AN ANALYSIS OF INTERNATIONAL STUDENT ACHIEVEMENT TEST OUTCOMES AND THE COMPETITIVENESS OF NATIONS

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David D. Meyer

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Major Professor: David Chaplin, Ph.D.

AUTHORIZATION TO SUBMIT

DISSERTATION

This dissertation of David Daniel Meyer, submitted for the degree of Doctor of Philosophy with a major in Educational Leadership and titled "An Analysis of International Student Achievement Test Outcomes and the Competitiveness of Nations" has been reviewed in final form. Permission, as indicated by the signatures and dates given below, is now granted to submit final copies.

Major Professor ______________________ Date 2 April 2015
Dr. David Chaplin

Committee Members ______________________ Date 2 April 2015
Dr. Don Bingham

______________________ Date 4-2-15
Dr. Paula Kellerer

Program Administrator ______________________ Date 4-2-15
Dr. Heidi Curtis

Discipline's College Dean ______________________ Date 4-2-15
Dr. Paula Kellerer

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DEDICATION

This dissertation is dedicated to my father, Dr. Andrew Meyer, who devoted his life to education, serving as a math teacher, counselor, vice-principal, principal, assistant-superintendent, and finally superintendent in the California and Idaho public school systems. He completed his doctorate on the topic of why school districts fail financially. His devotion to public education has always inspired me, but never more so than now. As I grow older and spend more years in the public education system serving in the same capacities he did, my appreciation for his talents and hard work deepens.

ABSTRACT

This study examines the correlation between international student achievement test outcomes and national competitiveness rankings. Student achievement data are derived from a variation-adjusted, common metric data set for 74 countries that have participated in any of the international mathematics and science achievement tests since 1964. National competitiveness data are taken from the 2014-15 Global Competitiveness Index published by the World Economic Forum. A Spearman's rank-order correlation was run to assess the relationship between student performance on international achievement tests and the competitiveness of nations. Preliminary analysis showed the relationship to be monotonic, as assessed by a visual inspection of a scatter plot. For all nations, there was a moderate positive correlation between student performance on international achievement tests and the competitiveness of a nation, r_s (98) = 0.688, $p < .001$. However, this relationship disappeared among the 18 most competitive nations, the cohort to which the United States belongs. The relationship also disappeared among the 18 nations with the highest achievement scores on international tests. Student performance on international assessments appears to have no relationship to the competitiveness of the United States. This study has implications for legislators and public education leaders who want to maximize the return on investments in education. Education dollars and initiatives should be diverted away from accountability initiatives for high-stakes exam outcomes toward addressing poverty, equitable school funding, social stress and violence, support for young families, and support for students of immigrant families.

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Chapter I

Introduction

The International Association for the Evaluation of Educational Achievement (IEA) administered the First International Mathematics Study (FIMS) to 13-year-olds in 12 countries in 1964 (OECD, 2010). This inaugurated an era of international student achievement comparisons and discussion about the impact of student achievement on national competitiveness in a global economy. During this same decade, economists became interested in measuring the impact of investments in education on national output and income. Modern economic growth theory originated with early empirical work by Cass (1965), Denison (1962, 1967), Solow (1956, 1957), and Swan (1956), who investigated the effects of capital and labor investments on economic growth. While effective at predicting short-term growth and convergence from diminishing returns on investment, neoclassical growth theory could not anticipate long-term growth because technological progress was kept exogenous to the model (Barro, 1996). Convergence is the theory that underdeveloped nations will experience a faster rate of growth than developed nations and will eventually catch up to them (Acemoglu, 2009). Shultz (1961) argued that inputs in capital and raw labor alone are not enough to explain economic growth. Human capital has direct effects on growth as well as indirect effects on physical capital and labor through the development of new ideas and technologies (Mankiw, Romer, and Weil, 1992). Building on the work of Shultz (1961) economic theorists began to look more closely into the dynamics of human capital formation on technological progress and growth (Arrow, 1962; Becker & Tomes, 1976; Ben Porath, 1967; Uzawa, 1965).

The trouble with the neoclassical theory of convergence is that it cannot explain why developed nations continue to outpace underdeveloped nations in the long term

(Barro, 1996; Lucas, 1988). Pritchett (1997) conducted a simulation of divergence of per capita GDP between 1870 and 1985 for 125 nations using data from the Penn World Tables. According to Pritchett (1997), developed nations as a group have shown strong evidence of convergence since 1870, while less developed nations have actually shown divergence. Among less developed nations growth has been inconsistent, volatile, and unpredictable (Pritchett, 1997). The missing piece of the equation, according to modern economic theorists, is technological progress, generated though the supply of new ideas from human capital (Barro, 1996; Barro, 2012; Barro & Becker, 1989; Mankiw, Romer, and Weil, 1992; Mtiigan & Sala-i-Martin, 1993; Roys & Seshadri, 2013).

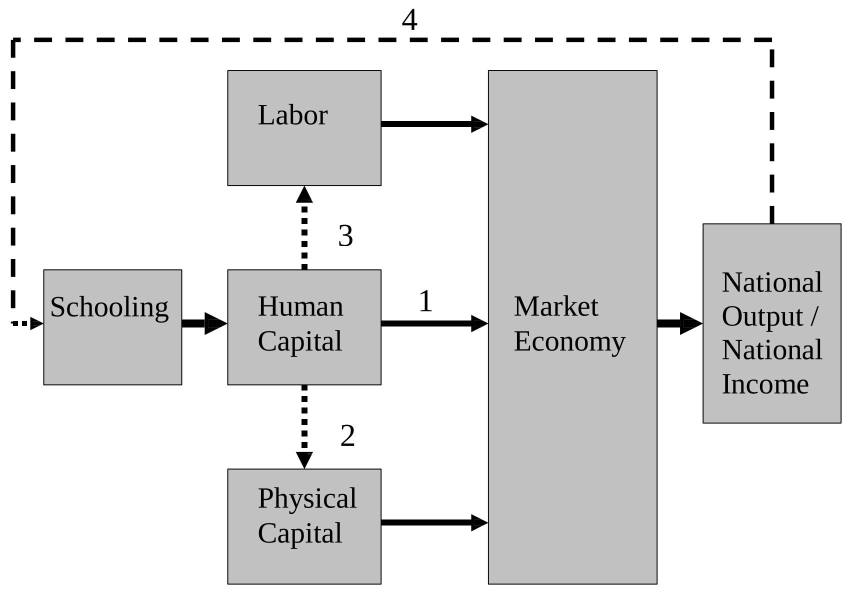
Contemporary empirical work extends the neoclassical model to incorporate human capital inputs, resulting in a model that is flexible enough to predict long-term growth and allow for the possibilities of convergence, divergence and diminishing returns (Barro, 2012; Barro & Becker, 1989; Mincer, 1974; Roys & Seshadri, 2013). Mankiw, Romer, and Weil (1992) used a Cobb-Douglas (1928) production function to model the complimentary dynamics of physical capital, human capital and labor. This expanded framework is called the augmented Solow growth model, or MRW (Mankiw, Romer, & Weil, 1992):

(1) $$Y = K^{\alpha} H^{\beta} L^{1-\alpha-\beta}$$

Where (Y) is national income, (K) is physical capital, (H) is human capital, and (L) is labor. Breton (2013) states that the MRW framework (Figure 1) is an effective way to understand the impact of investments in human capital on productivity and income at the national level.

Figure 1

Effect of Schooling on National Income in a Market Economy



MRW shows the direct (solid lines) and indirect (dashed lines) relationship between education, human capital, physical capital, labor, and income (Breton, 2013). Bernanke and Gurkaynak (2002) suggest researchers utilize MRW as a framework for evaluating any balanced growth model. This study evaluates the effects of cognitive skills on economic competitiveness within the MRW theoretical framework and the Hanushek-Woessmann educational production function:

(2) $g = \gamma H + \beta X + \varepsilon$

Where g is a country's growth rate, H is the skills of workers, and X is the variable for other factors including initial levels of income and technology, economic institutions, and other systematic factors (OECD, 2010).

The Hanushek-Woessmann production function builds on underlying models of human capital formation including intergenerational transmission of human capital (Becker & Tomes, 1976), years of schooling and economic growth (Mincer, 1974), the relationship between education and the development of new ideas and technologies (Barro, 1996; Lucas, 1988; Romer, 1986) the complimentary dynamics of physical capital, human capital and labor (Mankiw, Romer, and Weil, 1992), and theories of technological diffusion (Benhabib & Spiegel 2002; Nelson & Phelps, 1966). The Hanushek-Woessmann model measures cognitive skills, whereas previous models have utilized years of schooling as the human capital measure. School attainment is an ineffective measure because it assumes educational quantity produces equivalent levels of educational quality regardless of location (Hanushek & Woessmann, 2007; OECD, 2010).

Not long after the administration of FIMS, the First International Science Study (FISS) followed, and then the Second International Math Study (SIMS) and Second International Science Study (SISS). Table 1 illustrates the various international students achievement tests that have been administered since 1964. In 1995, the IEA administered the Third International Mathematics and Science Study (now referred to as Trends in Mathematics and Science Study or TIMSS). Nine and thirteen-year-olds in 46 countries participated (OECD, 2010). The Organisation for Economic Co-operation and Development (OECD) began assessing the performance of 15-year old students worldwide in 2000 using The Programme for International Student Assessment (PISA). The PISA has been administered every three years since 2000. The media has myopically focused public attention exclusively on the relative ranking of nations, rather than the larger picture of what a nation might learn from the assessment results (Pons, 2011). For nations that have rankings below the OECD average, this has resulted in alarm and efforts to update or repair apparently broken education systems (Alegre & Ferrer, 2010; OECD, 2010; Tienken, 2008).

Table 1

The International Student Achievement Tests

	Abbr.	Study	Year	Subject	Age[a,b]	Countries[c]	Organisation[d]	Scale[e]
1	FIMS	First International Mathematics Study	1964	Mathematics	13,FS	11	IEA	PC
2	FISS	First International Science Study	1970-71	Science	10,14,FS	14,16,16	IEA	PC
3	FIRS	First International Reading Study	1970-72	Reading	13	12	IEA	PC
4	SIMS	Second International Mathematics Study	1980-82	Mathematics	13,FS	17,12	IEA	PC
5	SISS	Second International Science Study	1983-84	Science	10,13,FS	15,17,13	IEA	PC
6	SIRS	Second International Reading Study	1990-91	Reading	9,13	26,30	IEA	IRT
7	TIMSS	Third International Mathematics and Science Study	1994-95	Mathematics/ Science	9(3+4), 13(7+8),FS	25,39,21	IEA	IRT
8	TIMSS-Repeat	TIMSS-Repeat	1999	Mathematics/ Science	13(8)	38	IEA	IRT
9	PISA 2000/02	Programme for International Student Assessment	2000+02	Reading/ Mathematics/ Science	15	31+10	OECD	IRT
10	PIRLS	Progress in International Reading Literacy Study	2001	Reading	9(4)	34	IEA	IRT
11	TIMSS 2003	Trends in International Mathematics and Science Study	2003	Mathematics/ Science	9(4),13(8)	24,45	IEA	IRT
12	PISA 2003	Programme for International Student Assessment	2003	Reading/ Mathematics/ Science	15	40	OECD	IRT

Notes:
a. Grade in parentheses where grade level was target population.
b. FS= final year of secondary education (differs across countries).
c. Number of participating countries that yielded internationally comparable performance data.
d. Conducting organisation: International Association for the Evaluation of Educational Achievement (IEA); Organisation for Economic Co-operation and Development (OECD).
e. Test scale: percent-correct formal (PC); item-response-theory proficiency scale (IRT).
Source: Hanushek and Woessmann (2009). Used with permission.

Statement of the Problem

Macroeconomic studies on the topic of international student achievement test outcomes and economic competitiveness have attracted the increasing attention of researchers since the turn of the 21st century, but are still relatively few in number (Chen & Luoh, 2010; Hanushek & Kimbo, 2000; Tienken, 2008; Yu, 2012; Yu, DiGangi & Jannasch-Pennell, 2012). Research has left gaps in the literature due to the exclusion of one or more international student achievement tests (ISAT), the use of academic attainment instead of an achievement proxy, the lack of a time lag analysis, and an insufficient index to measure economic competitiveness (Acar, 2012; Baker, 2007; Chen & Luoh, 2010; Hanushek & Woessmann, 2010b; Loveless, 2009; Yu, 2012; Yu, DiGangi & Jannasch-Pennell, 2012).

Studies that look for relationships only between one ISAT and other economic indicators do not provide a complete picture since each test has its own unique format and purpose (Acar, 2012; Hoi, Yan & Chan, 2008). Studying relationships between academic attainment and economic indicators assumes that a year of education has the same value for students regardless of where they live (Hanushek & Woessmann, 2007). The lack of a time lag analysis is problematic because there must be evidence that the educational input has a positive impact on economic output. Without a time lag, the children will not be old enough to be contributing to the economy (Yu, DiGangi & Jannasch-Pennell, 2012). Most studies look for relationships between academic inputs and gross domestic product (GDP), which is a measure of economic growth, not competitiveness. A reliable measure of competitiveness is the Global Competitiveness Index (GCI) produced by the World Economic Forum (Tienken, 2008). This study overcomes these limitations by utilizing the OECD common-scale metric of student achievement on all ISATs over the past 50 years and archival data from the World Economic Forum 2014-15 Global Competitiveness Report.

Up to this point in time, studies have largely focused on analyses between countries within individual assessments, and justifiably so. Each test has its own unique format and purpose, making a common ISAT scale elusive (OECD, 2010). Utilizing the International Data on Cognitive Skills common ISAT scale from the publication *The High Cost of Low Educational Performance: The Long-Run Economic Impact of Improving PISA Outcomes*, it is possible to standardize the results for all ISATs since 1964 (OECD, 2010). Filling this gap in the literature provides policymakers with more information about the validity of using ISAT achievement results to make predictions about the United States' competitive status in the world.

Background to the Study

Education reform in America began in earnest after the passage of the National Defense Education Act (NDEA) in 1958. The NDEA was passed in response to the launch of Sputnik and the subsequent perception that America was falling behind the Soviets in the fields of science and technology (Department of Education, 2012b). In 1965 Congress passed the Elementary and Secondary Education Act (ESEA), which has been reauthorized numerous times, the most recent being the No Child Left Behind Act of 2001. The ESEA mandates that states receiving federal Title money develop academic standards and increase accountability for student achievement (Department of Education, 2014).

The National Commission on Excellence in Education released *A Nation At Risk* (ANAR) in 1983, which claimed that, "Our once unchallenged preeminence in commerce, industry, science, and technological innovation is being overtaken by competitors throughout the world" (Department of Education, 1983). The first piece of evidence used to make this claim was U.S. performance on international student achievement tests compared with other industrialized nations. The ANAR report referenced Sputnik, claiming that average achievement on the College Board's Scholastic Aptitude Tests for high school students was lower in 1983 than 26 years previous when Sputnik was launched (Department of Education, 1983). This reignited concern that America's public school system was broken and reform efforts were redoubled across the nation.

The National Governors Association (NGA) met in 1986 and among its many recommendations, suggested that the U.S. education system benchmark its performance against international competitiveness (Alexander, 1986). President Bush's *America 2000* and President Clinton's *Goals 2000* specifically stated (in Goal 4 of *America 2000* and Goal 5 of *Goals 2000*) that American students should score first in the world in science and mathematics by the year 2000 (Department of Education, 1991, 1994). This goal was not met, and in 2002 President Bush signed into law the No Child Left Behind Act (NCLB). For the next decade, public schools labored under the requirements of NCLB to develop rigorous achievement standards and statewide assessments to measure student progress toward 100 percent proficiency for all students. The outcome of NCLB was a portrait of failure; more than half of America's schools were considered "failing" by 2010 and the rest were not far behind. In Massachusetts, a state considered to have the most rigorous standards, 80 percent of the schools were not making adequate yearly progress as required by NCLB (Karp, 2014).

In 2009, the National Governors Association and the Council of Chief State School Officers met to develop the Common Core State Standards Initiative. In a 2009 press release, the NGA made numerous references to American students falling behind their international counterparts. The press release promoted the need for common standards that can be benchmarked to other top performing nations around the world so that American students would be prepared to compete internationally (National Governors Association, 2009). In 2010, President Obama submitted to Congress his ideas for the reauthorization of ESEA citing in his introductory letter the moral imperative of creating a world-class education system in the United States (Department of Education, 2011). Facing a gridlocked Congress, President Obama and U.S. Secretary of Education Arne Duncan developed ESEA waivers whereby states could obtain relief from NCLB sanctions (Department of Education, 2012a). Among the requirements to obtain an ESEA waiver was the requirement that states develop college and career-ready standards, defined as “standards that are common to a significant number of states” (Department of Education, 2014).

Pons (2011) notes that most of the media attention from international assessment results has focused on the rank order of the countries themselves, rather than a deeper discussion and analysis of what is driving the relative success or failure of participating nations. The concern that the United States might be falling behind the rest of the world has led to reform efforts in public schools such as increased accountability through standardized testing. However, Wu (2010) points out that the statistical complexities of large-scale assessments make it difficult for policymakers to recognize the caveats in the data, leading to misguided conclusions and inappropriate policy decisions.

The degree to which international assessment data is misquoted or assumptions misunderstood casts doubt about how useful assessments are as tools for guiding national education policy (Baker, 1997; Breton, 2012; Tienken, 2008). Yore, Anderson, and Mei-Hung Chiu (2010) argue that politicians want fast and immediate results and use research data to justify their policy positions. International assessments are used as the impetus to pass previously designed policy initiatives, rather than being used for the purpose of crafting policy based on data (Chiu, 2010). Modern economic growth theory postulates that investments in education will produce future economic growth returns (Hanushek & Kimbo, 2000). Policies that use international student achievement test outcomes as indicators of whether or not American students will be able to compete in the future presume that there is a correlation between student achievement test metrics and economic competitiveness indicators.

