learning. In R. E. Mayer (Ed.), *The Cambridge handbook of multimedia learning* (pp. 31–48). New York: Cambridge University Press.

Mayer, R. E., & Moreno, R. (1998). A cognitive theory of multimedia learning: Implications for design principles.

Mayer, R.E. (1997). Multimedia learning: Are we asking the right questions? *Educational Psychologist,* 32, 1-19.

Mayer, R. E. (2001). Multimedia learning. New York: Cambridge University Press.

Mayer, R. E., & Moreno, R. (2003). Nine ways to reduce cognitive load in multimedia learning. *Educational Psychologist, 38,* 43-52.

McKeown, B., & Thomas, D. (1988). *Q methodoloy.* Newbury Park, CA: Sage.

Meyer, A., & Rose, D. H. (2005). The future is in the margins: The role of technology and disability in educational reform. In D. H. Rose, A. Meyer, & C. Hitchcock (Eds.), *The universally designed classroom: Accessible curriculum and digital technologies* (pp. 13–

35). Cambridge, MA: Harvard Education Press.

Mayer, R. E. (2005c). Principles for reducing extraneous processing in multimedia learning: Coherence, signaling, redundancy, spatial contiguity, and temporal contiguity principles. In R. E. Mayer (Ed.), The Cambridge handbook of multimedia learning (pp. 183–200). Cambridge, MA: Cambridge University Press.

Mayer, R. E. (2009). *Multimedia learning* (2nd ed). New York: Cambridge University Press.

Moreno R., Mayer R. E., (2000). Learner-centered approach to multimedia explanations: deriving instructional design principles from cognitive theory. Interactive Electronic Multimedia. Journal of Computer-Enhanced Learning, 2, (5).

Moreno, R., & Mayer, R. E. (2007). Interactive multimodal learning environments. *Educational Psychology Review, 19,* 309-326.

Moreno, R., & Mayer, R. (1999). Cognitive principles of multimedia learning: The role of modality and contiguity. Journal of Educational Psychology 91 (2): 358–368.

Mayer, R. E., & Anderson, R. B. (1991). Animations Need Narrations: An Experimental Test of a Dual-Coding Hypothesis. *Journal of of Educational Psychology, 83*(4), 484-490.

Mayer, R. E., & Anderson, R. B. (1992). The Instructive Animation: Helping Students Build Connections Between Words and Pictures in Multimedia Learning. *Journal of Educational Psychology, 84*(4), 444-452.

Mayer, R. E., & Moreno, R. (1997). A cognitive theory of multimedia learning: Implications for design principles: Wiley.

Mayer, R. E. (2009). Multimedia learning (2nd ed.). New York: Cambridge University Press.

Mayer, R. E., Bove, W., Bryman, A., Mars, R., & Tapangco, L. (1996). When less is more: Meaningful learning from visual and verbal summaries of science textbook lessons. Journal of Educational Psychology, 88, 64-73.

McKeown, B., & Thomas, D. (1988). *Q methodoloy.* Newbury Park, CA: Sage.

McGaw, B., Peterson, & Baker, E., (2005) Laboratory of Comparative Human Cognition. (In Press). Qualitative research: Cultural-historical activity theory. International Encyclopedia of Education, 3rd edition. New York: Elsevier.

Meyer, A. (2005). *The universally designed classroom: Accessible curriculum and digital technologies*. D. H. Rose, & C. Hitchcock (Eds.). Cambridge, MA: Harvard. Education Press.

Meyer, A., & Rose, D. H. (2005). The future is in the margins: The role of technology and disability in educational reform. *The universally designed classroom: Accessible curriculum and digital technologies*, 13-35.

Mitchem, K., Koury, K., Fitzgerald, G., Hollingsead, C., Miller, K., Tsai, H. H., & Zha, S. (2009). The effects of instructional implementation on learning with interactive multimedia case-based instruction. *Teacher Education and Special Education: The Journal of the Teacher Education Division of the Council for Exceptional Children*, *32*(4), 297-318.

Miller, G. A. (1956). The magical number seven, plus or minus two: Some limits on our capacity for processing information. Psychological Review, 63, 81-97.

Mishra, P., & Girod, M. (2006). Designing learning through learning to design. The High School. Journal, 90(1), 44-51.

Moreno, R., & Mayer, R. (2007). Interactive multimodal learning environments. *Educational Psychology Review*, *19*(3), 309-326.

Murphy, E., & Rodriguez-Manzanares, M. A. (2008). Using activity theory and its principle of contradictions to guide research in educational technology. *Australasian Journal of Educational Technology*, *24*(4), 442-457.

