A Conceptual Model for Measuring Technology Capacity in American Higher Education: An Exploratory Analysis

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The Graduate School of Education and Human Development of The George Washington University certifies that Jerri L. Bland has passed the Final Examination for the degree of Doctor of Education as of March 2, 2015. This is the final and approved form of the dissertation.

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Abstract of the Dissertation

A Conceptual Model for Measuring Technology Capacity in American Higher Education: An Exploratory Analysis

The ubiquity of technology in our daily lives sometimes obscures the fact that there are segments of American society who continue to experience a digital divide. The focus of this quantitative study was to explore a measurement instrument that can assess technology capacities among higher education institutions; thus, helping detect whether digital divides are present in this unit of analysis. A conceptual model of technology capacity based upon Barzilai-Nahon's (2006) digital divide index served as the theoretical foundation for this research.

Employing confirmatory and exploratory factor analyses, this study found that the ability to access technology along with the student experience with technology were the two factors that best defined technology capacity for an institution. Additionally, this study recognized that institutional characteristics such as institution location, size, Carnegie classification, and sector influence differences in institutional technology capacities. The research found the technology capacities of rural institutions trailed the technology capacities of institutions located in cities, suburbs, or towns. It was also found that institutions with more than 20,000 students and doctoral institutions far exceeded the capacities of smaller institutions and those of other Carnegie classifications.

One challenge of this study was the available data sets originally gathered in 2008 and 2009 by EDUCAUSE. The results garnered from these data sets revealed there was a digital divide within higher education. However, with the speed of change in the technology landscape, further research is needed to determine whether these divides

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persist today. The validated instrument developed by this study will make future and repeated measures of technology capacity attainable for researchers.

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CHAPTER 1:

INTRODUCTION

If a higher education chief information officer were to write an idyllic recruitment brochure for her institution, what would she say? Perhaps she would paint the vivid picture of students sitting on blankets surrounded by beautiful campus landscapes happily typing away on their laptops. Maybe she would brag about an infrastructure that allows students to wirelessly update their Facebook status on their Androids while walking to class; play Words With Friends on an iPad as they wait for their laundry; or enjoy the relaxation of playing Call of Duty 3 in their dorm rooms after class. She might also boast to faculty and graduate students of high-speed computers that can process thousands of rows of genetic data in mere minutes; classrooms that engage student-faculty collaboration and exploration; or the capacity to use real-time, high-quality videoconferencing to collaborate with colleagues across the globe. Or she could highlight the extensive online research databases available through the library in support of researchers and students alike. Finally, she may trumpet the role her institution is taking to make massive open online courses a standard in providing greater access to education.

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It sounds like a wonderful institution to attend or work for, right? Most people assume these types of digital amenities are available at institutions of higher education, and they are—but in differing quantities and varying capacities of delivery and use. Large variances in technology capacities are often referred to as the digital divide and are challenging to characterize and expensive to overcome. Ultimately, higher education needs the ability to understand how the digital divide manifests itself within the sector. Therein lies the problem: How do we effectively measure the differences in technology

capacities among higher education institutions? Are there ways to predict, and fix, areas of difference?

The digital divide is often discussed in terms of lack of access to technology (Horrigan & Rainie, 2002). However, the digital divide also exhibits itself through infrastructure (Hoffman, Novak, & Schlosser, 2000), levels and types of technology use (Warschauer, 2002), users' ability to receive training or help with technology (Crump & McIlroy, 2003), and impacts of social demography (Bell, Reddy, & Rainie, 2004). Higher education in the United States is not immune to these elements of the digital divide.

Experiencing elements of the digital divide can make a difference in the level or quality of education offered and received at a higher education institution. The skills and knowledge instilled in students during the pursuit of higher education are critical to the greater success of the individual and society as a whole. The economic, political, and educational ramifications of the digital divide can negatively impact the ability of students to be effective, successful players in the global marketplace. Warschauer (2003a) argued that the link between access and use of technology can be the difference between marginalization or inclusion in this modern era. Institutions of higher education that are not able to assess and address known elements of the digital divide place their students at risk of this marginalization.

This chapter begins with a statement of the problem of measuring the technology capacities in higher education followed by a description of the current study's purpose, research questions, and significance. These sections are followed by a presentation of the conceptual framework used to guide this study as well as an overview of the

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methodology. This chapter closes with a discussion of the study's delimitations, limitations, and definitions.

Statement of the Problem

The digital divide has been studied at multiple levels of analyses. Global commentary has focused on the growing gap between countries on the uses and extent of information and communications technologies that are presumed to drive social change (Menou, 2001). Perhaps the protests in Turkey and Egypt in which protestors used information and communications technologies to champion their causes to populations across the world are real-life examples of this particular dialogue. The global digital divide discussion has also dissected the relationship between the number of Internet users per country and national economic development, with more developed countries reflecting greater Internet usage (James, 2011). Alternatively, researchers have examined the global digital divide at the individual level in absolute numbers by calculating the number of mobile phone subscribers by geographic region (James, 2009). Digital divide discussions at the local or municipality level often focus on improving quality of life or access to information for constituencies (Chang, Yen, Chang, & Chou, 2012). Governmental institutions play a key role in the impact of the digital divide within the educational arena at all levels (Chang et al., 2012; Hernandez, 2010).