Research Hypotheses and Question

This study examines the relationship between international student achievement test performance and national competitiveness. The first null hypothesis of this study (H_o1) states that there will be no relationship between international student achievement test scores in mathematics and science, as measured by the International Data on Cognitive Skills and the 2014-15 Global Competitive Index. The first alternate hypothesis (H_A1) of this study states that there will be a relationship between international student achievement test scores in mathematics and science, as measured by the International Data on Cognitive Skills and the 2014-15 Global Competitive Index.

The second null hypothesis of this study (H_o2) states that when the GCI is divided into quartiles, there will be no relationship between international student achievement test scores in mathematics and science, as measured by the International Data on Cognitive Skills and the 2014-15 Global Competitive Index for nations in the top 25 percent of competitiveness. The second alternate hypothesis (H_A2) of this study states that when the GCI is divided into quartiles there will be a relationship between international student achievement test scores in mathematics and science, as measured by the International Data on Cognitive Skills and the 2014-15 Global Competitive Index for nations in the top 25 percent of competitiveness.

The third null hypothesis of this study (H_o3) states that when the COG is divided into quartiles, there will be no relationship between international student achievement test scores in mathematics and science, as measured by the International Data on Cognitive Skills and the 2014-15 Global Competitive Index for nations in the top 25 percent of achievement. The third alternate hypothesis (H_A3) of this study states that when the COG is divided into quartiles, there will be a relationship between international student achievement test scores in mathematics and science, as measured by the International Data on Cognitive Skills and the 2014-15 Global Competitive Index for nations in the top 25 percent of achievement.

An explanatory correlation research design is used to evaluate the extent to which ISAT scores for 74 of the 77 countries that have participated in any of the international mathematics and science tests since 1964 co-vary with statistics on international competitiveness. Three countries were excluded because they are not part of the 2014-15 Global Competitiveness Index (Liechtenstein, Macao-China, Palestine). Creswell (2012) states that research questions help narrow and focus a study's research design. This study answers the following research question:

1) What relationship, if any, exists between international student achievement test scores in mathematics and science, as measured by the International Data on Cognitive Skills and the 2014-15 Global Competitive Index?

Primary grades through the end of secondary school are included in the regression analysis for all years, 1964 through the 2003 cycles of PISA and TIMSS for 74 of the 77 countries that have participated in one or more of the mathematics or science ISATs.

Description of Terms

Actor-Network Theory. A research approach that investigates the underlying assumptions, biases, interests and needs of the groups involved in the creation of allegedly objective research data or examinations (Gorur, 2011).

Between-school Variance. The degree to which student outcomes vary between schools within an education system (Ho, 2010; Shukakidze 2008).

Convergence. In economics, the theory that underdeveloped nations will experience a faster rate of growth than, and eventually catch up to, developed nations because of the principle of diminishing returns (Acemoglu, 2009).

Competitiveness. The set of institutions, policies, and factors, which determine the level of productivity of a nation (Schwab, 2014)

Gross Domestic Product (GDP). In economics, GDP is a measure of the productivity of a nation. GDP is the sum of the market value of all the goods and services produced by a country in a given year (Acemoglu, 2009)

Human Capital. In economics, the intellectual ability, innovative capacity, creativity, skills, training, and knowledge possessed by the people in an economy (Acemoglu, 2009).

Neoclassical Growth Theory. In economics, a growth model that predicts economic growth purely as a function of capital and labor inputs (Acemoglu, 2009).

Open/Closed Education Systems. Open education systems have uniform standards, funding and pedagogy across states, provinces, and/or territories within a nation, while closed education systems are decentralized, characterized by inequities in funding, rigor of standards and pedagogy, and emphasize choice in the public education system, including public and private options and charter or voucher programs (Perelman & Santin 2011).

Physical Capital. In economics, the physical equipment, buildings, or machinery used for production (Acemoglu, 2009).

Production Function. In economics, the relationship between physical outputs and inputs in the production process (Acemoglu, 2009).

Stratified Education System. The classification of students into distinct groups. A stratified education system is one that enables students/families to self-select into separate education programs (Perelman & Santin 2011).

Technology/Technological Diffusion. In economics, the process by which new innovations and ideas spread (Acemoglu, 2009; Benhabib & Spiegel, 2002; Nelson & Phelps, 1966).

Time-lag Analysis. A study that examines data with a space of time between two datasets. Time-lag analyses are used because it takes time to see the results in the economy of education inputs (Yu, DiGangi & Jannasch-Pennell, 2012).

Undocumented Immigrant. A foreign national living unregistered in another country (Martin, Liem, Mok, & Xu, 2012).

Voucher Schools. School funded entirely or in part through government vouchers. Voucher law typically allows the public to spend the voucher at any school of choice, including private schools (Perelman & Santin 2011).

Significance of the Study

Previous research on international assessment outcomes and the economic and psychological well-being of nations has left gaps in the literature due to one or more of the following: the exclusion of one or more ISATs, the use of academic attainment instead of an achievement proxy, the lack of a time lag analysis, and an insufficient index to measure economic competitiveness (Chen & Luoh, 2010; Hanushek & Kimko, 2000; Hoi Yan & Chan, 2008; OECD, 2010; Peterson et al., 2011; Yu, 2012; Yu, DiGangi & Jannasch-Pennell, 2012). Studies that have analyzed the relationship between international assessments and the economy have almost universally focused on growth, using gross domestic product (GDP) as the metric (Baker, 2007; Bils & Klenow, 2000; Breton, 2013; Hanushek & Woessmann, 2007; Hoi Yan & Chan, 2008; OECD, 2010; Ramirez et al., 2006; Yu, 2012; Yu, DiGangi & Jannasch-Pennell, 2012). However, the central question of our day is whether or not the

United States is falling behind other nations competitively because of a failure on the part of its public education system to prepare students adequately for the future.

Tienken (2008) used the Global Competitiveness Index (GCI) published by the World Economic Forum as the metric for competitiveness in an analysis of the relationship between selected international assessment rankings and GCI rankings. GCI was used because it is a multi-faceted index that considers survey data and leading economic indicators to create national economic profiles and relative competitiveness between nations (Tienken, 2008). This study also uses GCI as the competitiveness metric because GCI has proven to be a reliable tool for predicting economic growth in the United States (Tienken, 2008).

While the findings from Tienken (2008) are important from a public policy perspective, the research literature still lacks a competitiveness study that uses a single, standardized metric that comprises all of the international assessments administered since 1964. Provasnik et al. (2009) explains that the various ISATs cannot be compared with each other directly because the purpose of each assessment, the subject matter, and grade or age assessed are different. Thus, up to this point in time, analyses have been between countries within individual assessments. Utilizing the International Data on Cognitive Skills common ISAT scale from the publication entitled *The High Cost of Low Educational Performance: The Long-Run Economic Impact of Improving PISA Outcomes*, it is possible to unify all of the ISATs since 1964 (OECD, 2010) and compare that metric with the GCI. Filling this gap in the literature provides policymakers with more information about the validity of using ISAT achievement results to make predictions about the United States' competitive status in the world.

Hanushek and Woessmann (2010b) describe the major benefits of conducting international studies on student achievement:

- International studies allow for greater institutional variation, important for empirical analysis, than could be achieved at the national level.
- Achievement data from multiple countries can explain whether observed phenomena are country-specific, apply across nations, or are coincidental.
- Differences in results across countries can lead to further inquiry about why those differences occurred.
- Selection bias can be avoided by aggregating institutional variables.
- Aggregated comparisons across countries make it possible to uncover important effects of variables that otherwise might be missed.

Limitations to international studies on student achievement, according to Hanushek and Woessmann (2010b) include:

- There are a limited number of countries cooperating to produce common data sets.
- Longitudinal research is impossible due to the cross-sectional design of international assessment instruments.
- Cultural factors may introduce bias.

Overview of Research Methods

This study evaluates the effects of cognitive skills on economic competiveness within the MRW theoretical framework and the Hanushek-Woessmann educational production function. The Hanushek-Woessmann production function builds on numerous underlying models of human capital formation (Mincer, 1974; Becker & Tomes, 1976; Romer, 1986; Lucas, 1988;

Mankiw, Romer, & Weil, 1992; Barro, 1996; Benhabib & Spiegel, 2002; Nelson & Phelps, 1966). The hypotheses of this study are:

- H_o1: There will be no relationship between international student achievement test scores in mathematics and science, as measured by the International Data on Cognitive Skills and the 2014-15 Global Competitive Index.
- H_o2: When the GCI is divided into quartiles, there will be no relationship between international student achievement test scores in mathematics and science, as measured by the International Data on Cognitive Skills and the 2014-15 Global Competitive Index for nations in the top 25 percent of competitiveness.
- H_o3: When the COG is divided into quartiles, there will be no relationship between international student achievement test scores in mathematics and science, as measured by the International Data on Cognitive Skills and the 2014-15 Global Competitive Index for nations in the top 25 percent of achievement.

The GCI is a multi-faceted index that considers survey data and leading economic indicators to create national economic profiles and relative competitiveness between nations (Tienken, 2008). Since the GCI ranks nations based on relative competitiveness, the data is ordinal (Tanner, 2012). In an email correspondence, Dr. Eric Hanushek of Stanford University described the OECD data as ordinal because they are psychometric constructs (E. Hanushek, personal communication, February 26, 2014). According to Tanner (2012), the best statistic to use for ordinal data is Spearman's *rho*. Spearman's *rho* is used to determine correlations between ordinal scale variables, or interval scale variables that have been reduced to ordinal scale (Tanner, 2012). Archival data of student achievement on all ISATs over the past 50 years is used for this study. The International Association for the Evaluation of Educational Achievement and the Organisation for Economic Co-operation and Development are the two organizations that have conducted ISATs and collected the student achievement data since 1964 (OECD, 2010). The International Data on Cognitive Skills (COG) is a standardized metric of performance for all participating countries on all ISATs developed by the IEA and OECD since 1964.

The Human Research Review Committee (HRRC) at Northwest Nazarene University approved this study on March 11, 2014 and authorized the research. Spearman's *rho* correlations of the OECD common-scale metric of student achievement on all ISATs over the past 50 years and of archival data from the World Economic Forum 2014-15 Global Competitiveness Report were used to model the relationship between ISAT average test scores in mathematics and science and the GCI. The strength and direction of the correlational tests were analyzed. This study incorporated a time-lag analysis of ISAT data from 1964-2003 with 2014-15 GCI data, ensuring that the students who participated in the 2003 ISATs are now 25 years old and can be contributing to the economy. In a phone conversation, Chong Ho Yu of Azusa Pacific University explained that concurrent studies lacking a time lag do not ensure that the students who took the international assessments are the same people who are now contributing to the economy (C. Yu, personal communication, August 30, 2013).

Large-scale assessments like PISA and TIMSS have a number of inherent measurement, sampling and equating errors (OECD, 2010; Hanushek & Woessmann, 2010a; Tienken, 2008; Yu et al., 2012; Yu, 2012). There are a limited number of countries cooperating to produce common data sets (Hanushek & Woessmann, 2010a). Longitudinal research is impossible due to the cross-sectional design of international assessment instruments (Hanushek & Woessmann, 2010b). Furthermore, the cross-sectional design only shows correlations, not causation (Loveless, 2009). This study utilizes a common-scale metric that has been calibrated based on the standardization group that participated in PISA 2000. The PISA assessment, upon which the common-scale metric depends for a variation-adjusted test score, has a number of limitations that are noted in more detail in Chapter 3. Poverty and cultural influences have been shown to correlate with achievement on standardized test scores, which may introduce downward or upward bias (Ammermueller, 2007; Bracey, 2009; Hanushek & Woessmann, 2010b; Tienken, 2008).

Chapter II

The Literature Review

Introduction

International student achievement tests (ISATs) have been used since 1964 to assess the progress of U.S. students compared to their counterparts in other nations. Alegre and Ferrer (2010) point to the 1966 Coleman report as the beginnings of research into the effects of various school types on academic outcomes. According to Tienken (2008), ISAT results have influenced education policy in the United States for the past 50 years. There is a vast body of research on the topic of international assessments, human capital formation, and economic competitiveness (Gutema & Bekele, 2004; Hanushek & Kimbo, 2000; Hoi Yan & Chan 2008; Ramirez et al., 2006). These studies demonstrate that national economic growth (GDP) is related to the quality of a country's human capital, which can be improved by a country's policies and institutions.

Most of the available research literature can be categorized into three large areas that focus on the following:

- The validity of comparing nations with vastly different demographics and geographical size (Ammermueller, 2007; Bracey, 2009; Cavanagh & Manzo, 2009; Loveless, 2009; Martin et al., 2012; Perry, 2009; Petrilli, Scull, & Thomas B. Fordham, 2011; Shiel, & Eivers, 2009; Yu et al., 2012),
- The student-level and school-level factors that affect student achievement (Alegre & Ferrer, 2010; Andersen, 2010; Aydin, Erdagf & Tas, 2011; Choi, Calero & Escardibul 2012; Demir & Kiliç, 2010; Gilleece, Cosgrove, & Sofroniou, 2010; Ho, 2010; Kilic, Çene, & Demir, 2008; Liu, Wu & Zumbo 2006; Marks, 2006; Yildirim, 2012; Zhang & Kong, 2012), and

- The merits of specific school reforms (Anil, 2011; Bybee & Stage, 2008; Chou, 2012; Dolin & Krogh, 2010; Finkel, 2012; Frede & Barnett, 2011; Hofman, Hofman, & Gray, 2010; Pons, 2011; Yore et al., 2010).

A smaller body of research focuses on international assessment outcomes and what, if any, relationship those outcomes have with the economic and psychological well-being of nations (Chen & Luoh, 2010; Hanushek & Kimko, 2000; Hoi Yan & Chan, 2008; OECD, 2010; Peterson et al., 2011; Yu, 2012; Yu, DiGangi & Jannasch-Pennell, 2012). However, this smaller body of research has left gaps in the literature due to one or more of the following: the exclusion of one or more ISATs, the use of academic attainment instead of an achievement proxy, the lack of a time lag analysis, and an insufficient index to measure economic competitiveness. Studies that have analyzed the relationship between international assessments and the economy have almost universally focused on growth, using gross domestic product (GDP) as the metric (Baker, 2000; Bils & Klenow, 2000; Breton, 2013; Hanushek & Woessmann, 2007; Hoi Yan & Chan, 2008; OECD, 2010; Ramirez et al., 2006; Yu, 2012; Yu, DiGangi & Jannasch-Pennell, 2012). The literature needs more studies that analyze connections between student achievement on international assessments and competitiveness (Tienken, 2008).

Theoretical Framework

Meyer, Boli, Thomas, and Ramirez (1997) argue that the calamities of WWII and the subsequent Cold War gave rise to economic theories of human progress and development. The idea that nation-states can directly impact socioeconomic development has been deeply institutionalized at a global level and has become the basis for production and modification of societal structures (Meyer et al., 1997). This idea, however, is frequently at odds with inconvenient realities. For example, mass schooling with the accompanying societal belief that it is necessary and beneficial for economic growth often goes unquestioned even though the functional correlation between mass education as a societal structure and economic growth is weak and highly conditional (Meyer et al., 1997). The idea that nation-states are products of the policies and actions of legislative bodies is contrasted with the idea that socio-political forms will naturally arise from society, independent of the nation-state. By far, the model of rational state actor with its accompanying goals, territorial boundaries, notions of individual rights, and law-based control systems, dominates how nations present themselves in the world today (Meyer et al., 1997). Research into the effects of student academic achievement on human capital formation and economic growth is unavoidably connected to this economic growth model.

Ramirez et al. (2006) cite examples of the public criticism America’s schools have received from policy-makers due to mediocre academic achievement on international assessments in mathematics and science. An illustration from the National Research Council shows the popular line of reasoning: that improvement in pedagogical approaches will lead to greater achievement on ISATs, which will lead to increasing numbers of students majoring in science and engineering, which will lead to more scientists and engineers in the labor force, which will lead to national economic growth and development (Ramirez et al., 2006). This line of reasoning is encapsulated by human capital and modernization theories. Ramirez et al. (2006) stresses the importance of moving the national conversation beyond causation towards a discussion of what specific conditions lead to economic growth and labor-force quality.

This study evaluates the effects of cognitive skills on economic competitiveness within the MRW theoretical framework and the Hanushek-Woessmann educational production function. The Hanushek-Woessmann production function builds on underlying models of human capital formation including intergenerational transmission of human capital (Becker & Tomes, 1976), years of schooling and economic growth (Mincer, 1974), the relationship between education and the development of new ideas and technologies (Barro, 1996; Lucas, 1988; Romer, 1986), the complimentary dynamics of physical capital, human capital and labor (Mankiw, Romer, and Weil, 1992), and theories of technological diffusion (Benhabib & Spiegel, 2002; Nelson & Phelps, 1966). The Hanushek-Woessmann model measures cognitive skills, whereas previous models have utilized years of schooling as the human capital measure. School attainment is an ineffective measure because it assumes educational quantity produces equivalent levels of educational quality regardless of location (Hanushek & Woessmann, 2007; OECD, 2010).

Diversity, Immigration, Gender, and Geography

After reviewing the results of the 2000 PISA showing that German students performed well below the OECD average, a public outcry led politicians to ask why Germany performed so poorly and what could be done to improve test results. Ammermueller (2007) noted that Germany's ranking in PISA 2000 would have improved if immigrant students had been excluded from the comparison. Immigrant students do not perform as well on PISA in Germany primarily due to the fact that as a group they enroll later in school, repeat courses at a higher rate, and have home environments that do not provide assistance or resources to help the student with schoolwork (Ammermueller, 2007). The differences in characteristics and determinants of test scores between native and immigrant students in Germany were examined. Germans were defined as students whose parents were both born in Germany (81 percent of the sample); "immigrants" were considered students with at least one parent born abroad. Ammermueller (2007) found that the background of students is the most decisive factor in explaining student performance on the PISA. The effects of immigration in Germany on PISA scores might help explain the lower U.S. score on the PISA considering that both Germany and the United States have open immigration policies.