Muthukumar, S. L., (2005). Creating interactive multimedia-based educational courseware : cognition in learning. *Cognitive Technology Work*, *7*(1), 46-50.

Meyer, A. & Rose, D. H. (2005). The future is in the margins: The role of technology and disability in educational reform. In D. H. Rose, A. Meyer, & C. Hitchcock (Eds.), *The universally designed classroom: Accessible curriculum and digital technologies* (pp. 13–35). Cambridge, MA: Harvard Education Press.

Moos, D. C., & Marroquin, L. (2010). Multimedia, hypermedia, and hypertext: Motivation considered and reconsidered. *Computers in Human Behavior, 26,* 265–276.

Nardi, B. (Ed.) (1996a). *Context and consciousness: Activity theory and human-computer interaction.* Cambridge, MA: MIT Press.

National Assessment of Educational Progress. (2005). Summary of Results for Massachusetts: Massachusetts Department of Education.

National Governors Association. (2005). Closing the achievement gap. Retrieved Feb 21, 2013, from http://www.subnet.nga.org/educlear/achievement/index.html

Noguera, P. A. (2008). Creating Schools Where Race Does Not Predic Acievement: The Role and Significant of Race in the Racial Achievement Gap. *Journal of Negro Education, 77*(2).

No Child Left Behind Act. (2001). Public Law 107-110. Washington, DC: U. S. Government Printing Office.

Norman, D.A.(2005). Human-centered design considered harmful, *ACM Interactions, 12*, 4, 14-19.

Norman, D. (1988). *The Psychology of Everyday Things.* New York: Basic Books.

Norman, D. (1993). Things that Make Us Smart: defending human attributes in the age of the machine. MA: Addison Welseley Publishers.

National Kaohsiung University of Applied Science (NKUAS). (2011 July). 2nd Order Design Thinking: Evidence- based Design Thinking Process. Kaohsiung, Taiwan, ROC.

Nocon, H., Gordon, V., Jackson, T., Garía, O. L., & Minami, Y. (2005). Laboratory of Comparative Human Cognition. (In Press). Qualitative research: Cultural-historical activity theory. In: B. McGaw, P. Peterson, & E. Baker (Eds.) *International Encyclopedia of Education,* 3rd edition. New York: Elsevier.

Olszewski-Kubilius, P., & Thomson, D. (2010). Gifted programming for poor or minority urban students: Issues and lessons learned. *Gifted Child Today, 33*(4), 58-64.

Okolo, C. M. (2000). Technology for individuals with mild disabilities. In J. Lindsey (Ed.), Technologya nd exceptionali ndividuals (3rd ed., pp. 243-301). Austin, TX: Pro-Ed.

Pantic, M., Sebe, N., Cohn, J.F., and Huang, T.S. (2005), Affective Multimodal Human-Computer Interaction, ACM Multimedia, 669- 676.

Paas, F. G. W. C., Renkl, A. & Sweller, J. (2004). Cognitive load theory: instructional implications of the interaction between information structures and cognitive architecture. *Instructional Science, 32,* 1–8.

Paas, F., Renkl, A. & Sweller, J. (2003) Cognitive load theory and instructional design: Recent developments, *Educational Psychologist* 38: 1–4.

Paas, F., Tuovinen, J.E., Tabbers, H.K., & Van Gerven, P.W.M. (2003). Cognitive load measurement as a means to advance cognitive load theory. *Educational Psychologist* 38 (1): 63–71.

Papert, S. (1991). Situating constructionism. In I. Harel & S. Papert. (Ed.) Constructionism. Norwood. NJ: Ablex.

Paivio, A. (1986). Mental representations: A dual coding approach. Oxford, England: Oxford University Press.

Pelachaud, C., Carofiglio, V., De Carolis, B., de Rosis, F. & Poggi, I. (2002). Embodied Contextual Agent in Information Delivering Application. In Proceeding of the First International Joint Conference on Autonomous Agents & Multi-Agent Systems. Bologna, Italy.

Posner, M. I (1978). *Chronometric explorations of mind.* Hillsdale, N.J.: Erlbaum.

Queen, B., & Lewis, L. (2011). Distance Education Courses for Public Elementary and Secondary School Students: 2009-10 (NCES 2012-009). U.S. Department of Education, National Center for Education Statistics. http://nces.ed.gov/ pubs2012/2012008.pdf.

Rauh, W. J. (2011). Online education as a toll good: An examination of the South Carolina Virtual School Program. Computers and Education, 57(2), 1583-1594.

Rhode, P. C., Froehlich-Grobe, K., Hockemeyer, J. R., Carlson, J. A., & Lee, J. (2012). Assessing stress in disability: Developing and piloting the Disability Related Stress Scale. *Disabil Health J, 5*(3), 168-176. doi: 10.1016/j.dhjo.2012.03.002.