A significantly smaller proportion of the literature on the digital divide has focused on variability of technology capacities across the U.S. postsecondary education sector. A small number of studies have assessed the digital divide at the institution level within community colleges (Katsinas & Moeck, 2002) and minority-serving institutions (NAFEO, 2000; Clinedinst, 2004). However, these studies have been primarily

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descriptive in nature and have not focused on the complex relationships between the multiple elements of technology capacity and the digital divide. With President Obama's initiative to build American skills, it is expected that community colleges will produce an additional 5 million graduates by 2020 (White House, 2014). It is anticipated that community colleges will develop online course to "…help students learn more, and learn better, in less time" (White House, 2014). However, it is assumed these institutions have the necessary infrastructure to support these desires. For example, while the percentage of students who own their own laptops is a metric relevant to assessing technology capacity, this single measure has not been placed in the context of the institution's ability to support an infrastructure for these laptops. Similarly, whether an institution has the capability to create online courses with the pedagogical and technological effectiveness required to meet the needs to President Obama's initiative is another unknown element of technology capacity.

Additionally, studies have not offered a single survey instrument that purports to measure the digital divide within higher education in a comprehensive, complex manner. When the Institute for Higher Education Policy published its assessment of 320 responses to a digital divide survey from members of the Alliance for Equity in Higher Education, the descriptive findings offered in-depth discussion of the responding universities as a whole and between groupings of institutions based upon institutional characteristics (Clinedinst, 2004). But, it was not evident whether the survey instrument itself was based upon any particular theory or framework that ostensibly measured either technology capacity or the digital divide. The same was true for the National Association for Equal Opportunity in Higher Education (2000) survey of historically black colleges and

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universities (HBCUs). While both studies are considered seminal publications in measuring the digital divide in higher education, neither offered any formalized assessment of the technology capacities of responding institutions, individually or collectively. Neither study was able to offer an individual institutional measurement of technology capacities, nor did these studies offer the opportunity to compare technology capacities among institutions.

The current study sought to create a single valid, reliable instrument based upon a digital divide conceptual model to measure technology capacities within higher education institutions in the United States. The comparison of technology capacities between and among institutions will enable fuller, more in-depth assessment of the digital divide. The analysis of technology capacities across institutional characteristics such as size, geographic location, special mission, and Carnegie classification may also help identify whether certain characteristics play a significant role in the level of technology capacities exhibited by groups of institutions, which may help inform collective solutions to equalize these capacities across institutions. To fully capture the elements of the digital divide debate within this higher education study, the digital divide was defined as the inequities or inequalities created by the inability to access or use technology to advance learning and scholarship—academically, professionally, or personally.

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Purpose and Research Questions

The purpose of the present study was to explore the digital divide within higher education in the United States with emphasis on measuring the technology capacities of higher education institutions based upon a conceptual model of technology capacity factors. Confirmatory factor analysis and exploratory factor analysis were used to test

the conceptual model. The presence of significant differences in technology capacities between institutions was acknowledged as indicative of the digital divide. As defined by the conceptual model for this study, the dimensions of technology capacity—technology access, infrastructure, use, user support, and institutional characteristics—were used to address three research questions:

1. Do extant measures of technology dimensions support the underlying construct of institutional technology capacity?
2. Which technology dimensions are most relevant for predicting a higher education institution's technology capacity?
3. Do significant differences in technology capacity exist as a function of institutional characteristics?

For the third research question, nine hypotheses were tested:

$H_0$1: There is no association between the sector designation of an institution and its technology capacities.

$H_0$2: There is no association between the control designation of an institution and its technology capacities.

$H_0$3: There is no association between the HBCU designation of an institution and its technology capacities.

$H_0$4: There is no association between the tribal colleges and universities designation of an institution and its technology capacities.

$H_0$5: There is no association between the locality of an institution and its technology capacities.

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$H_0$6: There is no association between the size of an institution and its technology capacities.

$H_0$7: There is no association between the Hispanic-serving institution designation of an institution and its technology capacities.

$H_0$8: There is no association between the minority-serving institution designation of an institution and its technology capacities.

$H_0$9: There is no association between the Carnegie classification of an institution and its technology capacities.

Statement of Potential Significance

While the phenomenon of the digital divide may appear to be focused on technology, at least on the surface, there are more fundamental or basic rights at stake. The Organisation for Economic Co-operation and Development (OECD) (2001) indicated that the digital divide is an issue of social inequality. The National Telecommunications and Information Administration (NTIA) of the U.S. Department of Commerce suggested that for the United States, the digital divide is a leading economic and civil rights issue (NTIA, 1999), referencing the "haves" and "have nots" and the information disadvantaged (NTIA, 1995). Duff (2010) argued that information technology brings social justice to the forefront by discussing technology as a component in the fair distribution of worldly goods.