PISA score differences between Finland and Denmark point to immigration policy as a possible factor influencing international student rankings on PISA (Andersen, 2010). Finland continues to outperform Denmark on the PISA in spite of Denmark having one of the world's most expensive education systems. Andersen (2010) discovered that the subgroup creating the performance disparity was the lowest scoring 25 percent. In this subgroup, the Finnish students outperformed the Danish students. Andersen (2010) postulates the following reasons for the difference: that Finnish teachers are treated with more respect, have classrooms that are more highly structured, and play a central role in the education process during the day. Andersen (2010) admits, however, that the lowest scoring 25 percent of students consist demographically of children from immigrant families known as the 'ghetto-class'. Anderson, Mei-Hung Chiu, and Yore (2010) analyzed datasets from the 2000, 2003, and 2006 PISA of participating countries in the Americas, Asia, Australia, and Europe and found that immigrant status tended to negatively influence achievement.

Scores on the PISA from Ireland suggest that immigration may lead to ranking differences among countries. Ireland ranked 16th in mathematics and 14th in science among participating OECD nations on the PISA 2006 (Gilleece, Cosgrove, & Sofroniou, 2010). Gilleece, Cosgrove, and Sofroniou (2010) found that, "Students who speak languages other than English or Irish at home were about three times more likely to be in the low achievement group than the medium group in both mathematics and science" (p. 491). Acknowledging that immigrant students tend to achieve at significantly lower levels than their nonimmigrant peers, Martin, Liem, Mok, and Xu (2012) point out that, "unregistered or undocumented immigrants are not usually included in PISA data. Thus, nations with large undocumented immigrant numbers may not be adequately represented" (p. 1069). The United States is one such country that has a large number of undocumented children. According to the National School Boards Association, the estimated number of undocumented children living in the United States is more than one million (Borkowski, 2009). If the United States already shows lower performance with the known immigrant statistic, it stands to reason that the United States' rank among nations on PISA would be even lower if the undocumented population were included in PISA data. This tends to support the hypothesis that reliable comparisons between nations cannot be made unless data is disaggregated for student background to account for immigrant status.

Not all researchers agree that the ranking of the United States can be attributed to immigration policy. Schleicher (2009) contends that the slipping rank of the United States in world comparisons is not due to the United States getting worse at educating its citizens; rather other countries are getting better at a faster rate. Schleicher (2011) speaks of a 'first-mover advantage' that the United States has enjoyed since the close of World War II and the subsequent flood of immigration talent to America. Schleicher (2011) points out, however, that the United States has remained unchanged in terms of high school graduation rates (76 percent) while the rest of the world has aggressively surpassed that completion rate at an OECD average of 80 percent. Similarly, increasing college graduation rates in other nations have caused the United States to drop from second place in 1995 to fourteenth place in 2009 (Schleicher, 2011).

Nevertheless, according to Rutkowski and Rutkowski (2010), the achievement data on large-scale assessments such as the PISA cannot be used to make international comparisons based on the cognitive assessment items alone; the context of student background data is also needed. This is challenging because although PISA collects student background data, much of the data is provided at the student level (Rutkowski & Rutkowski, 2010). Students may or may not know the answers to questions like, “What is the highest level of education your parent has attained?” Shiel, and Eivers (2009) studied the effects of gender, reading engagement, and socioeconomic status on achievement in reading literacy and found that one reason Finland does so well on the PISA is due to its homogeneous culture. Aydin, Erdagf, and Tas (2011) found that Turkish students generally do not have higher-order reading skills needed to comprehend implicit information in a text. Gender differences exist in Turkey, with female students scoring on average 34 points higher than males. Still, Turkish females show little ability to do more with a text than draw knowledge from it (Aydin, Erdagf, & Tas, 2011). Kilic et al. (2012) conducted a three-level analysis comparing Turkish mathematics achievement with eight countries and confirmed that gender, socio-economic status, elaboration, control strategy, home resources, possessions, school size, and GDP all have a positive impact on student mathematics achievement. Aydin, Erdagf, and Tas (2011) found that Turkey spends only $1,100 per student at the primary level compared to more than $5,000 per student in successful OECD countries. Lastly, the secondary school graduation rate in Turkey is 45 percent compared with 80 percent in the top-five OECD countries. This translates into very little support at home for high academic achievement (Aydin, Erdagf, & Tas, 2011).

Achieving national agreement about what students should know and be able to do in school is more challenging for a large, diverse nation such as the U.S. compared to a small, homogeneous nation such as Finland (Ammermueller, 2007; Andersen, 2010; Gilleece, Cosgrove, & Sofroniou, 2010; Liem, Mok, and Xu, 2012; Schleicher, 2011). Each state in the U.S. has its own department of education, which is broken down into a number of local districts. Each of these has its own particular culture, curriculum, and measure of academic excellence.

With the advent of Common Core, states are moving closer to national agreement about what students should know and be able to do, but Finland has had this advantage for a long time (Andersen, 2010; Shiel & Eivers, 2009). In Finland, there is agreement about academic outcomes and methodology, a homogeneous culture, and very little diversity to muddy the water (Shiel & Eivers, 2009).

Education Systems, Student and School-level Factors

An ‘open’ education system is one that all students have access to regardless of income, location, ethnicity, or immigrant status. A ‘closed’ system creates barriers to access including self-selection to schools (school choice), inequities in funding and/or academic standards, and inequities in teacher quality from one school to another (Perelman & Santin, 2011). Alegre and Ferrer (2010) conclude that the Coleman report marked the beginning of research into the effects of various school types and their impact on academic outcomes. The Coleman report, published in 1966, found that desegregation would improve the academic performance of black students (Alegre & Ferrer, 2010). It was the beginning of a deliberate, national focus on making public schools in the United States more inclusive through public policy initiatives. Countries that perform at the top on the PISA have education systems that are highly inclusive, publicly directed, and unified in terms of outcomes and pedagogical expectations (Perelman & Santin, 2011). One reason that the PISA scores in the United States are so much lower than Finland, Denmark, China and others may be the high amount of stratification that still exists in the U.S. education system in spite of efforts to make it more inclusive and equitable (Alegre & Ferrer, 2010; Perelman & Santin, 2011). Prior to the Common Core movement, there were no unified national outcome standards for K-12 education. The United States education system is a mixture of public schools, private schools, and charter schools, operated by local education agencies under the jurisdiction of the several states (National Governors Association, 2009). Within the conventional public school system, the U.S. has no national funding mechanism to ensure equitable funding for all schools (Department of Education, 2012b).

Equity of access to high-quality teachers and curriculum regardless of location is another factor that influences student performance. According to Demır and Kiliç (2010) and Šapkova (2013), the number one variable positively associated with student achievement in mathematics is school location. Schools in rural areas and inner cities must be equitably funded so that location is irrelevant to access a high quality education. Immigrant students who cannot afford to live in more affluent areas and attend schools that are adequately funded have little support to make academic gains, thus effecting the aggregate performance of nations that embrace immigration and diversity (Demır and Kiliç, 2010; Šapkova, 2013). Yildirim (2012) highlights four factors that affect student learning. In order of strongest impact to weakest, home and parent factors had an impact of 52 percent, student related factors 14 percent, teaching processes 6 percent, and school environmental factors 1.4 percent. Student learning in Turkey is affected most by low levels of parental educational achievement. Turkish students have few resources at home, particularly in the area of technology (Yildirim, 2012). Turkish students generally feel little motivation to improve their socioeconomic situation through education, and businesses do not make strong connections to the education system (Yildirim, 2012). Edgerton, Peter, and Roberts (2008) also found that socio-economic status, gender, and region persist as sources of student inequity in Canada’s education system. Comparing these findings with the study by Demır and Kiliç (2010) examining factors effecting Turkish student performance in mathematics, and the study by Ho (2010) examining between-school variance in student performance, location appears to play a significant role in student performance in countries with high between-school variance.

Between-school variance is a measure that can be helpful in assessing equity in a country's education system. Between-school variance is the degree to which schools within the region are achieving equitable outcomes (Ho, 2010). A higher percentage of variance indicates that from school to school children will have very different experiences that will affect their academic performance. Shukakidze (2008) uncovered a startling example of between-school variance by comparing the outcomes of PISA 2009 reading scores for two former Soviet republics, Estonia and Azerbaijan. Estonia has attempted to restructure its education system patterned after European Union education systems. The Azerbaijan school system remains very much unchanged from the days of being a Soviet republic. Azerbaijani ninth graders have negative attitudes about school, instruction is teacher-driven with little active participation by students, and teachers do not utilize modern teaching methods (Shukakidze, 2008). Estonian ninth graders outperformed all former Communist bloc countries in the PISA 2009. Azerbaijani ninth graders scored below their peers in 65 different countries and/or economies (Shukakidze, 2008).

Baker and Holsinger (1996) conducted a regional comparison of secondary schools in developing Asian countries and cities (Hong Kong, Korea, Singapore, and Taiwan) to determine if a unique and uniform endogenous Asian model can explain national human capital formation through the expansion of formal schooling. Those who postulate that a unique Asian model of education exist generally argue that after WWII Asian nations rejected the Western approach to human capital and school development and constructed their own approach that is now outpacing the West (Baker & Holsinger, 1996). Alternatively, Baker and Holsinger (1996) investigated whether or not Asian countries have merely benefited from a century-long global trend in expanding state-supported education systems and increasing enrollment in public schools initiated in 1960’s by developed nations such as the United States. Contrary to popular belief, Baker and Holsinger (1996) found that the Asian region as a whole does not have a unique model of school expansion, and at least at the time of the study, were not the global leaders of human capital formation that many portrayed them to be. Marks (2006) contends that socio-economic status (SES) does not explain differences in student performance and Ho (2010) supports that claim, noting that the performance differences among Hong Kong students in science had mostly to do with the lack of resources such as classical literature, poetry, and works of art available in their homes.

Germany scored below the OECD average in Math, Science, and Reading in PISA 2000. This was very embarrassing to the country and policy-makers re-examined their education system. The German Federal Ministry of Education and Research (BMBF) reacted to the nation’s poor PISA performance by creating national standards. Ertl (2006) criticized the standards effort and noted that none of the BMBF reforms addressed systemic problems and location issues. Choi, Calero and Escardibul (2012) found that private tutoring can make a big impact on the academic performance of Korean children. Those families that are wealthy enough to hire better private tutors have an advantage. The children who are able to attend elite colleges end up being the business leaders and policy-makers of Korean society (Choi, Calero & Escardibul, 2012). The idea that students can compensate for a lack of tutoring through self-study fails to recognize that poorer students have fewer educational resources at home, making their self-study time less efficacious. The United States faces a similar situation with a highly stratified system of education; affluent students self-selecting into the best public and private schools or receiving private tutoring, and immigrant and low SES students left to struggle in inadequately funded inner-city and rural schools (Cavanagh, 2007a). The average science score in the United States on PISA 2006 is lower than 16 other countries of 30 industrialized nations (Cavanagh, 2007b). The PISA average is 500 and U.S. students scored 491 (Cavanagh, 2007b). According to Cavanagh (2007a), poverty affects student achievement more in the U.S. than in other countries. Eighteen percent of the variation in science scores was due to socioeconomic factors, compared with only 8 percent in Finland and Canada. This is not due to the United States falling behind per se, but rather to the fact that other countries have school systems that compensate better for socioeconomic variations among students (Cavanagh, 2007a).

How schools are funded may also play a role when it comes to international testing. Hofman, Hofman, and Gray (2010) found that public school systems that have very equitable funding do well on international assessments. Similarly, education systems that have a mix of equitably funded public schools and private schools subsidized by grant aide also do well. Such systems are considered ‘open’. Karpenko, Bershadskaia, and Voznesenskaia (2009) point out that the United States has long held first place in higher education in terms of its foreign college student enrollments. The United States is far and above the world leader in terms of having the majority of the world’s best colleges and universities. It also ranks best in the world in terms of access to higher education, the percentage of the population who complete higher education, and the overall size of the system of higher education. However, when it comes to performance on international assessments like PISA, the United States scores below the international average and is not found ranked even among the top 20 nations (Karpenko et al., 2009, p. 79-80). Baker (1997) found that a major factor contributing to the mediocre performance of U.S. students on TIMSS is the wide variation in classroom achievement from school to school in the United

States. Compared to Japanese students, the distribution of change in mathematics achievement was very wide with a much lower mean. According to Baker (1997), the uneven allocation of resources across American public schools is a major reason why the United States has a marginal TIMSS average compared to other nations. Perry (2009) agrees that a primary reason for the lower ranking of the United States on international achievement tests is that the system of public education in the United States is not open enough in terms of national consistency in pedagogy and distribution of funding. According to Perry (2009):

> With its comprehensive system of secondary education and low levels of privatization, school choice and school selectivity, the United States is a perplexing case. Of the twelve countries in the sample, it has the highest poverty and income inequality rates. It is also the only country in the sample that relies substantially on local funding of public schools, with the result that the resources available to students vary widely across the country. Finally, significant tracking and ability grouping occurs in American secondary schools, which leads to the provision of differentiated education to students. It is likely that high inequality of both income and educational resources, as well as significant tracking within schools, combine to work against features of the American educational system that could promote equity of outcomes (p. 93).

Perelman and Santin (2011) argue that student achievement is based largely on the systemic qualities of the education system. For example, in Spain (and in the United States) students can choose to attend public schools or private-voucher schools. Consequently, the private-voucher schools enroll more students with favorable backgrounds and the public schools enroll a higher percentage of students with less favorable backgrounds. School choice, according to Perelman and Santin (2011), creates a more closed education system that is not conducive to student achievement across all student groups. In a closed system students with less favorable backgrounds (foreigners, the poor, populations with language difficulties, and students with special needs) tend to suffer (Perelman & Santin, 2011). In China, Zhang and Kong (2012) divide their reasons for the success of Chinese students into three traditional factors and six modern factors. The traditional factors contributing to the success of Chinese students are the high value placed on education by parents, a widespread belief that with hard work they can succeed, and a national examination structure that allows for students from all backgrounds to have a chance at a prosperous future if they are smart enough. The modern factors are a willingness to embrace foreign educational theories and methods, large-scale comprehensive pedagogical reform, innovations in teacher training, an emphasis on improving schools with disadvantaged students, reworking systems of financial resource allocation, and the implementation of a quota system for high school admissions (Zhang & Kong, 2012).

Anil (2011) shows that learning time is the most significant predictor of student achievement on PISA in Turkey. Second to time is the environment at home (whether or not students had a place to study, access to a computer and the Internet). Education, environment, attitude and time account for 36 percent of the overall variance of the science achievement score (the dependent variable). Anil (2011) provides additional research regarding the importance of learning time to achievement and recommends that schools allocate more time to science studies to improve scores. From a public policy perspective, Anil (2011) recommends widespread access to the Internet. He also notes a positive correlation between the parents' level of education and student achievement in science: the higher the education of the parent, the higher student achievement is in science.

The solution, it seems, is not desegregation alone. The solution requires redesigning the education system to ensure that common standards are taught in every school in the United States and that every school in the United States is equitably funded so that regardless of where a student lives, he or she will obtain a comparable education (Hofman, Hofman, & Gray, 2010; Perelman & Santin, 2011; Perry, 2009; Zhang & Kong, 2012). However, even that effort is inadequate to make a comparison between U.S. performances on PISA to smaller and/or more homogeneous nations (Cavanagh, 2007a; Cavanagh, 2007b; Perry, 2009). A nation that has a high immigrant population will continue to wrestle with the low performance of students who have limited proficiency in English, are highly transient, and who possess little in the way of resources to help them at home with learning (Demır and Kiliç, 2010; Šapkova, 2013, Yildirim, 2012).

National School Reform Priorities and Needs

The priority a nation places on education and on specific education reforms may affect student performance on international student achievement tests. For example, in the United States, very little priority is placed on early childhood education. Frede and Barnett (2011) argue that the PISA 2009 results demonstrate that the United States must begin to implement pre-K programs on a widespread basis to enable American students to catch up with their counterparts in Shanghai. However, according to Chou (2012) some nations or regions may deliberately choose not to reform their education systems. For example, Macau has not felt any pressure to reform its education system because its casino economy does not depend on highly educated citizens. In fact, a recent report by the Brookings Institution of the fastest growing metropolitan economies ranks Macau number one among 300 cities globally (Parilla, Trujillo, Berube & Ran, 2015). Hong Kong, however, traces much of its political value system to its colonial heritage and has an economy that depends heavily on its education system (Chou, 2012). International comparisons of student performance on ISATs do not necessarily translate into education policy reforms because some countries simply do not place education at the top of the priority list for cultural, economic, or other reasons.

Another example of this is found in Denmark's response to PISA. Dolin and Krogh (2010) point out that the Danish people have traditionally viewed the role of the teacher as a mentor; someone who helps each student to prepare themselves in differentiated ways for the unique contributions they will make in the world. Students have a great deal of say in this cooperative education process. The Danish school system has always provided teachers with a large degree of autonomy (Dolin & Krogh, 2010). Academic frameworks have always been based on cultural traditions rather than specific things that children must know and be able to do (Dolin & Krogh, 2010). The transmission of cultural values and traditions has been the primary purpose of the school for almost two centuries, even if those traditions have not benefited all students (Dolin & Krogh, 2010). Kjaernsli and Lie (2004) uncovered significant academic differences between genders in Denmark and its Nordic neighbors showing a relative advantage for boys in Denmark. The culture of Denmark encourages girls to underachieve by promoting high academic expectations as something only boys should be interested in (Kjaernsli & Lie, 2004).

The recent PISA results, however, have sent Danish education policymakers into a tailspin (Dolin & Krogh, 2010). Even though PISA results show that Danish students are among the most motivated to learn, they score just barely above the average mark in science and math (Dolin & Krogh, 2010). Denmark is feeling global pressure to demonstrate that its students can perform well compared with other students around the world. Such comparisons are new to

Denmark and policymakers are wrestling with the implications of reforming their system of education from a values/culture-transmitter to a knowledge/skills-transmitter (Dolin & Krogh, 2010, Kjaernsli & Lie, 2004).