Rose, D. H., Meyer, A., & Hitchcock, C. (2005). *The universally designed classroom: Accessible curriculum and digital technologies.* Cambridge, MA: Harvard Education Press.

Rosenberg, M.S., Westling, D.L., & McLeskey, J. (2011) "Primary Characteristics of Students with Intellectual Disabilities." Retrieved on Jan 13, 2013. http://www.education.com/reference/article/characteristics-intellectual-disabilities/

Rose, D. H., et. al., (2008). Accurate for All: Universal Design for Learning and the Assessment of Students with Learning Disabilities. *Perspectives on Language and Lliteracy* v. 34 no. 4, p. 23-25, 28

Rose, D. H., Harbour, W. S., Johnston, C. S., Daley, S. G., & Abarbanell, L. (2006). Universal Design for Learning in Postsecondary Education: Reflections on Principles and Their Applications. *Journal of Postsecondary Education and Disability*, 19 (2): 135–56.

Rose, D. H., & Meyer, A. (2002). *Teaching Every Student in the Digital Age: Universal Design for Learning*. Association for Supervision and Curriculum Development, 1703 N. Beauregard St., Alexandria, VA 22311-1714

Rose, D. H., & Meyer, A. (2006). *A Practical Reader in Universal Design for Learning*. Harvard Education Press. 8 Story Street First Floor, Cambridge, MA 02138.

Rozalia, G. (2008). Q factor analysis (Q-methodology) as data analysis technique. *Annals of the University of Oradea, Economic Science Series*, *17*(4), 871-876.

Rodina, K. (2007, in press) The Impact of Vygotsky`s Cultural-Historical Concept of Disability in Inclusive Preschool Education in Russia. In Siebert, B. (Hrsg). Integrative Pädagogik und kulturhistorische Theorie. Frankfurt a. M.: Peter Lang Verlag.

Savoji, A. P., Hassanabadi, H., & Fasihipour, Z. (2011). The modality effect in learner-paced multimedia learning. Procedia-Social and Behavioral Sciences, 30, 1488-1493.

Sajadi, S. S., (2010). Multimedia e-learning for special education needs (SEN). Brunel Business School Doctoral Symposium 4th & 5th March 2010. http://www.brunel.ac.uk/bbs/research/phd-programmes-opportunities/bbs-doctoral-symposium/2010. Retrieve on March 3, 2012.

Schmidt, M. E., & Vandewater, E. A. (Spring 2008). Media and attention, cognition and school achievement. *The Future of children, 18*(1), 63-85.

Schnotz, W., (2005). An integrated model of text and picture comprehension. In R.E. Mayer (Ed.), *The Cambridge Handbook of Multimedia Learning.* New York: Cambridge University Press.

Schultz, D. M. (2009). Constructing Effective Oral Presentations. In *Eloquent Science* (pp. 273-290). American Meteorological Society.

Sims, R. (1997). Interactivity: A forgotten art: Computers in Human Behavior, 13(2), 157–180.

Sweller, J. (1988). Cognitive load during problem solving: Effects on learning. *Cognitive Science,* 12, 257-285.

Sweller, J. (1994). Cognitive load theory, learning difficulty, and instructional design. *Learning and Instruction,4,* 295-312.

Sweller, J. (1999). Instructional design in technical areas. Camberwell, Australia: ACER Press.

Sweller, J. (2004). Instructional design consequences of an analogy between evolution by natural selection and human cognitive architecture. *Instructional Science, 32,* 9-31.

Schwamborn, A., et al. (2011). Cognitive load and instuctionally supported learning with provided and learner-generated visualizations. *Computers in Human Behavior, 27(*1*),* 89-93.

Sweller, J. (2005). Implications of cognitive load theory for multimedia learning. In R. E. Mayer (Ed.), The Cambridge handbook of multimedia learning (pp. 19–30). Cambridge, MA: Cambridge University Press.

Sweller, J., Van Merriënboer, J. & Paas, F. (1998) Cognitive architecture and instructional design. *Educational Psychology Review, 10*, 251-296.

Seaman, J., & Nelsen, P. J. (2011). An Overburdened Term: Dewey's Concept of "Experience" as Curriculum Theory. *Education and Culture*, *27*(1), 4.

Stahl, S. (2008). *NIMAS: Accessible textbooks in the classroom II.* Wakefield, MA: NIMAS Development and Technical Assistance Centers.

Steyn, M. M. D., du Toit, C.J., & Lachmann, G. (1999). The implementation of a multimedia program for first year university chemistry practicals. South African Journal of Chemistry-Suid-Afrikaanse Tydskrif Vir Chemie, 52(4), 120-126.