However, the digital divide is not so easily compartmentalized. In defining the digital divide as "the gap between individuals, households, businesses, and geographic areas at different social-economic levels with regard both to their opportunities to access information and communication technologies and to their use of the Internet for a wide

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variety of activities," the OECD suggested two facets of the digital divide: access to technology and how technology is used (2001, p. 5). These two facets move the digital divide discussion beyond a simple assessment of "haves" and "have nots" (Selwyn, 2004). Different stratifications of the digital divide suggest that "have nots" in one context may be "haves" in another context, further blurring the definition of the digital divide (Warschauer, 2003b). Refocusing the digital divide discussion might require looking at the social contexts of how technology is used in addition to providing computers and Internet access (Warschauer, 2003b). Resolving the inequalities evidenced as a result of the digital divide may demand focus on the unequal ways computers are used rather than the unequal access (Warschauer, 2003b), and understanding how computers can be used to solve problems rather than simply installing computer hardware (Young, 2001).

Students attending postsecondary institutions must be trained to use technology if they hope to compete for high-paying jobs (Carnevale, 2003). Those students who do not have access to gain these skills are at a distinct disadvantage (Carnevale, 2003). The ultimate fear is that the competitiveness of the United States will be undermined by the digital divide (Carnevale, 2003). Such was the concern about the digital divide that the U.S. House of Representatives passed House Resolution 2183 (2003) to fund a $250 million program to help bridge the digital divide in order to educate and prepare a 21st century workforce. However, this program was never funded by Congress.

By creating a single instrument designed to measure institutional technology capacity, this study has the potential to provide researchers, sector leaders, and government officials the opportunity to assess the extent of the digital divide within higher education at

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depths not previously available. This study offers the unique opportunity not only to reinvigorate the discussion of the digital divide within higher education, but also to provide a reliable instrument and framework for identifying long-lasting solutions.

Conceptual Framework

Most frameworks for measuring the digital divide have focused on the global unit of analysis. These frameworks focus on measuring the depth of the digital divide between countries. The PingER (Cottrell & Matthews, 2003) framework measured the digital divide by analyzing Internet performance throughput along with the United Nations gross domestic product per capita and the Human Development Index for each country. It was immediately clear that this particular framework would not be effective in measuring the digital divide in higher education, as two of its three factors cannot be calculated at the institutional level.

Although developed for a global unit of analysis, the Balanced Scorecard Framework (Yu & Wang, 2005) moves closer to providing a framework that can be molded to a digital divide measurement instrument for higher education. The pillars of its measurement construct are four dimensions (technology diffusion, equal opportunities, information society/e-readiness, and competitiveness) with four digital divide perspectives (financial, beneficiaries, governmental functions and processes, and nationwide learning and growth). This framework also attempts to identify leading and lagging indicators of the digital divide. Performance measures must be generated for each of the eight dimensions. In the higher education context, this model would potentially require wholesale reevaluation of the eight measurement dimensions for relevancy. This

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issue made use of this framework a larger task than desired for the timeframe of this study.

Avoiding the inherent pitfalls of using a global framework and an overly complicated evaluation matrix, the integrative measurement framework proposed by Barzilai-Nahon (2006) was used to develop the conceptual model for measuring the digital divide in higher education. This digital divide index framework allows researchers the freedom and flexibility to create a measurement instrument that is both unit of analysis and item independent, but still offers a complex modeling of relationships between digital divide factors. This particular framework avoids some of the pitfalls identified by other frameworks.

After critically analyzing existing indices and frameworks as well as reviewing the digital divide literature, Barzilai-Nahon (2006) proposed that six factors have a direct impact on the ability to describe the status of the digital divide as well as an indirect influence on each other. The six factors in this comprehensive model for measuring the digital divide are as follows:

- *Support*: Training and institutional support, which help reduce the digital divide.
- *Affordability:* The increased affordability of products, services, and software as the digital divide is reduced.
- *Sociodemographic factors:* The correlation of different elements of social demographics, such as race, income, and gender, to the digital divide.
- *Use:* How technology is used, which is a factor in explaining the digital divide.
- *Infrastructure:* The foundational aspects of the digital divide, including networking and broadband access.

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- *Access:* A rarely studied factor of access to technology by individuals with physical disabilities.

For this study, the researcher made some modifications to the comprehensive measurement and weightings of the key factors of the digital divide index model to effectively describe and measure the status of the digital divide within higher education. To operationalize the framework for this study, the factors of the digital divide index framework were used to calculate a technology capacity index (TCI) score for individual institutions. Comparisons of TCI scores between groupings of institutions by institutional characteristics were used to define whether a digital divide was evident in higher education.

Table 1.1 shows the adapted factors along with sample measures gathered from the literature and relationships that comprise the TCI for higher education.

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