Through a careful study based in actor-network theory, Gorur (2011) traces the biases and politics embedded in the very origins of the PISA itself. Even though the aim of the exam is to be objective, standardized, and representative of participating nations' student performance, PISA has political, scientific, ethical, and technical limitations and biases due to the various interests and needs of the countries involved in creating it (Gorur, 2011). One of the major flaws of PISA, according to Hopmann (2008) is that it has been interpreted as an instrument merely for ranking nations. Anything that can be learned from PISA results is based on a number of assumptions that may not be valid or that are flawed. Pons (2011) agrees and laments the fact that most of the media attention was on the rank order of the countries themselves, rather than a deeper discussion and analysis of what is driving the relative success or failure of participating nations.

The type of learning that is popular in a nation may also influence student performance on ISATs. Cavanagh and Manzo (2009) find that American students perform differently depending on the international test. U.S. students do very well on TIMSS, which tests school-based content knowledge in math and science, and fare poorly on PISA, which tests skills and the application of knowledge to real-world problems (Cavanagh & Manzo, 2009). Still, according to one interview with Gary Phillips, Vice-President and Chief Scientist at the Washington-based American Institutes for Research, PISA is "the most relevant standard for judging U.S. students" because unlike TIMSS, it "compares American students against only relatively wealthy, industrialized nations" (Cavanagh & Manzo, 2009, p. 3). TIMSS includes developing nations in its mix of participants. In an interview with Hal Salzman, a professor of Public Policy at Rutgers University, Salzman suggests that the United States looks to Massachusetts and Minnesota for ways to improve public schools before it looks to Finland. Massachusetts and Minnesota perform comparably to nations like Finland at the top of the PISA ranks, and they share a more common culture and demography with other states than Finland does (Cavanagh & Manzo, 2009).

Through an equipercentile equating of score scales from the National Assessment of Educational Progress (NAEP), TIMSS and PISA assessments, Hambleton, Sireci, and Smith (2009) attempt to answer the question of whether or not U.S. achievement expectations on the NAEP are rigorous enough. The comparison of scores shows that a higher percentage of students from other countries scored “proficient” than did U.S. students (meaning that achievement levels on the NAEP are not too rigorous within an international context); however the comparison further shows that even the highest scoring nations did not achieve 100 percent proficient as required by the No Child Left Behind Act (Hambleton et al., 2009). The closest nation is Singapore at 76.8 percent of students at or above “proficient” on the TIMSS comparison, and Finland at 52.9 percent of students at or above “proficient” on the PISA comparison (Hambleton et al., 2009). While achievement levels on the NAEP are not too rigorous within an international context, the NCLB expectation of a 100 percent proficient rate is unrealistic (Hambleton et al., 2009).

According to Milford, Ross, and Anderson (2010) the media portrays PISA as the authoritative determiner of the success or failure of education systems around the world. Who is to say, however, that the knowledge being tested on PISA will make any difference in a child’s ability to be successful in life? Schleicher (2007) finds that competencies assessed by the PISA are in no way all-inclusive of the knowledge and skills students need to be successful in life. Jambor (2009) points out that the high performance of Korea on PISA does not translate into success at the university level. Korean schools are teacher-centered, creating an environment of highly disciplined, intelligent students. However, this same model stifles creativity, individualism, and the ability to self-manage. Upon entering U.S. colleges, Korean students struggle without the highly structured direction of their Korean teachers (Jambor, 2009). Jambor (2009) suggests that Korean schools begin utilizing a pedagogy that encourages independence, leadership, and time management skills.

Wu (2010) points out that the statistical complexities of large-scale assessments such as PISA prevent policymakers from being able to recognize the caveats in the results, leading to misguided conclusions and inappropriate policy decisions. The degree to which PISA data is misquoted, assumptions are misunderstood, or data provided at the student level is inaccurate casts doubt about how useful the assessment is as a tool for guiding national education policy. According to Yore, Anderson, and Chiu (2010), PISA is sometimes used as evidence to promote previously contrived policy initiatives. Yore, Anderson, and Chiu (2010) argue that politicians want fast and immediate results and use research data to justify their policy positions, rather than developing policy positions based on data.

ISAT Outcomes and Productivity Indicators

Based on Section 604 of the America COMPETES Reauthorization Act of 2010 (COMPETES), the Secretary of Commerce completed a study of the economic competitiveness and innovative capacity of the United States (Department of Commerce, 2012). A number of variables that impact competitiveness are addressed in the report including: tax policy, business climate, regional issues, barriers to business startups, trade policy, federal research and development policy, intellectual property in the U.S. and abroad, manufacturing, and science and technology education. The report suggests that only a workforce equipped with skills in science, technology, engineering, and math (STEM) will be capable of generating the innovation necessary to be competitive in the global marketplace (Department of Commerce, 2012).

Finkel (2012) notes that prior to World War II it was common for America to benchmark its academic performance against other nations. Since then, the United States has not adopted the effective learning strategies that other nations use. Meanwhile, America's average performance on PISA 2009 places its students 4th in reading, 17th in science and 25th in mathematics among 70 countries (Finkel, 2012). Finkel (2012) also notes that other nations do not replicate American education reforms. That being said, it is difficult to compare America to other nations due to its exceptional geographical size, diversity, system of state sovereignty, and economic prowess; the closest comparable nation is Canada (Yu, Kaprolet, Jannasch-Pennell & DiGangi, 2012). Categorizing countries into classes of similar ISAT achievement and/or economic indicators may offer more comparable data than comparing nations of vastly different sizes, demography, and economies (Kay Cheng, 2012).

Through a clustering and discriminant analysis, Acar (2012) finds that national ranking on PISA tends to correlate with a country's class in terms of public-debt-to-GDP, inflation, long-term interest rate, and budget-balance-to-GDP. In every nation there are high and low-performing schools. Therefore, any analysis of best practices should be narrowed to the specific regions, provinces, or schools that are performing well (Liu, Wu, & Zumbo 2006). Such an analysis can be done within the United States since there are exemplary states and school districts that are on par with the highest performing nations in the world. Looking within the context of U.S. culture and domestic socioeconomic realities for reform solutions may be more effective than looking to other nations for ideas (Salzman & Lowell, 2008).

Baker (2007) conducted a correlation analysis between the First International Mathematics Study (FIMS) and seven indicators of national success. Baker (2007) used wealth as measured by GDP, rate of growth as measured by growth rate, productivity as measured by GDP per hour, quality of life as measured by the United Nations Quality of Life Index, livability as measured by the Most Livable Countries Index, democracy as measured by the Economy Intelligence Unit's Index of Democracy, and creativity as measured by the average number of patents. Baker (2007) found that countries with the best outcomes in terms of the indicators measured have performed at or near the average on international assessments. Similar patterns show up for PISA and FIMS (Baker, 2007). This would indicate that there is no correlation between ISATs and national productivity indicators. Chen and Luoh (2010) claim educators have accepted the idea that a connection exists between science and mathematics emphasis in schools and the future ability of students to compete in the world. In fact, they found that there is no correlation between test scores and income differences.

The Thomas Fordham Institute published a preliminary analysis of the Common Core Standards Initiative (CCSSI), the National Assessment of Educational Progress (NAEP), the Trends in International Mathematics and Science Study, and the Programme for International Student Assessment, to determine which of these frameworks is most promising as a tool for benchmarking the academic progress of the nation (Carmichael, Wilson, Finn, Winkler, Palmieri, & The Thomas Fordham Institute, 2009). Carmichael et al. (2009) gave each framework a grade based on its content, rigor, and clarity, as well as the frameworks' usefulness as a basis for developing academic achievement standards. Chester Finn and Amber Winkler listed three major assumptions, the most glaring of which is whether CCSSI, a content based framework can even be compared with NAEP, TIMSS and PISA which are test frameworks. Not surprisingly PISA scored a D in this analysis because its framework is not content-based at all. Quite the opposite, PISA tests the application of knowledge to real-world problems and relies on students acquiring knowledge from both in-school and outside-of-school. Carmichael et al. (2009) recommends that U.S. policy-makers not look to PISA results to guide their decisions in setting standards and curriculum, and that they use caution when examining PISA data to draw conclusions about the performance of U.S. students. Loveless (2009) adds that PISA data is cross-sectional and only shows correlations, not causation. In addition there are problems with PISA governance, lack of alignment to school curricula, selective treatment of data, policy recommendations that are not supported by valid data, and ideological/political bias embedded in test questions (Loveless, 2009).

Bracey (2009) speaks of an “education/economy fallacy” and agrees there is no connection between large-scale test results and economic health (p. 35). Bracey (2009) summarizes the findings of historical research studies surrounding the usefulness of the National Assessment of Educational Progress (NAEP), the Program for International Student Assessment (PISA) and Trends in International Mathematics and Science Study (TIMSS). Bracey (2009) cites his criticisms of utilizing large-scale assessments like NAEP, PISA and TIMSS to draw conclusions about the relative progress of nations. For example, concerning the PISA Bracey (2009) questions the validity of comparing the United States, a nation with a highly diverse population of over 300 million, to small, homogeneous nations. Bracey (2009) goes on to criticize the fact that 15 year olds are placed at many different grade levels depending on the country they live in. PISA test questions are not content based, but rather designed for students to use knowledge to solve practical problems. Bracey (2009) argues that this gives more affluent students an advantage because of the abundance of resources in their homes and more opportunities to apply their knowledge. PISA test questions are translated verbatim, which can create cultural misunderstandings as well as downright nonsensical passages (Bracey, 2009). Finally, the majority of media attention is placed on the United States' relatively low average PISA score, with little if any mention that the United States also has twice as many high scoring students as any other nation (Bracey, 2009). In fact, Petrilli and Scull (2011) found that the United States produces many more high-achieving students than any other OECD nation. Racial and ethnic segments of the U.S. population rival overall populations in other countries as well (Petrilli & Scull, 2011).

Bils and Klenow (2000), on the other hand, cite numerous studies that claim schooling positively correlates with the growth rate of per capita GDP across countries. Bils and Klenow (2000) find that a correlation exists between ISATs and GDP, but that it only accounts for one-third of the per capita GDP growth. Growth is also being stimulated by other policy factors such as property rights and openness in the marketplace. These findings suggest that an investment in education attainment alone is insufficient from a national standpoint to make any incremental impact on GDP. Bybee and Stage (2005) present arguments that U.S. performance on PISA is justification for the reform efforts of No Child Left Behind. They present an overview of the differences between TIMSS and PISA, the two most prominent international assessments. Bybee and Stage (2005) also present evidence that NCLB reform efforts have closed the achievement gap somewhat, but that more needs to be done. PISA data present additional evidence that the achievement gap in the U.S. is real (Bybee & Stage, 2005). TIMSS data shows that the U.S. is producing gains in basic facts and procedures, and PISA data shows that the U.S. is not doing enough to make gains in problem solving and critical evaluation (Bybee & Stage, 2005). Bybee and Stage (2005) argue that the U.S. education system needs a more challenging curriculum for all students.

Hanushek and Woessmann (2007) challenge the notion that an increase in the education level (school attainment) of the population will translate into increased economic growth for nations. Instead, Hanushek and Woessmann (2007) find a causal relationship between an increase in cognitive skills and economic growth. This suggests that an emphasis on mastery of specific standards or skills should be emphasized, as opposed to attainment of degrees or the accumulation of academic credits. In a working paper series Hanushek and Woessmann (2010a) address sampling criticisms of research on economic growth and education. The central criticism is that flaws in random sampling of students on international student achievement tests in some countries make comparisons of tests scores biased. Hanushek and Woessmann (2010a) find that countries with higher school enrollment numbers, higher numbers of students excluded from the targeted sample, and higher non-response rates, perform better on international student achievement tests. However, the irregular sampling patterns do not change the results of previous economic growth regressions, suggesting that there is no relationship between sampling mismeasurement and econometric analyses (Hanushek & Woessmann, 2010a).

Hoi Yan and Chan (2008) find that PISA scores are significantly related to employment and that the amount of students entering research and development fields predicts the GDP of nations at 67 percent. A solid foundation in mathematics and science is critical to increasing the R&D population. PISA scores in science, reading and math predict employment in the industrial sector for both males and females (Hoi Yan & Chan, 2008). Gutema and Bekele (2004) conducted an empirical analysis using archival data from national and international statistics publication and data on GDP per capita and total labor force from World Bank 2002 for a period of 41 years (1960-2000) involving 19 African countries. According to the results of their analysis, empirical data support the hypothesis that schooling is a significant factor in human capital accumulation and economic growth. However, research conducted by Breton (2013) finds that investments in education increase marginal productivity for countries with a highly educated population by 12 percent, while the marginal productivity gains for counties with less-educated populations are higher – greater than 50 percent (Breton, 2013). This finding shows that the economic principal of diminishing returns seems to apply to investments in education as well. As nations become more educated, it becomes more difficult to raise national income through continued investments in education (Breton, 2013). Econometric studies clearly show a relationship between higher education and productivity of workers, however it remains unclear as to whether education raises productivity and income, or whether increased levels of productivity and income increase the demand people have to obtain more education (Breton, 2013).

Through simultaneous equations modeling (SEM), Jun, Xiao, and Xiaoyu (2009) evaluate the interaction among the endogenous variables of income distribution inequality and education inequality, as well as the instant-impacts and cumulative impacts of these variables. Jun, Xiao, and Xiaoyu (2009) found that income inequality leads to educational inequality, but that attempts to create education equity do not reduce income inequality. Making a basic education available to more people generally raises the income and education of the population, but there is no causal effect between education equality and income equality (Jun, Xiao, & Xiaoyu, 2009). In other words, efforts to raise the education level of the population through educational policy initiatives does not automatically translate into increased income equality.

The Organisation for Economic Co-operation and Development conducted a study to analyze the growth of real GDP per capita that is possible through achievement gains on PISA. The OECD study reveals that an average increase in PISA scores of 25 points over the next 20 years could result in an aggregate gain of GDP $115 trillion (OECD, 2010). The value of educating U.S. students to a level that increases U.S. PISA performance over the next 20 years to the level of Finland could result in a gain of GDP $103 trillion for the United States alone (OECD, 2010). While OECD points to studies that rule out other impacting variables, it does not claim a causal relationship from these findings. Peterson et al. (2011) offers additional support for these findings concluding that productivity in the United States could increase by 30-50 percent by focusing on training students in science and math to realize ISAT achievement on par with Canada and Korea. The comparison of NAEP scores and PISA scores for the Class of 2011 shows that students are ill-prepared to compete with their peers around the world in careers that require science and math (Peterson et al., 2011).

Tienken (2008) analyzes the relationship between international test rankings from three time periods (1957-1982, 1983-2000, and 2001-2006) and Global Competitiveness Index rankings. The Global Competitiveness Report is a publication of the World Economic Forum. Statistical data for the index is obtained from the World Bank, the International Monetary Fund (IMF) the United Nations Educational, Scientific, and Cultural Organization (UNESCO) and the World Health Organization (WHO). More than 100 indicators are used to calculate the GCI (Schwab, 2014). The Tienken (2008) analysis is limited to math and science (reading tests were excluded because math and science achievement receives the most attention from policymakers in the United States) and finds stronger correlations between GCI and ISAT achievement for nations in the bottom 50 percent than for nations in the top 50 percent. This suggests that ISAT performance may predict future economic growth for emerging economies, but not for advanced economies. Tienken (2008) also finds that current ISATs have stronger correlations than older ISATs do. These findings are consistent with Hanushek and Woessmann (2009), which finds a strong correlation between variances in cognitive skills and differences in economic growth. The convergence effect of investments in top-performing students on economic growth is stronger in underdeveloped countries than it is for advanced economies (Hanushek & Woessmann, 2009). The best remedy, according to Hanushek and Woessmann (2009) is policy aimed at providing a basic education for all as well as programs that get greater numbers of students performing at top levels.

Yu (2012) conducted a two-step cluster analysis to see if differences in ISAT performance impacted other indices of national well-being. The relationships between the Human Development Index (HDI), the Happy Planet Index (HPI), and performance on PISA 2000 were explored. The earliest data set from PISA 2000 was used because the population of students who were 15 years old in 2000 is the first population now at ages 24 or 25 who could be contributing to the economy in meaningful ways. Regression modeling from Chong's study shows that PISA is a significant predictor of HDI and HPI. In other words, nations that score well on PISA should see those students becoming happy, productive adults.

In another study, Yu, DiGangi and Jannasch-Pennell (2012) were interested in seeing whether or not findings from the Chen and Luoh (2010) study would hold up under a time-lag analysis. Chen and Luoh (2010) found that there was no link between PISA achievement and labor force quality. Instead, they found a relationship between the number of research and development researchers per capita or scientific/technical journal articles per capita and the economic condition of nations. However, a major limitation of Chen and Louh (2010) was that it was a concurrent cross-sectional design. A time-lag was missing to allow for the 15-year old students who took the PISA to grow up some, graduate from college and begin making economic contributions to society. Yu, DiGangi and Jannasch-Pennell (2012) find that GDP is among the highest in 2007 for nations that are productive in publishing research articles and have a high degree of openness in trade. What Yu, DiGangi and Jannasch-Pennell (2012) call the "elite model" explains why some nations with a small number of research articles might still have a healthy GDP. Research and development do not depend on the masses of society, but instead on a small number of elite scientists. It only takes one Bill Gates or Steve Jobs, for example, to create enormous boosts in GDP.

Ramirez et al. (2006) used ordinary least squares (OLS) regression analysis to examine the relationship between national economic growth and several independent variables to see whether the connection between national achievement and economic growth is stable over time and across educational systems. Intervening variables were also modeled to determine whether student achievement has an effect on the size of the scientific labor force, higher education enrollment in science and engineering, scientific publication rates per capita, and patents granted per capita (Ramirez et al., 2006). The overall finding is that student achievement in mathematics and science does have a positive correlation to economic growth (Ramirez et al., 2006). The correlation is weakened, however, when South Korea, Taiwan, Hong Kong, and Singapore are excluded (Ramirez et al., 2006). These rapidly growing economies have an enormous impact on academic-achievement-to-economic-growth correlations, and many variables other than academic achievement have contributed to the rapid growth of these nations (Ramirez et al., 2006).

The 2015 Index of Economic Freedom, a publication of The Heritage Foundation, reports a significant drop for the United States from the 6th most-free economy in 2009 to 12th most-free economy in 2015. The Index of Economic Freedom ranks 186 economies using ten quantitative and qualitative factors, categorized into four pillars of economic freedom (Miller & Kim, 2015):

- Rule of Law (property rights, freedom from corruption);
- Limited Government (fiscal freedom, government spending);
- Regulatory Efficiency (business freedom, labor freedom, monetary freedom); and
- Open Markets (trade freedom, investment freedom, financial freedom).