Sweller, J., van Merrienboer, J., & Paas, F. (1998). Cognitive architecture and instructional design. Educational Psychology Review, 10, 251-296.

Sweller, J. (2003) Evolution of human cognitive architecture. In: B. Ross (ed), *The Psychology of Learning and Motivation,* Vol. 43, pp. 215–266. San Diego: Academic Press.

Tabachnick, B. G., Fidell, L. S., (2001). Using Multivariate Statistics. 4th ed. Needham Heights, MA: Allyn and Bacon.

Thurlow, M., Bremer, C., & Albus, D. (2008). Good News and Bad News in Disaggregated Subgroup Reporting to the Public on 2005–2006 Assessment Results. from University of Minnesota, National Center on Educational Outcomes. Retrieve on March 4, 2012 from http://www.cehd.umn.edu/NCEO/onlinepubs/Tech52/index.htm

Tempelman-Kluit, N. (2006). Multimedia learning theories and online instruction. College & Research Libraries 67 (4): 364-9.

Thompson, S. J., Johnstone, C. J., & Thurlow, M. L. (2002). *Universal design applied to large scale assessments* (Synthesis Report 44). Minneapolis, MN: University of Minnesota, National Center on Educational Outcomes. Retrieved October 2012, from http://education.umn.edu/NCEO/OnlinePubs/Synthesis44.html

Tabachnick, B. G., Fidell, L. S., (2001). Using Multivariate Statistics. 4th ed. Needham Heights, MA: Allyn and Bacon.

Tang, J. C., & Isaacs, E. (1993). Why do users like video? Studies of multimedia-supported collaboration. Computer-Supported Cooperative Work: An International Journal, 1, 163e196.

U. S. Department of Education (2000). *22nd annual report to Congress on the implemnetatoin of the Individuals with Disabilities Education Act. Washington : DC: U.S. Government Pringting Office.*

United States Department of Education. (2010) Race to the Top Executive Summary. Retrieved January 23, 2013, from http://www2.ed.gov/programs/racetothetop-assessment/executive-summary-042010.pdf

United States Department of Education. (2009). Race to the Top Program Executive Summary: Washington, D.C. 20202. Retrieved Feb 21, 2013, from http://www2.ed.gov/programs/racetothetop/executive-summary.pdf

United States Department of Education, National Center for Education Statistics. (2012). *Digest of Education Statistics, 2011* (NCES 2012-001), Chapter 6. Retrieved March 21, 2013, from http://nces.ed.gov/programs/digest/d11/ch_6.asp

University of Helsinki, Center for Activity Theory and Developmental Work Research (2004). Cultural-Historical Activity Theory. Retrieved March 19, 2012, from http://www.edu.helsinki.fi/activity/pages/chatanddwr/chat/

Volkwein, J. F. (2010). Reporting research results effectively. *New Directions for Institutional Research, 2010* (S1), 155-163. doi: 10.1002/ir.337.

Veresov, N. (2010). Introducing cultural historical theory: main concepts and principles of genetic research methodology. *Cultural-historical psychology*, *4*, 83-90.

Vygotsky, L.S. (1978). Mind in society: The development of higher psychological processes. Cambridge: Harvard University Press.

Van Merriënboer, J. J. G., & Ayres, P. (2005). Research on cognitive load theory and its design implications for e-learning. *Educational Technology Research and Development, 53(3),* 5-13.

Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes*. Cambridge: Harvard University Press.

Vygotsky, L.S. (1978). Mind in society: The development of higher psychological processes. Cambridge: Harvard University Press.

Valenta, A. L., & Wigger, U. (1997). Q-methodology: Definition and application in health care informatics. *Journal of the American Medical Informatics Association, 4,* 501-510.

Willett, L. V. (1992). The efficacy of using the visual arts to teach math and reading concepts. Paper presented at the annual meeting of the American Educational Research Association, San Francisco, CA.

Wickens, C.D., Lee, J.D., Liu, Y., Becker, S.E.G. (2004). *An Introduction To Human Factors Engineering*, 2nd edition, New Jersey: Pearson Prentice Hall.

Watson, J., et. al. (2012). Keeping Pace with K-12 Online & Blended Learning: An Annual Review of Policy and Practice. Evergreen Education Group. http://kpk12.com/reports/.

Queen, B., & Lewis, L. (2011). Distance Education Courses for Public Elementary and Secondary School Students: 2009-10 (NCES 2012-009). U.S. Department of Education, National Center for Education Statistics. Retrieved March 21, 2013, http://nces.ed.gov/pubs2012/2012008.pdf.