The United States trails Hong Kong, Singapore, New Zealand, Australia, Switzerland, Canada, Chile, Estonia, Ireland, Mauritius, and Denmark in its economic freedom score. The erosion of the United State's economic freedom score is due to deteriorations in upholding the rule of law and maintaining a limited government during the war on terror and Great Recession years (Miller & Kim, 2015). This is mitigated only by recent control of government spending (Miller & Kim, 2015).

In connection with the 2015 Index of Economic Freedom, another report published in January 2015 as a joint project of the Horace Mann League and the National Superintendents Roundtable provides evidence that student and education system outcomes are tied to larger societal challenges (Harvey, McKay, Fowler & Marx, 2015). The report, *School Performance in Context: Indicators of School Inputs and Outputs in Nine Similar Nations*, analyzes 24 indicators in six categories for Canada, China, Finland, France, Germany, Italy, Japan, the United Kingdom, and the United States. The report emphasizes that national rankings on international assessment outcomes lose much of their relevance when they are decoupled from societal factors that contribute to poor student achievement (Harvey, McKay, Fowler & Marx, 2015).

Policymakers are encouraged to focus on initiatives that tackle problems beyond school accountability but which directly impact school systems, and to subdue rhetoric that the sky is falling when student performance is lackluster. For example, the report recommends policies that address social inequality, social stress and violence, and support for young families (Harvey, McKay, Fowler & Marx, 2015). Policies directed specifically at the public school system should address the achievement gap, on-time graduation rates, funding equity, and teacher quality (Harvey, McKay, Fowler & Marx, 2015).

Conclusion

Since the Colman report in 1966, the U.S. school system has been rife with reform activity including the end of racial segregation, the publication of *A Nation At Risk*, outcome-based education, Goals 2000, No Child Left Behind, and most recently, Common Core. Reform efforts have largely been influenced by concerns about the United States' national competitiveness in a global economy. What the research literature lacks is a study that unifies all of the international assessments since 1964 and shows the relationship, if any, achievement on ISATs has had on the global competitiveness of the United States and other nations. Provasnik et al. (2009) explains why the various ISATs cannot be compared with each other directly; the purpose of each assessment, the subject matter, and grade or age assessed are different. Thus, up to this point in time, analyses have been between countries within individual assessments (Ammermueller, 2007; Bracey, 2009; Cavanagh & Manzo, 2009; Chen & Luoh, 2010; Edgerton, Peter, & Roberts, 2008; Finkel, 2012; Gorur, 2011; Ho, 2010; Loveless, 2009; Perelman & Santin, 2011; Perry, 2009; Petrilli, Scull, & Thomas B. Fordham, 2011; Pons, 2011; Shiel & Eivers, 2009; Shukakidze, 2008; Yu, DiGangi & Jannasch-Pennell, 2012; Yildirim, 2012; Zhang & Kong, 2012).

Utilizing the International Data on Cognitive Skills common ISAT scale from the publication *The High Cost of Low Educational Performance: The Long-Run Economic Impact of Improving PISA Outcomes*, it is possible to unify all of the ISAT data since 1964 (OECD, 2010). This study evaluates the effects of cognitive skills on economic competitiveness within the MRW theoretical framework and the Hanushek-Woessmann educational production function. The Hanushek-Woessmann production function builds on numerous underlying models of human capital formation (Mincer, 1974; Becker & Tomes, 1976; Romer, 1986; Lucas, 1988; Mankiw, Romer, & Weil, 1992; Barro, 1996; Benhabib & Spiegel, 2002; Nelson & Phelps, 1966). This study provides policymakers with more information about the validity of using ISAT achievement results to make predictions about the United States' competitive status in the world.

Chapter III

Design and Methodology

Since 1964, a total of 12 international student achievement tests (ISATs) have been administered (OECD, 2010). Conducting an explanatory correlation research study that directly equates all ISATs has, to date, only been accomplished by the Organisation for Economic Co-operation and Development (OECD, 2010). Previous to the OECD (2010) study, analyses focused on relationships between controls and variables within individual ISATs (Ammermueller, 2007; Bracey, 2009; Cavanagh & Manzo, 2009; Chen & Luoh, 2010; Edgerton, Peter, & Roberts, 2008; Finkel, 2012; Gorur, 2011; Ho, 2010; Perelman & Santin, 2011; Loveless, 2009; Perry, 2009; Petrilli, Scull, & Thomas B. Fordham, 2011; Pons, 2011; Shiel & Eivers, 2009; Shukakidze, 2008; Yu, DiGangi & Jannasch-Pennell, 2012; Yildirim, 2012; Zhang & Kong, 2012). For example, a researcher might analyze the relationship between immigration status and PISA test achievement or between immigration status and TIMSS achievement, but not immigration status and comparisons across PISA and TIMSS. The OECD, however, has calibrated the overall distribution of ISAT scores across the full-time period of testing since 1964 to arrive at a common metric of cognitive skills (OECD, 2010). This chapter outlines how the OECD common metric was calibrated to make a comparative analysis possible and articulates the design and methodology of this study.

The first null hypothesis of this study (H_o1) states that there will be no relationship between international student achievement test scores in mathematics and science, as measured by the International Data on Cognitive Skills and the 2014-15 Global Competitive Index. The first alternate hypothesis (H_A1) of this study states that there will be a relationship between international student achievement test scores in mathematics and science, as measured by the International Data on Cognitive Skills and the 2014-15 Global Competitive Index.

The second null hypothesis of this study (H_o2) states that when the GCI is divided into quartiles, there will be no relationship between international student achievement test scores in mathematics and science, as measured by the International Data on Cognitive Skills and the 2014-15 Global Competitive Index for nations in the top 25 percent of competitiveness. The second alternate hypothesis (H_A2) of this study states that when the GCI is divided into quartiles there will be a relationship between international student achievement test scores in mathematics and science, as measured by the International Data on Cognitive Skills and the 2014-15 Global Competitive Index for nations in the top 25 percent of competitiveness.

The third null hypothesis of this study (H_o3) states that when the COG is divided into quartiles, there will be no relationship between international student achievement test scores in mathematics and science, as measured by the International Data on Cognitive Skills and the 2014-15 Global Competitive Index for nations in the top 25 percent of achievement. The third alternate hypothesis (H_A3) of this study states that when the COG is divided into quartiles, there will be a relationship between international student achievement test scores in mathematics and science, as measured by the International Data on Cognitive Skills and the 2014-15 Global Competitive Index for nations in the top 25 percent of achievement.

This study answers the following research question:

1. What relationship, if any, exists between international student achievement test scores in mathematics and science, as measured by the International Data on Cognitive Skills and the 2014-15 Global Competitive Index?

Primary grades through the end of secondary school are included in the regression analysis for all years: 1964 through the 2003 cycles of PISA and TIMSS for 74 of the 77 countries that have participated in one or more of the mathematics or science ISATs. Three countries were excluded because they are not part of the 2014-15 Global Competitiveness Index (Liechtenstein, Macao-China, Palestine).

Research Design

This study examines the relationship between international student achievement test (ISAT) performance and national competitiveness within the MRW theoretical framework and the Hanushek-Woessmann educational production function. The Hanushek-Woessmann production function builds on numerous underlying models of human capital formation (Mincer, 1974; Becker & Tomes, 1976; Romer, 1986; Lucas, 1988; Mankiw, Romer, & Weil, 1992; Barro, 1996; Benhabib & Spiegel, 2002; Nelson & Phelps, 1966). An explanatory correlation research design is used to evaluate the extent to which ISAT scores for 74 of the 77 countries that have participated in any of the international mathematics and science tests since 1964 co-vary with statistics on international competitiveness. Spearman's *rho* correlations are used to model the relationship between ISAT average test scores, scaled to PISA 2000, in mathematics and science and the Global Competitive Index. Primary grades through the end of secondary school are included in the regression analysis for all years 1964 through the 2003 cycles of PISA and TIMSS. The majority of the existing literature regarding connections between education and economic growth utilizes years of school attainment as the cognitive skills metric. This is a drawback because a year of education does not necessarily equate to the same increase in knowledge and skills across all education systems around the world (Hanushek & Woessmann, 2007; OECD, 2010). For example, a year of schooling in Kyrgyzstan does not yield the same benefits to a student as does a year of schooling in Finland (OECD, 2010). This study uses the Hanushek-Woessmann educational production function, which uses student achievement as the cognitive skills metric.

Participants

Archival data of student achievement on all ISATs over the past 50 years was obtained from the OECD (2010) study and used for this research. The data file is available in the public domain at http://hanushek.stanford.edu/download. Hundreds of thousands of students between the ages of nine and fifteen (depending on the ISAT) from 77 countries participated in one or more of the mathematics or science ISATs. In the OECD (2010) study, Hanushek and Woessmann obtained a standardized comparison across ISATs through a multi-step empirical calibration (OECD, 2010). First, student performance in the United States on the National Assessment of Educational Progress (NAEP) since 1969 was used as a pattern to scale each international assessment to this known performance over time (OECD, 2010). Hanushek and Woessmann then selected thirteen countries that had participated in a sufficient number of ISATs and had maintained relatively stable educational systems since 1964 to be a standardization group for the study (OECD, 2010). The mean scores for each ISAT that an OECD country participated in were then calibrated to the variance observed on the PISA 2000 assessment. PISA 2000 was selected as the calibration point because that is the only assessment that all nations participated in together (OECD, 2010). Adjustments in achievement levels based on the NAEP were combined with the standardization group calibration to PISA 2000 to calculate standardized scores for all countries on all ISATs (OECD, 2010).

Data Collection

The Human Research Review Committee (HRRC) at Northwest Nazarene University approved this study on March 11, 2014 and authorized the research. The International Association for the Evaluation of Educational Achievement and the Organisation for Economic Co-operation and Development are the two organizations that have conducted ISATs and collected the student achievement data since 1964 (OECD, 2010). The data file for the International Data on Cognitive Skills is available in the public domain at http://hanushek.stanford.edu/download and is displayed in Appendix B. The international competitiveness data used for regression analysis was the Global Competitiveness Index published by the World Economic Forum. This archival data is available in the public domain at the World Economic Forum website and is displayed in Appendix C. The Global Competitiveness Index is computed based on more than 100 economic indicator and survey scores, which are grouped into 12 component scores, or pillars, categorized under three subindexes: basic requirements, efficiency enhancers, and innovation. Nations represented in the GCI are categorized into stages of development based on GDP per capita and the amount of exports made up of mineral goods. The subindexes are weighted differently depending on the nation's stage of development. The economic theory of stages of development states that nations will require different initiatives depending on what stage of development they are in to grow and remain competitive. For example, a nation in civil war, without basic government services and reliable transportation and communication infrastructure has different needs than a developed, peaceful nation does. Additional data for this study was obtained through the U.S. Department of

Commerce, the United Nations Children's Fund (UNICEF), and the National Center for Education Statistics.

Analytical Methods

An empirical calibration was required to obtain a common-scale metric so that international performance across ISATs can be compared. This study uses the common-scale metric derived by the Organisation for Economic Co-operation and Development (OECD, 2010). This metric is an internationally standardized average of all mathematics and science ISATs that describes the performance relationship between past, present and future ISAT achievement. Spearman’s *rho* correlations are used to model the relationship between ISAT average test scores and in mathematics and science, primary through the end of secondary school for all years scaled to PISA, and the Global Competitive Index. Spearman’s *rho* is used to determine correlations between ordinal scale variables, or interval scale variables that have been reduced to ordinal scale (Tanner, 2012). The strength and direction of the correlational tests are analyzed. This study incorporates a time-lag analysis of ISAT data from 1964-2003 with 2014-15 GCI data, ensuring that the students who participated in PISA 2003 are now old enough to be contributing to the economy. Interpretations and conclusions are made based on the outcome of the correlational tests.

Limitations

Large-scale assessments like PISA and TIMSS have a number of inherent errors related to measurement, sampling and equating (OECD, 2010; Hanushek & Woessmann, 2010a; Tienken, 2008; Yu et al., 2012; Yu, 2012). There are a limited number of countries cooperating to produce common data sets (Hanushek & Woessmann, 2010a). When selecting countries that were part of the data standardization group, two criteria were used: stability and secondary population (OECD, 2010). Countries had to be member states of the OECD since 1964 and they needed to have had a significant population of secondary students in 1964. Thirteen countries met both of these criteria: Austria, Belgium, Canada, Denmark, France, Germany, Iceland, Japan, Norway, Sweden, Switzerland, the United Kingdom, and the United States (OECD, 2010). Longitudinal research is impossible due to the cross-sectional design of international assessment instruments (Hanushek & Woessmann, 2010b). Furthermore, the cross-sectional design only shows correlations, not causation (Loveless, 2009).

This study utilizes a common-scale metric that has been calibrated based on the standardization group that participated in PISA 2000. The PISA assessment, upon which the common-scale metric depends for a variation-adjusted test score, has a number of limitations that should be noted. When disaggregating data by ethnicity, unregistered or undocumented immigrants are not usually included in PISA data (Martin et al., 2012). Inconsistencies between what is being taught in schools and what is being tested on PISA may put some nations at a disadvantage (Tienken, 2008). Grouping the United States with other OECD nations is problematic because other OECD nations are smaller and/or more homogeneous (Bracey, 2009; Cavanagh, 2007a; Cavanagh, 2007b; Perry, 2009). Tienken (2008) notes that other nations are selective about the student populations that participate in PISA, resulting in samples that may not reflect the whole nation. According to a 2012 report of the United Nations Children's Fund, only Romania ranks lower than the United States in terms of the percent of children living in households with incomes lower than 50 percent of the national median (UNICEF, 2012) Poverty and cultural influences have been shown to correlate with achievement on standardized test scores which may introduce bias (Ammermueller, 2007; Bracey, 2009; Hanushek & Woessmann, 2010b; Tienken, 2008).

Chapter IV

Results

Introduction

Previous studies that have analyzed the relationship between investments in education and the impact of those investments on the economy have left gaps in the literature due to the exclusion of one or more international student achievement tests (ISATs), the use of academic attainment instead of an achievement proxy, the lack of a time lag analysis, and an insufficient index to measure economic competitiveness (Acar, 2012; Baker, 2007; Chen & Luoh, 2010; Hanushek & Woessmann, 2010b; Loveless, 2009; Yu, 2012; Yu, DiGangi & Jannasch-Pennell 2012). This study adds to the literature by answering the question of whether or not there is a correlation between the competitiveness of the United States and student achievement on international assessments. This study incorporates a time lag by utilizing cognitive data from 1964-2003. The cognitive data represents student cognitive skill instead of academic attainment. The Global Competitiveness Index, a publication of the World Economic Forum, is a respected and robust measure of international competitiveness (Schwab, 2014; Tienken, 2008).

An explanatory correlation research design is used to evaluate the extent to which ISAT scores for 74 of the 77 countries that have participated in any of the international mathematics and science tests since 1964 co-vary with statistics on international competitiveness. Prior to running a statistical analysis using SPSS, the International Data on Cognitive Skills and the Global Competitiveness data were examined to determine the appropriate statistical test. The first null hypothesis of this study (H_o1) states that there is no relationship between international student achievement test scores in mathematics and science, as measured by the International Data on Cognitive Skills and the 2014-15 Global Competitive Index. The first alternate hypothesis (H_A1) of this study states that there is a relationship between international student achievement test scores in mathematics and science, as measured by the International Data on Cognitive Skills and the 2014-15 Global Competitive Index.

The second null hypothesis of this study (H_o2) states that when the GCI is divided into quartiles, there is no relationship between international student achievement test scores in mathematics and science, as measured by the International Data on Cognitive Skills and the 2014-15 Global Competitive Index for nations in the top 25 percent of competitiveness. The second alternate hypothesis (H_A2) of this study states that when the GCI is divided into quartiles there is a relationship between international student achievement test scores in mathematics and science, as measured by the International Data on Cognitive Skills and the 2014-15 Global Competitive Index for nations in the top 25 percent of competitiveness.

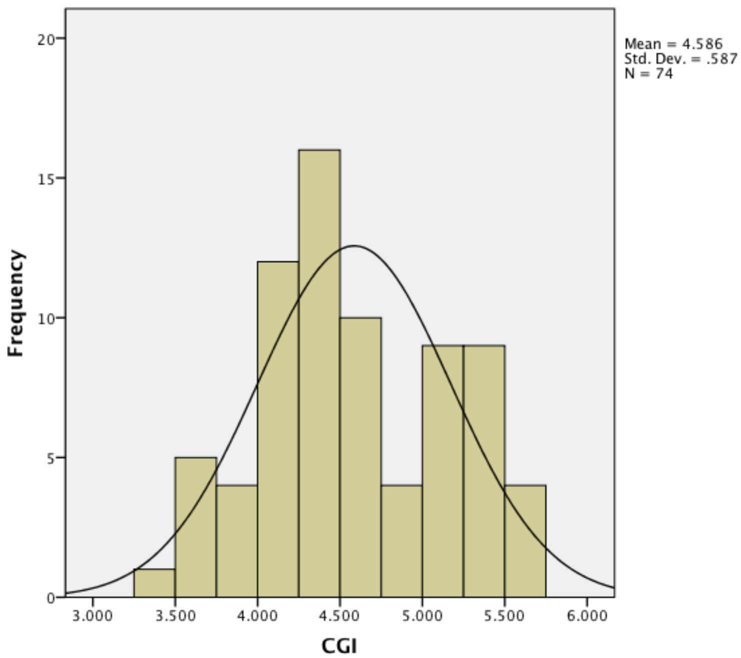
The third null hypothesis of this study (H_o3) states that when the COG is divided into quartiles, there is no relationship between international student achievement test scores in mathematics and science, as measured by the International Data on Cognitive Skills and the 2014-15 Global Competitive Index for nations in the top 25 percent of achievement. The third alternate hypothesis (H_A3) of this study states that when the COG is divided into quartiles, there is a relationship between international student achievement test scores in mathematics and science, as measured by the International Data on Cognitive Skills and the 2014-15 Global Competitive Index for nations in the top 25 percent of achievement.

Summary of the Results

A visual inspection (Figure 2) of the data distribution for the Global Competitiveness Index (GCI) shows that the data does not appear to be normally distributed. A basic assumption to utilize the Pearson correlation is that the data be normally distributed (Tanner, 2012). To be certain, a Shapiro-Wilk test was run, which indicates a significance value of .026, $p < .05$. For this test, if the significance value is less than .05, normality has been violated. Not all variables for the GCI data are normally distributed as assessed by Shapiro-Wilk test.

Figure 2

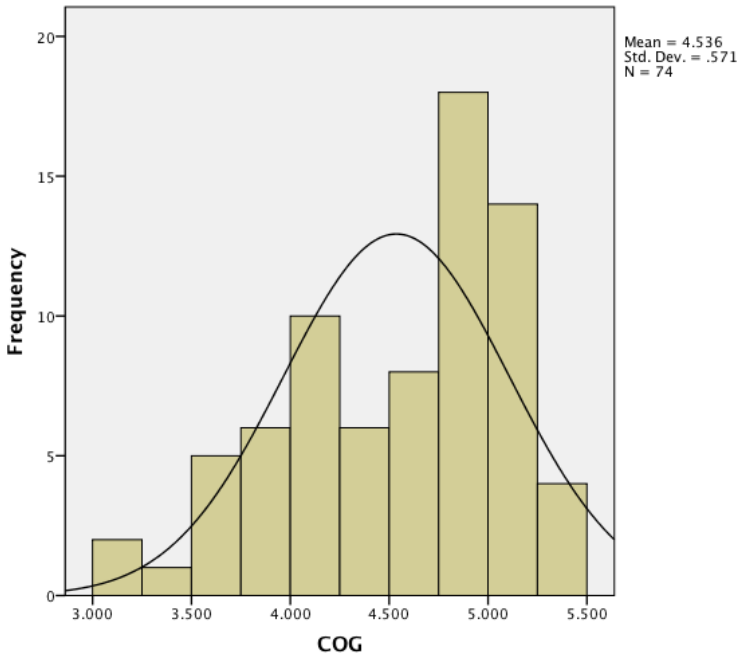
Histogram Illustrating the Data Distribution of the Global Competitiveness Index (GCI) of 74 Nations



A visual inspection (Figure 3) of the data distribution for the International Data on Cognitive Skills (COG) shows that the data is negatively skewed, indicating the data are not normally distributed. Again, a Shapiro-Wilk test was run, which indicates a significance value of .002, $p < .05$. The COG data are not normally distributed as assessed by the Shapiro-Wilk test.

Figure 3

Histogram Illustrating the Data Distribution of the International Data on Student Achievement (COG)



Visual inspections of the data distributions combined with Shapiro-Wilk tests revealed that both variables of this study are not normally distributed. With two variables that are not normally distributed, the best correlation test is the Spearman's *rho* (Creswell, 2012, Tanner, 2012). Spearman's *rho* is used to determine correlations between ordinal scale variables, or interval scale variables that have been reduced to ordinal scale (Creswell, 2012; Tanner, 2012). The formula for Spearman's *rho* is:

(3) $$r_s = 1 - \frac{6\sum d^2}{n(n^2 - 1)}$$

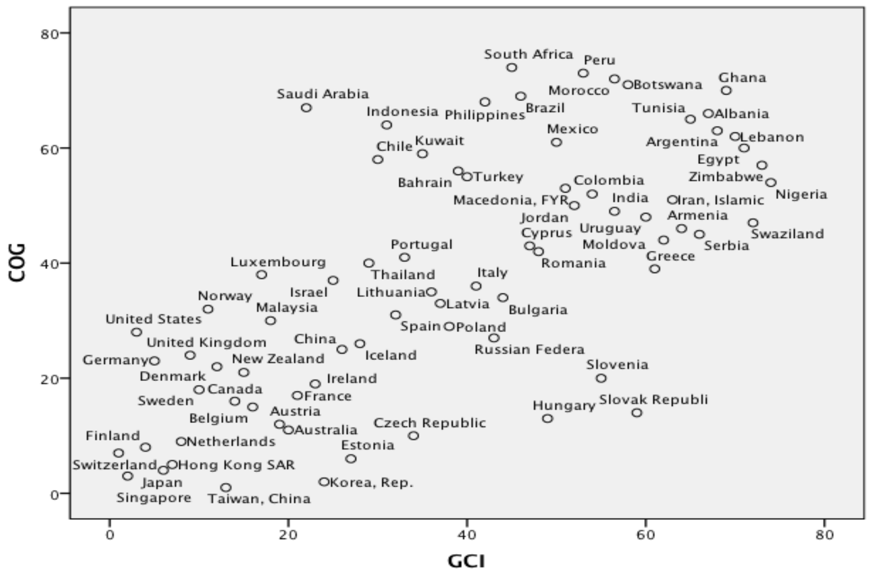
Where r_s is Spearman's *rho*, *d* is the difference between the ranked scores, and *n* is the number of pairs of data. The assumptions that must be met to use Spearman's *rho* include (Tanner, 2012):

- Both variables are at the interval or ordinal level
- Both variables represent paired observations
- Both variables share a monotonic relationship

Both the GCI and the COG can be used to rank nations according to their respective scores, which indicates the data are ordinal, satisfying the first requirement to conduct the Spearman's *rho*. The 2014-15 GCI reports competitiveness indices for 144 economies around the world. The COG data reports cognitive achievement indices for 77 nations that have participated in at least one of the ISATs in mathematics or science since 1964. The two sets of data were arranged in columns and each column was ranked separately. The number 1 was assigned to the nation with the highest value in each data set, followed by a 2 for the next highest value and so on. Scores that had the same value were averaged and given the same rank. After eliminating the countries not shared by both sets of data, both variables represented 74 paired observations (satisfying the second requirement to conduct the Spearman's *rho*). Three countries were excluded because they are not part of the 2014-15 Global Competitiveness Index (Liechtenstein, Macao-China, Palestine). A visual inspection of a scatter plot (Figure 4) shows the relationship between GCI and COG is monotonic (satisfying the third required assumption to conduct the Spearman's *rho*). Note that Figure 4 represents the ranks of nations 1-74, therefore the nations with the highest ranks appear near the origin of the graph, and the nations with the lowest ranks appear in the upper right of the graph.

Figure 4

Scatter plot Showing the Monotonic Relationship between ISAT Cognitive Data (COG) and Global Competitiveness Index (GCI)



As shown in Table 2, the Spearman's *rho* rank-order correlation coefficient value is r_s = .688 for *n* = 74 paired observations. The two-tailed significance level is $p < .001$. According to the Cohen and Manion (1994) standard for interpreting the strength of association, there is a moderate, positive, significant correlation between performance on international student achievement tests and the competitiveness of nations, r_s (98) = .688, $p < .001$. H_o1 is rejected and H_A1 is accepted. This finding does not mean that stronger performance on achievement tests causes a nation to be more competitive, just that the two factors are associated. To know whether or not the correlation can be applied to the United States, the COG and GCI data were divided into quartiles and a Spearman's *rho* analysis was conducted for the nations in the top 25 percent for each data set. The remaining hypotheses examine whether or not the same relationship exists when the analysis is restricted to these highest performing cohorts.

Table 2

Spearman's rho Correlation COG to GCI for 74 Nations

Correlations				
			COG	GCI
Spearman's rho	COG	Correlation Coefficient	1.000	.688**
		Sig. (2-tailed)	.	.000
		N	74	74
	GCI	Correlation Coefficient	.688**	1.000
		Sig. (2-tailed)	.000	.
		N	74	74
**. Correlation is significant at the 0.01 level (2-tailed).				

Table 3 shows the cohort of nations ranked in the top 25 percent of competitiveness on the 2014-15 GCI. For this analysis the top 25 percent represents the 18 most competitive nations of 74 nations in the study, or ranks 1-18.

Table 3

Nations Ranked in the Top 25 percent on the 2014-15 Global Competiveness Index (GCI)

COG	GCI	NATION
7	1	Switzerland
3	2	Singapore
28	3	United States
8	4	Finland
23	5	Germany
4	6	Japan
5	7	Hong Kong SAR
9	8	Netherlands
24	9	United Kingdom
18	10	Sweden
32	11	Norway
22	12	Denmark
1	13	Taiwan, China
16	14	Canada
21	15	New Zealand
15	16	Belgium
38	17	Luxembourg
30	18	Malaysia

For (*n* = 18) nations, r_s (98) = .42, *p* = .083, indicating no statistically significant relationship. Figure 5 illustrates this visually in a scatter plot. H_o2 was accepted. When the GCI is divided into quartiles, there is no statistically significant relationship between ISAT scores in mathematics and science, as measured by the International Data on Cognitive Skills and the 2014-15 Global Competitive Index for nations in the top 25 percent of competitiveness. Performance on international assessments appears to have no relationship to the competitiveness of nations that have the highest competitive rankings on the GCI.

This finding has enormous policy implications, which will be elaborated on in Chapter 5 along with an explanation for the extraordinary success of Switzerland and Singapore. Suffice it to say that one basis (U.S. international student achievement test performance) for the claim by ANAR in 1983 that the United States' "once unchallenged preeminence in commerce, industry, science, and technological innovation is being overtaken by competitors throughout the world," as it turns out, is faulty (Department of Education, 1983). Subsequent reform efforts (America 2000, Goals 2000, No Child Left Behind, and now Common Core) were all based on the same faulty conclusion; that is, if the United States does not make cognitive gains as evidenced by improved scores on international achievement tests, the nation will fall behind the rest of the world competitively (Alexander, 1986; U.S. Department of Education, 1983, 1991, 1994, 2011, 2012a, 2014). As Wu (2010) observed, the statistical complexities of large-scale assessments often lead to misguided conclusions and inappropriate policy decisions. At the very least, this finding raises a reasonable doubt about whether policymakers should continue to use international achievement test outcomes as a basis for public school reform initiatives.

Figure 5

Scatter plot Showing the Relationship Between ISAT Cognitive Data (COG) and Global Competitiveness Index (GCI) for Top 25 percent Most Competitive Nations

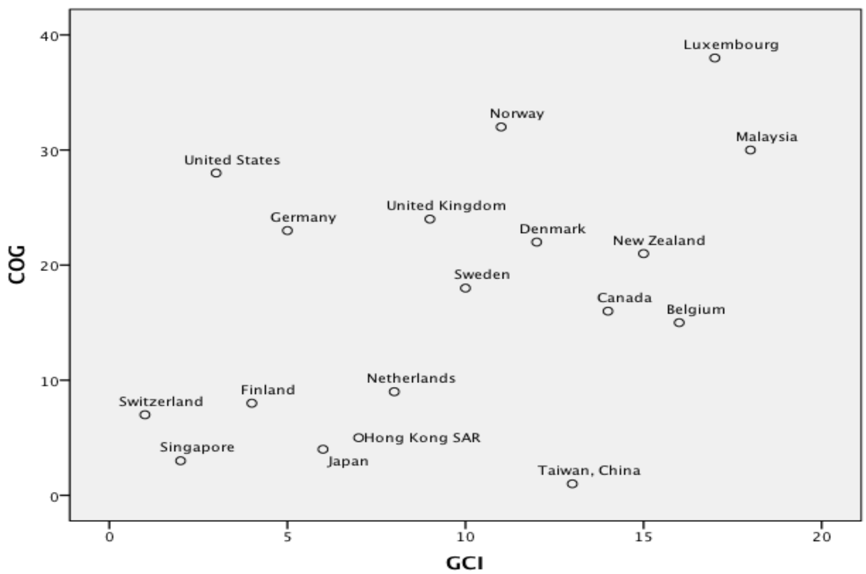


Table 4 shows the cohort of nations ranked in the top 25 percent of cognitive skill from the International Data on Student Achievement. For this analysis the top 25 percent represents the 18 highest achieving nations on ISATs of 74 nations in the study, or ranks 1-18. It is notable that the United States is not included in this list. The United States is a perplexing case. On the one hand it belongs to the cohort of nations ranked in the top 25 percent on the GCI. On the other hand, when the data is sorted by cognitive achievement, it belongs to the cohort of nations in the middle 50 percent, albeit near the top of that cohort. This points back to the literature review in Chapter 3 which discusses many of the possible reasons why the United States ranks lower on international achievement tests than other advanced economies. How to reconcile this should be the topic of future research and will be elaborated upon in Chapter 5.

Table 4

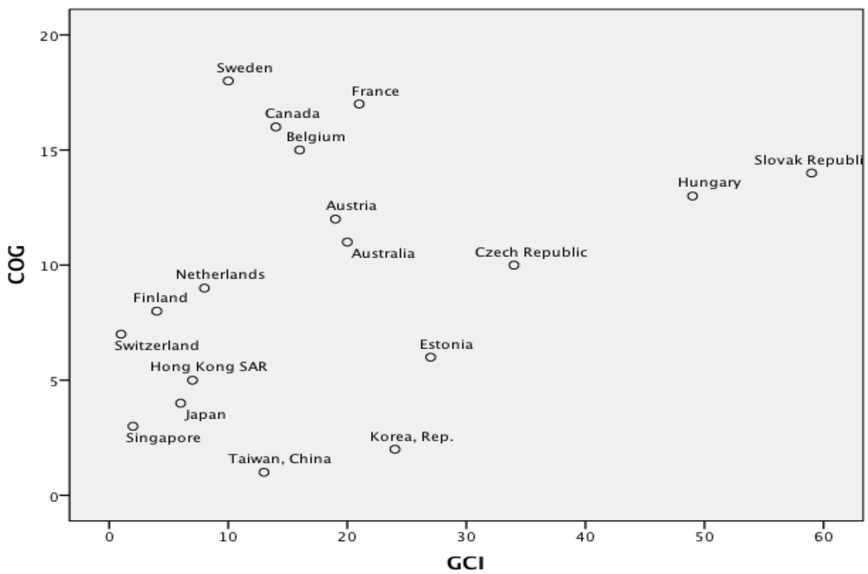
Nations Ranked in the Top 25 percent from the International Data on Student Achievement (COG)

COG	GCI	NATION
1	13	Taiwan, China
2	24	Korea, Rep.
3	2	Singapore
4	6	Japan
5	7	Hong Kong SAR
6	27	Estonia
7	1	Switzerland
8	4	Finland
9	8	Netherlands
10	34	Czech Republic
11	20	Australia
12	19	Austria
13	49	Hungary
14	59	Slovak Rep.
15	16	Belgium
16	14	Canada
17	21	France
18	10	Sweden

For (n = 18) nations, r_s (98) = .354, p = .150, indicating no statistically significant relationship. Figure 6 illustrates this visually in a scatter plot. H_o3 was accepted. When the COG is divided into quartiles, there is no statistically significant relationship between ISAT scores in mathematics and science, as measured by the International Data on Cognitive Skills and the 2014-15 Global Competitive Index for nations in the top 25 percent of achievement. Performance on international assessments appears to have no relationship to the competitiveness of nations that rank in top 25 percent on the COG. Again, this finding has important implications. Even though the United States ranks with the cohort of the middle 50 percent in cognitive achievement, this finding shows that all correlation with competitiveness among the nations in the top 25 percent will vanish if and when the U.S. ever rises into that cohort.

Figure 6

Scatter plot Showing the Relationship Between ISAT Cognitive Data (COG) and Global Competitiveness Index (GCI) for the Top 25 percent of Cognitive Skill



For nations ranked in the middle 50 percent (quartiles 2 and 3) of competitiveness on the 2014-15 GCI, (*n* = 37) nations, r_s (98) = .445, *p* = .006, indicating a significant, moderate correlation. Performance on international assessments appears to have a moderate relationship to the competitiveness of nations that rank in quartiles 2 and 3 on the GCI. For nations ranked in the middle 50 percent of cognitive skill on the International Data on Student Achievement, (*n* = 37) nations, r_s (98) = .711, *p* < .001, indicating a significant, strong correlation. Performance on international assessments appears to have a strong relationship to the competitiveness of nations that rank in quartiles 2 and 3 on the COG. For nations ranked in the lowest 25 percent (4^{th} quartile) of competitiveness on the 2014-15 GCI (*n* = 19) nations, r_s (98) = .126, *p* = .606, indicating no significant relationship. Performance on international assessments appears to have no relationship to the competitiveness of nations that rank in the lowest 25 percent on the GCI.

For nations ranked in the 25th percentile of cognitive skill on the International Data on Student Achievement, (n = 19) nations, r_s (98) = -.012, p = .960, indicating no significant relationship. Performance on international assessments appears to have no relationship to the competitiveness of nations that rank in the lowest 25 percent on the COG.

These findings show that the law of diminishing returns applies to investments in education and are consistent with Breton (2013) who found that investments in education increase marginal productivity for countries with a highly educated population by just 12 percent compared to the marginal productivity gains greater than 50 percent for counties with less-educated populations. Returning to the theoretical framework for this study, the idea that cognitive gains through schooling at the primary and secondary levels has no correlation with the economic competitiveness of the United States seems extraordinarily counterintuitive and may be unsettling to readers. The idea that nation-states can directly impact socioeconomic development through the public schools has been deeply institutionalized at a global level and has become the basis for production and modification of societal structures (Meyer et al., 1997). This idea, however, is frequently at odds with inconvenient realities. For example, mass schooling with the accompanying societal belief that it is necessary and beneficial for economic growth often goes unquestioned even though the functional correlation between mass education as a societal structure and economic growth is weak and highly conditional (Meyer et al., 1997). As to the question of convergence and why developed nations continue to outpace underdeveloped nations in the long term, if investments in primary and secondary education do not explain this, what does? This question is investigated more in Chapter 5.

Chapter V

Conclusion

Introduction

Education reform in the United States since the 1960s has been based on the premise that a nation can improve its competitive position in the world by making investments in human capital, the education and training of the population (Alexander, 1986; U.S. Department of Education, 1983, 1991, 1994, 2012a, 2012b; National Governors Association, 2009). However, in spite of the fact that the United States spends more than any other developed nation on education, U.S. students ranked 25th in math and 17th in science among 34 OECD nations on the 2009 PISA (Kena et al., 2014; OECD, 2011) Given the enormous allocation of resources devoted to education reform, policymakers should know if this money will indeed translate into the United States remaining competitively relevant in the world. This study adds to the literature by providing legislators and public education leaders insight into whether or not valid conclusions about the future competitiveness of the United States can be made based on student performance on International Student Achievement Tests.

Summary of Results and Conclusions

This study evaluated the effects of cognitive skills on economic competitiveness within the MRW theoretical framework and the Hanushek-Woessmann educational production function. A Spearman's rank-order correlation was run to assess the relationship between student performance on international achievement tests and the competitiveness of nations. Preliminary analysis showed the relationship to be monotonic, as assessed by a visual inspection of a scatter plot. For all nations, there was a moderate positive correlation between student performance on international achievement tests and the competitiveness of nations, r_s (98) = 0.688, $p < .001$.

However, this relationship disappeared among the top 25 percent most competitive nations, the cohort to which the United States belongs, r_s (98) = .42, *p* = .083. Cognitive skill, measured by increased performance on international assessments, also appears to have no relationship to the competitiveness of nations performing in the top 25 percent, r_s (98) = .354, *p* = .150. Interestingly, Baker (2007) found that countries with the best outcomes in terms of wealth, rate of growth, productivity, quality of life, livability, democracy, and creativity have performed at or near the average on international assessments.

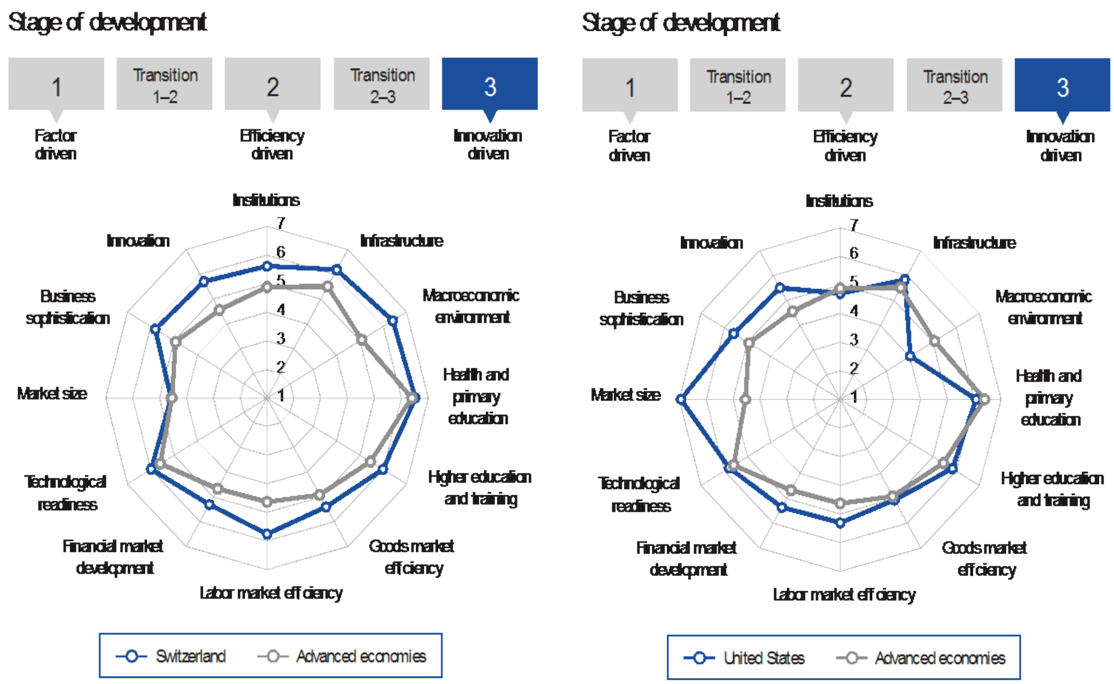
These findings are consistent with Tienken (2008), who found ISAT performance does not correlate with future economic strength for advanced economies like the United States. These findings are also consistent with Hanushek and Woessmann (2009), which found the convergence effect of investments in top-performing students on economic growth to be stronger in underdeveloped countries than for advanced economies (Hanushek & Woessmann, 2009). The findings in this study are also consistent with the findings of Breton (2013), that investments in education increase marginal productivity for countries with a highly educated population by just 12 percent compared to the marginal productivity gains greater than 50 percent for counties with less-educated populations. There is a moderate correlation between investments in education and competiveness for developing nations that disappears for advanced economies in the top quartile of competitiveness. The findings of this study provide further evidence that it is inaccurate to claim that the global competitiveness of the United States is in jeopardy based on student performance on international assessments. As nations become more educated, it becomes more difficult to raise national income through continued investments in education (Breton, 2013; Hanushek & Woessmann, 2009; Tienken, 2008). It also appears to be the case that as nations become richer and more educated, it becomes more difficult to justify investments education reforms that revolve around accountability as measured by high-stakes testing. To maximize the return on investments in education, money and reform initiatives should be channeled toward addressing poverty, equitable school funding, reducing social stress and violence, support for young families, and support for students of immigrant families (Anil, 2011; Cavanagh, 2007a; Harvey, McKay, Fowler & Marx, 2015; Perelman & Santin, 2011).

Recommendations for Further Research

The findings of this study raise additional questions, all of which could be the subject of additional research. The most obvious of these is if student cognitive achievement on ISATs is not associated with the competitiveness of the United States, what is? Consider the web graph in Figure 7, which shows a side-by-side comparison of the 2014-15 GCI component scores for Switzerland and the United States. A close look at the 12 component scores, or pillars that generate a nation's rank on the GCI shows other more likely culprits for a potential decline in the relative competitiveness of the United States. Examining the 2014-15 Global Competitiveness Report, high-interest payments on government debt coupled with unsustainable levels of public debt, overregulation, lack of transparency to prevent fraud and mismanagement of the private sector, public distrust of elected officials, and legislative gridlock all threaten the future competitiveness of the United States. In fact, the 2014 Executive Opinion Survey (utilized in connection with economic data from international organizations and national statistical offices to calculate the GCI) revealed that an inadequately educated workforce was the top concern for business leaders in Switzerland. Business leaders in the United States ranked several other problematic factors for doing business higher including tax rates, tax regulations, inefficient government bureaucracy, access to financing, restrictive labor regulations, and a poor work ethic in the national labor force (Schwab, 2014).

Figure 7

2014-15 GCI Component Scores for Switzerland and the United States



In 2012 the Secretary of Commerce completed a study of the economic competitiveness and innovative capacity of the United States under Section 604 of the America COMPETES Reauthorization Act of 2010 (Department of Commerce, 2012). Tax policy, business climate, regional issues, barriers to business startups, trade policy, federal research and development policy, protection of intellectual property in the U.S. and abroad, manufacturing, and science and technology education were all listed as threats to U.S. competitiveness (U.S. Department of Commerce, 2012). Future studies should examine in greater depth the impact of these factors on competitiveness and attempt to find causal relationships. Speculation that the competitiveness of the United States is at risk because of pedagogical failures in primary and secondary public schools wastes valuable time and resources that could be devoted elsewhere to preventing the decline of U.S. competitiveness in the world. More specifically, the findings of the 2014-15 Global Competitiveness report indicate that policymakers should be prioritizing their efforts on adjusting tax rates, simplifying tax regulations, and repairing inefficiencies in government bureaucracy for the United States to remain competitive in the world (Schwab, 2014). An inadequately educated workforce is also a concern, but no more so than for other nations in the highest ranks on the GCI.

Singapore, occupying 2nd place on the 2014-15 Global Competitiveness Report, and 3rd place in cognitive achievement on international assessments, provides another interesting example to examine. Singapore was originally founded in 1819 as a British trading post (Leitch, 1989). Over the past 50 years since declaring its independence in 1965, Singapore has become an economic powerhouse with a GDP per capita higher than that of the United States (Leitch, 1989; Schwab, 2014). An island nation of 5.4 million people, Singapore has no natural resources to speak of and is heavily dependent on external markets and suppliers (Leitch, 1989; Schwab, 2014). This reality compelled the nation to centrally control its factors of production while maintaining strong adherence to free trade and market principles (Leitch, 1989).

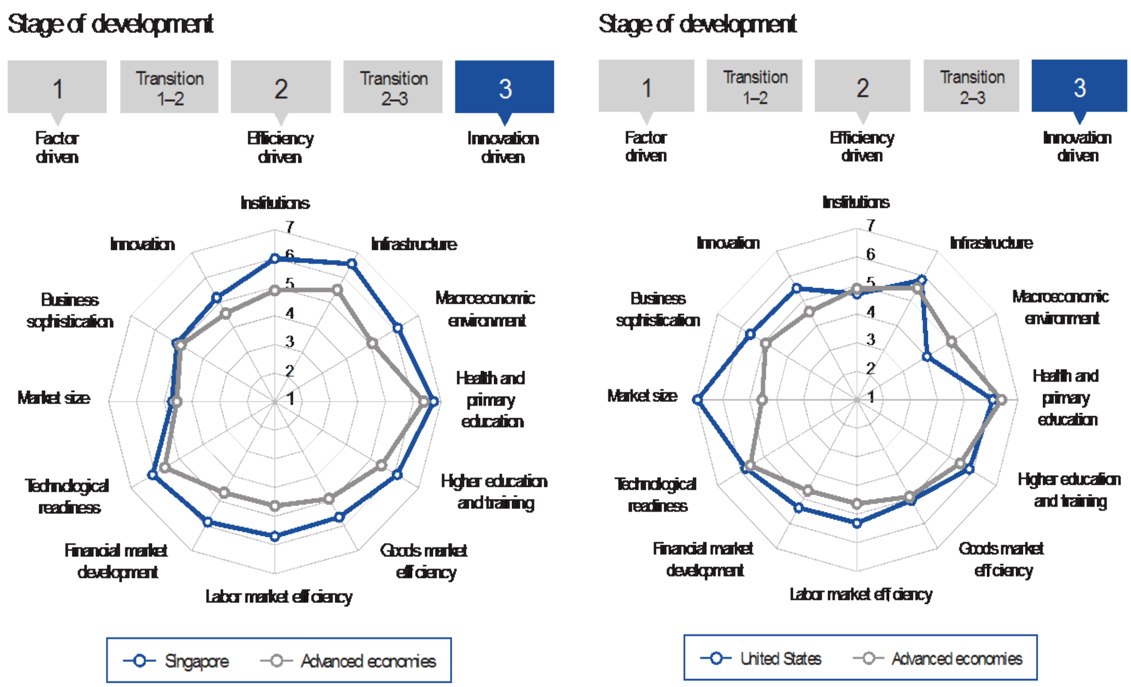
Figure 8 shows a side-by-side comparison of the 2014-15 GCI component scores for Singapore and the United States. Notable strengths that have made tiny Singapore jump to the 2nd most competitive economy in the world in just 50 years are:

- trustworthy legal and administrative framework to protect property rights (institutions)
- strategic location and reliable transportation and communications network (infrastructure)
- high private and public savings rate mixed with limited debt (macroeconomic environment)

- low levels of government interference with business activity and openness to foreign direct investment (goods market efficiency)

Figure 8

2014-15 GCI Component Scores for Singapore and the United States



In addition, Singapore has a primary and secondary education system that rivals its cohort nations, even though it is nationalized and based on a highly scripted, uniform curriculum designed to transmit factual and procedural knowledge (Hogan, 2014). It is interesting to note that the United States also experienced its period of greatest economic growth during the 50 years following the Civil War when the nation had the closest approximation to a national curriculum (also highly scripted, factual, and procedural) in the form of the Eclectic Education Series (Hughes, 1932; Kirkland, 1961).

The Economic Freedom of the World Report is a publication of the Cato Institute and the Fraser Institute that assesses global freedom of exchange and market coordination, both of which are linked to economic growth and competitiveness (Gwartney, Lawson, & Hall, 2014). The 2014 report drops the United States' economic freedom rank to 12th place from 2nd in 2000 due to an increasing shift away from the rule of law towards heavy regulation, increased use of eminent domain, and wars on terrorism and drugs (Gwartney, Lawson, & Hall, 2014). The 2014 Global Innovation Index (GII), which considers 81 innovation indicators across a variety of themes for 143 economies, reports a slip from 5th in 2013 to a rank of 6th in 2014 for the United States (Cornell University, INSEAD, & WIPO, 2014). Areas of concern cited in the report are low levels of tertiary international student exchange and low levels of tertiary graduates in science and engineering (Cornell University, INSEAD, & WIPO, 2014). Future studies should look into the relationship between tertiary graduation rates in science and engineering and competitiveness. It would also be revealing to determine whether or not a correlation exists between other indices (such as the GII) and cognitive skill. Archival data for these suggested analyses are readily available in the public domain.

As mentioned in Chapter 4, the United States is a perplexing nation to study. On the one hand, it belongs to the cohort of nations ranked in the top 25 percent on the GCI. On the other hand, when the data is sorted by cognitive achievement, it belongs to the cohort of nations in the middle 50 percent (albeit near the top of that cohort). There are many possible reasons for this, which should be the topic of future studies. Some of these include the diversity of the U.S. population, evidence that the United States is not falling behind per se, but rather that other countries are getting better at a faster rate than the U.S., a lack of national agreement about what students should know and be able to do in school, and a decentralized education system with no national funding mechanism to ensure equitable funding for all schools (Ammermueller, 2007; Andersen, 2010; Gilleece, Cosgrove, & Sofroniou, 2010; Demır & Kiliç, 2010; Department of Education, 2012b; Liem, Mok, and Xu, 2012; Šapkova, 2013; Schleicher, 2011; Shiel & Eivers 2009). There is some evidence that poverty affects student achievement more in the U.S. than in other countries, which should be studied in greater depth (Cavanagh, 2007a). The effects of investments in pre-K programs should also be studied more. Frede and Barnett (2011) argue that the United States must begin to implement pre-K programs on a widespread basis to enable American students to catch up with their counterparts in Shanghai. Whatever the reasons are, this dissertation reveals a troubling conundrum about the United States; that is, it continues to be highly competitive in spite of a primary and secondary education system that produces average results on ISATs.

Implications for Professional Practice and Policy

The rationale for primary and secondary public education reform in the United States is that a failure to repair a supposedly broken education system will cause the U.S. to fall behind the rest of the world competitively (Alexander, 1986; Department of Education, 1983, 1991, 1994, 2012a; National Governors Association, 2009). The publication of *A Nation At Risk* in 1983 made the claim that, “Our once unchallenged preeminence in commerce, industry, science, and technological innovation is being overtaken by competitors throughout the world” (Department of Education, 1983). Without a doubt other nations have outpaced the United States competitively over the past two decades, but this study demonstrates that in the United States at least, policymakers should be addressing other, more critical components of the economy before addressing primary and secondary accountability. The public school system in the United States can and should improve itself, and policymakers do not necessarily need to look abroad to find examples of how to do it. There are examples within the nation of states that perform as well as the highest performing countries around the world (Salzman & Lowell, 2008). The focus of primary and secondary education reform should be improving equity of access to quality school buildings, resources, and quality teachers. Instead of myopically focusing on holding schools accountable for student test performance, policymakers should first ensure teachers have the technology, training, support, and financial incentives to do the job the public expects of them. Ensuring families have the resources at home to support their children at school is also critical to public school reform (Anil, 2011). Without support for struggling families, many subpopulations of students will remain disadvantaged in school compared with peers who have more resources at home (Harvey, McKay, Fowler & Marx, 2015; Perelman & Santin, 2011).

The public has become skeptical of federal education reform initiatives. A recent Phi Delta Kappan/Gallup poll reveals that most Americans perceive education reform efforts in the United States to be federally orchestrated and do not support change initiatives they believe federal policymakers created and continue to push on local and state education agencies (Bushaw & Calderon, 2014). From a policy standpoint, this research may prompt state and federal elected officials to rethink education reform in the United States. This study should prompt policymakers, local school board members, and superintendents to critically investigate the research behind reform initiatives. Reform proposals that arise during legislative sessions at state and federal levels should be scrutinized to determine whether or not such proposals are based on research that is correlated to the desired outcome. Policymakers could recommend any number of public school initiatives in connection with correlated outcomes of investments in human capital. For example, research has found significant correlations between formal schooling and a number of areas including: higher personal earnings, increases in economic growth (GDP), increases in worker productivity, benefits to health and longevity, lowered incidences of criminal activity, greater civic participation, and lower reliance on welfare (Greenwood, 1997; Grossman & Kaestner, 1997; Kenkel, 1991; Lleras-Muney & Lichtenberg, 2002; Lochner & Moretti, 2004; Maynard & McGrath, 1997; Milligan, Moretti & Oreopoulos, 2004; OECD, 2010; Wolfe & Haveman, 2001).

The Global Competitiveness Index is computed based on more than 100 economic indicator and survey scores, which are grouped into 12 component scores, or pillars, categorized under three subindexes: basic requirements, efficiency enhancers, and innovation. Nations represented in the GCI are categorized into stages of development based on GDP per capita and the amount of exports made up of mineral goods. The subindexes are weighted differently depending on the nation's stage of development. The United States is classified in the innovation-driven stage of development, so 'basic requirements' is weighted at 20 percent of the overall GCI score because its institutions, infrastructure, macroeconomic environment, health and primary education systems are firmly in place. A nation that does not have basic requirements in place or that is in the initial stages of developing its institutions and infrastructure would receive a weight of 60 percent for this subindex. Fifty percent of the GCI score for the United States is based on efficiency enhancers, and 30 percent is based on innovation and sophistication factors. Economic theory of stages of development states that nations will require different initiatives depending on what stage of development they are in to grow and remain competitive.

For a nation like the United States to remain competitive in the world, policymakers need to work on enhancing business sophistication and innovations in research and development through quality scientific research institutions, corporate spending on research and development, university-industry collaboration in research and development, government procurement of advanced technology products, availability of scientists and engineers, patent applications, and intellectual property protection. Even though the United States is in the innovation stage of development, it should not ignore the foundations of the economy by allowing its institutions, infrastructure, macroeconomic environment, and health and primary education to crumble away. However, a careful look again at the 2014-15 GCI component scores for the United States, Switzerland, and Singapore reveals precisely which components need attention. The United States scores near the average of advanced economies for its public institutions score, which includes indicators such as property rights, judicial independence, ethical behavior of firms, and public trust in politicians. The United States scores near the average of advanced economies for its infrastructure score, which includes indicators such as the quality of roads, the quality of railroads, ports, and air transportation, the quality of the electrical supply, and mobile telephone subscriptions. The United States scores well below the average of advanced economies for its macroeconomic environment score, which includes indicators such as gross national savings, inflation, government debt, and the country credit rating. However, Switzerland and Singapore have outpaced the United States in each of these basic requirements scoring well above average, and they do nearly as well or better than the United States in the efficiency enhancer components (except market size) and innovation and sophistication factors critical to the continued competitiveness of advanced economies. In the area of health and primary education, Singapore, Switzerland, and the United States are neck and neck.

As mentioned previously, the lack of a correlation between the competitiveness of the United States and cognitive achievement on international student achievement tests does not imply policymakers should not continue to examine the quality of the public school system and make efforts to improve it. However, policymakers should not use the nation's competitiveness as a rationale for reform initiatives. False alarms about a dire future stand in stark contrast to this research and others that show the United States produces many more high-achieving students than any other nation across racial and ethnic lines (Bracey, 2009; Petrilli & Scull, 2011). Any number of justifications for reform may be valid, but they should be researched and proven to have a correlation to the desired outcome (and better yet, be proven to cause the desired outcome) before the public is made to believe they are true and billions of dollars are spent on staircases that lead to nowhere and doors that open into walls.

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Appendix A

Research Certification

Certificate of Completion

The National Institutes of Health (NIH) Office of Extramural Research certifies that **David Meyer** successfully completed the NIH Web-based training course "Protecting Human Research Participants".

Date of completion: 10/23/2013

Certification Number: 1309168

Appendix B

International Data on Cognitive Skills
(Sorted Alphabetically)

Code	Country	gsample	cognitive	lowsec	basic	top
ALB	Albania	0	3.785	3.785	0.424	0.013
ARG	Argentina	1	3.920	3.920	0.492	0.027
ARM	Armenia	0	4.429	4.490	0.745	0.008
AUS	Australia	1	5.094	5.138	0.938	0.112
AUT	Austria	1	5.089	5.090	0.931	0.097
BEL	Belgium	1	5.041	5.072	0.931	0.094
BGR	Bulgaria	0	4.789	4.789	0.765	0.083
BHR	Bahrain	0	4.114	4.114	0.608	0.003
BRA	Brazil	1	3.638	3.638	0.338	0.011
BWA	Botswana	0	3.575	3.575	0.374	0.000
CAN	Canada	1	5.038	5.125	0.948	0.083
CHE	Switzerland	1	5.142	5.102	0.919	0.134
CHL	Chile	1	4.049	3.945	0.625	0.013
CHN	China	1	4.939	4.939	0.935	0.083
COL	Colombia	1	4.152	4.152	0.644	0.000
CYP	Cyprus	1	4.542	4.413	0.825	0.011
CZE	Czech Rep.	0	5.108	5.177	0.931	0.122
DNK	Denmark	1	4.962	4.869	0.888	0.088
EGY	Egypt	1	4.030	4.030	0.577	0.010
ESP	Spain	1	4.829	4.829	0.859	0.079
EST	Estonia	0	5.192	5.192	0.973	0.095
FIN	Finland	1	5.126	5.173	0.958	0.124
FRA	France	1	5.040	4.972	0.926	0.085
GBR	United Kingdom	1	4.950	4.995	0.929	0.088
GER	Germany	0	4.956	4.959	0.906	0.105
GHA	Ghana	1	3.603	3.252	0.403	0.010
GRC	Greece	1	4.608	4.618	0.798	0.042
HKG	Hong Kong	1	5.195	5.265	0.944	0.123
HUN	Hungary	0	5.045	5.134	0.941	0.103
IDN	Indonesia	1	3.880	3.880	0.467	0.008
IND	India	1	4.281	4.165	0.922	0.013
IRL	Ireland	1	4.995	5.040	0.914	0.094
IRN	Iran	1	4.219	4.262	0.727	0.006
ISL	Iceland	1	4.936	4.945	0.908	0.074
ISR	Israel	1	4.686	4.660	0.826	0.053
ITA	Italy	1	4.758	4.693	0.875	0.054
JOR	Jordan	1	4.264	4.264	0.662	0.044
JPN	Japan	1	5.310	5.398	0.967	0.168
KOR	Korea, Rep.	1	5.338	5.401	0.962	0.178
KWT	Kuwait	0	4.046	4.223	0.575	0.000
LBN	Lebanon	0	3.950	3.950	0.595	0.002
LIE	Liechtenstein	0	5.128	5.128	0.860	0.198
LTU	Lithuania	0	4.779	4.694	0.891	0.030
LUX	Luxembourg	0	4.641	4.641	0.776	0.067
LVA	Latvia	0	4.803	4.779	0.869	0.050

MAC	Macao-China	0	5.260	5.260	0.919	0.204
MAR	Morocco	1	3.327	3.243	0.344	0.001
MDA	Moldova	0	4.530	4.419	0.787	0.029
MEX	Mexico	1	3.998	3.998	0.489	0.009
MKD	Macedonia	0	4.151	4.151	0.609	0.028
MYS	Malaysia	1	4.838	4.838	0.864	0.065
NGA	Nigeria	0	4.154	4.163	0.671	0.001
NLD	Netherlands	1	5.115	5.149	0.965	0.092
NOR	Norway	1	4.830	4.855	0.894	0.056
NZL	New Zealand	1	4.978	5.009	0.910	0.106
PER	Peru	1	3.125	3.125	0.182	0.002
PHL	Philippines	1	3.647	3.502	0.485	0.006
POL	Poland	0	4.846	4.861	0.838	0.099
PRT	Portugal	1	4.564	4.592	0.803	0.032
PSE	Palestine	0	4.062	4.062	0.571	0.008
ROM	Romania	1	4.562	4.562	0.780	0.046
RUS	Russian Fed.	0	4.922	4.906	0.884	0.081
SAU	Saudi Arabia	0	3.663	3.663	0.331	0.000
SGP	Singapore	1	5.330	5.512	0.945	0.177
SRB	Serbia	0	4.447	4.447	0.718	0.024
SVK	Slovak Rep.	0	5.052	5.052	0.906	0.112
SVN	Slovenia	0	4.993	5.076	0.939	0.061
SWE	Sweden	1	5.013	4.948	0.939	0.088
SWZ	Swaziland	0	4.398	4.398	0.801	0.004
THA	Thailand	1	4.565	4.556	0.851	0.019
TUN	Tunisia	1	3.795	3.889	0.458	0.003
TUR	Turkey	1	4.128	4.128	0.582	0.039
TWN	Taiwan (Chinese Taipei)	1	5.452	5.599	0.958	0.219
URY	Uruguay	1	4.300	4.300	0.615	0.049
USA	United States	1	4.903	4.911	0.918	0.073
ZAF	South Africa	1	3.089	2.683	0.353	0.005
ZWE	Zimbabwe	1	4.107	4.107	0.684	0.010

For details, see: Eric A. Hanushek, Ludger Woessmann. 2009. Do Better Schools Lead to More Growth? Cognitive Skills, Economic Outcomes, and Causation.

Variables:

gsample	Indicator of whether country is in the main sample of 50 countries contained in the growth regressions, for which internationally comparable GDP data is available.
cognitive	Average test score in math and science, primary through end of secondary school, all years (scaled to PISA scale divided by 100).
lowsec	Average test score in math and science, only lower secondary, all years (scaled to PISA scale divided by 100).
basic	Share of students reaching basic literacy (based on average test scores in math and science, primary through end of secondary school, all years).
top	Share of top-performing students (based on average test scores in math and science, primary through end of secondary school, all years).

Appendix C

International Data on Cognitive Skills
(Sorted by Cognitive Score)

Code	Country	gsample	cognitive	lowsec	basic	top
TWN	Taiwan (Chinese Taipei)	1	5.452	5.599	0.958	0.219
KOR	Korea, Rep.	1	5.338	5.401	0.962	0.178
SGP	Singapore	1	5.330	5.512	0.945	0.177
JPN	Japan	1	5.310	5.398	0.967	0.168
MAC	Macao-China	0	5.260	5.260	0.919	0.204
HKG	Hong Kong	1	5.195	5.265	0.944	0.123
EST	Estonia	0	5.192	5.192	0.973	0.095
CHE	Switzerland	1	5.142	5.102	0.919	0.134
LIE	Liechtenstein	0	5.128	5.128	0.860	0.198
FIN	Finland	1	5.126	5.173	0.958	0.124
NLD	Netherlands	1	5.115	5.149	0.965	0.092
CZE	Czech Rep.	0	5.108	5.177	0.931	0.122
AUS	Australia	1	5.094	5.138	0.938	0.112
AUT	Austria	1	5.089	5.090	0.931	0.097
SVK	Slovak Rep.	0	5.052	5.052	0.906	0.112
HUN	Hungary	0	5.045	5.134	0.941	0.103
BEL	Belgium	1	5.041	5.072	0.931	0.094
FRA	France	1	5.040	4.972	0.926	0.085
CAN	Canada	1	5.038	5.125	0.948	0.083
SWE	Sweden	1	5.013	4.948	0.939	0.088
IRL	Ireland	1	4.995	5.040	0.914	0.094
SVN	Slovenia	0	4.993	5.076	0.939	0.061
NZL	New Zealand	1	4.978	5.009	0.910	0.106
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MYS	Malaysia	1	4.838	4.838	0.864	0.065
NOR	Norway	1	4.830	4.855	0.894	0.056
ESP	Spain	1	4.829	4.829	0.859	0.079
LVA	Latvia	0	4.803	4.779	0.869	0.050
BGR	Bulgaria	0	4.789	4.789	0.765	0.083
LTU	Lithuania	0	4.779	4.694	0.891	0.030
ITA	Italy	1	4.758	4.693	0.875	0.054
ISR	Israel	1	4.686	4.660	0.826	0.053
LUX	Luxembourg	0	4.641	4.641	0.776	0.067
GRC	Greece	1	4.608	4.618	0.798	0.042
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SWZ	Swaziland	0	4.398	4.398	0.801	0.004
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ARG	Argentina	1	3.920	3.920	0.492	0.027
IDN	Indonesia	1	3.880	3.880	0.467	0.008
TUN	Tunisia	1	3.795	3.889	0.458	0.003
ALB	Albania	0	3.785	3.785	0.424	0.013
SAU	Saudi Arabia	0	3.663	3.663	0.331	0.000
PHL	Philippines	1	3.647	3.502	0.485	0.006
BRA	Brazil	1	3.638	3.638	0.338	0.011
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MAR	Morocco	1	3.327	3.243	0.344	0.001
PER	Peru	1	3.125	3.125	0.182	0.002
ZAF	South Africa	1	3.089	2.683	0.353	0.005

For details, see:	Eric A. Hanushek, Ludger Woessmann. 2009. Do Better Schools Lead to More Growth? Cognitive Skills, Economic Outcomes, and Causation.

Variables:

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basic	Share of students reaching basic literacy (based on average test scores in math and science, primary through end of secondary school, all years).
top	Share of top-performing students (based on average test scores in math and science, primary through end of secondary school, all years).

Appendix D

Global Competitive Index Table

The Global Competitiveness Index 2014-2015 rankings

	GCI 2014-2015		GCI 2013-2014
Country/Economy	Rank (out of 144)	Score	Rank (out of 148)
Switzerland	1	5.70	1
Singapore	2	5.65	2
United States	3	5.54	5
Finland	4	5.50	3
Germany	5	5.49	4
Japan	6	5.47	9
Hong Kong SAR	7	5.46	7
Netherlands	8	5.45	8
United Kingdom	9	5.41	10
Sweden	10	5.41	6
Norway	11	5.35	11
United Arab Emirates	12	5.33	19
Denmark	13	5.29	15
Taiwan, China	14	5.25	12
Canada	15	5.24	14
Qatar	16	5.24	13
New Zealand	17	5.20	18
Belgium	18	5.18	17
Luxembourg	19	5.17	22
Malaysia	20	5.16	24
Austria	21	5.16	16
Australia	22	5.08	21
France	23	5.08	23
Saudi Arabia	24	5.06	20
Ireland	25	4.98	28
Korea, Rep.	26	4.96	25
Israel	27	4.95	27
China	28	4.89	29
Estonia	29	4.71	32
Iceland	30	4.71	31
Thailand	31	4.66	37
Puerto Rico	32	4.64	30
Chile	33	4.60	34

Indonesia	34	4.57	38
Spain	35	4.55	35
Portugal	36	4.54	51
Czech Republic	37	4.53	46
Azerbaijan	38	4.53	39
Mauritius	39	4.52	45
Kuwait	40	4.51	36
Lithuania	41	4.51	48
Latvia	42	4.50	52
Poland	43	4.48	42
Bahrain	44	4.48	43
Turkey	45	4.46	44
Oman	46	4.46	33
Malta	47	4.45	41
Panama	48	4.43	40
Italy	49	4.42	49
Kazakhstan	50	4.42	50
Costa Rica	51	4.42	54
Philippines	52	4.40	59
Russian Federation	53	4.37	64
Bulgaria	54	4.37	57
Barbados	55	4.36	47
South Africa	56	4.35	53
Brazil	57	4.34	56
Cyprus	58	4.31	58
Romania	59	4.30	76
Hungary	60	4.28	63
Mexico	61	4.27	55
Rwanda	62	4.27	66
Macedonia, FYR	63	4.26	73
Jordan	64	4.25	68
Peru	65	4.24	61
Colombia	66	4.23	69
Montenegro	67	4.23	67
Vietnam	68	4.23	70
Georgia	69	4.22	72
Slovenia	70	4.22	62
India	71	4.21	60
Morocco	72	4.21	77
Sri Lanka	73	4.19	65
Botswana	74	4.15	74
Slovak Republic	75	4.15	78
Ukraine	76	4.14	84

Croatia	77	4.13	75
Guatemala	78	4.10	86
Algeria	79	4.08	100
Uruguay	80	4.04	85
Greece	81	4.04	91
Moldova	82	4.03	89
Iran, Islamic Rep.	83	4.03	82
El Salvador	84	4.01	97
Armenia	85	4.01	79
Jamaica	86	3.98	94
Tunisia	87	3.96	83
Namibia	88	3.96	90
Trinidad and Tobago	89	3.95	92
Kenya	90	3.93	96
Tajikistan	91	3.93	n/a
Seychelles	92	3.91	80
Lao PDR	93	3.91	81
Serbia	94	3.90	101
Cambodia	95	3.89	88
Zambia	96	3.86	93
Albania	97	3.84	95
Mongolia	98	3.83	107
Nicaragua	99	3.82	99
Honduras	100	3.82	111
Dominican Republic	101	3.82	105
Nepal	102	3.81	117
Bhutan	103	3.80	109
Argentina	104	3.79	104
Bolivia	105	3.77	98
Gabon	106	3.74	112
Lesotho	107	3.73	123
Kyrgyz Republic	108	3.73	121
Bangladesh	109	3.72	110
Suriname	110	3.71	106
Ghana	111	3.71	114
Senegal	112	3.70	113
Lebanon	113	3.68	103
Cape Verde	114	3.68	122
Côte d'Ivoire	115	3.67	126
Cameroon	116	3.66	115
Guyana	117	3.65	102
Ethiopia	118	3.60	127
Egypt	119	3.60	118

Paraguay	120	3.59	119
Tanzania	121	3.57	125
Uganda	122	3.56	129
Swaziland	123	3.55	124
Zimbabwe	124	3.54	131
Gambia, The	125	3.53	116
Libya	126	3.48	108
Nigeria	127	3.44	120
Mali	128	3.43	135
Pakistan	129	3.42	133
Madagascar	130	3.41	132
Venezuela	131	3.32	134
Malawi	132	3.25	136
Mozambique	133	3.24	137
Myanmar	134	3.24	139
Burkina Faso	135	3.21	140
Timor-Leste	136	3.17	138
Haiti	137	3.14	143
Sierra Leone	138	3.10	144
Burundi	139	3.09	146
Angola	140	3.04	142
Mauritania	141	3.00	141
Yemen	142	2.96	145
Chad	143	2.85	148
Guinea	144	2.79	147

Appendix E

Permission to Use Figure 1

Theodore Richard Breton tbreton@eafit.edu.co Jan 12, 2014

to me

Mr. Meyer,
Yes. Please do, but you should be aware that the MRW model is not an endogenous growth model. Good luck in your research.
Best Regards,
Theodore R. Breton

De: David Meyer
Enviado: viernes, 10 de enero de 2014 9:14 a. m.
Para: Theodore Richard Breton
Cc: Lori Werth
Asunto: Request to use figures

Mr. Breton,

I am working on a dissertation through Northwest Nazarene University (NNU) in Idaho, USA, to obtain my doctorate in Educational Leadership. May I have your permission to use Figure 4 from your paper "The Role of Education in Economic Development: Theory, History, and Current Returns" published May, 2012?

I have enjoyed reading your work in this area and hope my research can add to the literature. Dr. Lori Werth, NNU Doctoral Program Administrator, has been copied on this email should you need to contact her.

Best regards,

David Meyer
NNU Doctoral Student

Appendix F

Permission to Use Table 1

Mar 1, 2014

Eric Hanushek

to me

Dave

Of course you can.

Rick

On Sat, Mar 1, 2014 at 6:39 AM, David Meyer wrote:
Dr. Hanushek,

I would like to use the International Student Achievement Tests table from Hanushek and Woessmann(2009) and as published in the OECD The High Cost of Low Educational Performance: The Long-Run Economic Impact of Improving PISA Outcomes to summarize the international student achievement tests that have been given since 1964. May I use that table in my dissertation? I will be sure to cite its source.

Best regards,

Dave Meyer
NNU Doctoral Student