A SURVEY INTO THE PHYSICAL AND PSYCHOLOGICAL DIFFERENCES OF THE AMERICAN, GERMAN, AND JAPANESE EDUCATIONAL METHODS IN TEACHING THE SUBJECT OF MATHEMATICS

By

Ilona Ridgeway

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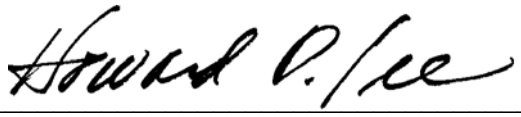

Dr. Howard D. Lee, Investigation Advisor

The Graduate School
University of Wisconsin-Stout
April, 2002

The Graduate School
University of Wisconsin-Stout
Menomonie, WI 54751

ABSTRACT

Ridgeway Ilona
(Writer) (Last Name) (First) (Initial)

A Survey into the Physical and Psychological Differences of the American, German, and Japanese Educational Methods in Teaching the Subject of Mathematics

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This thesis paper takes a look at the cultural differences in teaching the subject of mathematics. Few studies have focused on a combination of the physical and psychological aspects of different international cultures, specifically the United States of America, Germany, and Japan in teaching the subject of math.

These countries were chosen for this study partly because there is a plethora of information about these countries, but also because they were chosen for studies by numerous other researchers for good reasons. “Germany and Japan were chosen because they are both seen as important economic and financial rivals of the United States. Japan

is of special interest because it has repeatedly scored near the top in international comparisons of mathematical achievement." (Stigler & Heibert, 1997).

The purpose of this study is to compare the physical and psychological impact these differences can make in a student's overall performance. The findings of this study will have broad implications for the entire American educational system. It will contrast our successes and failures with those of other countries in order to expose a path of techniques that can be adapted or assimilated to ensure the continued accomplishments of the American student.

American students have trouble maintaining academic levels of English, math and science compared to previous years and in comparison to their international counterparts. The American educational system is clearly failing many of its customers. The problem is American high school students' math scores are falling in comparison to their international counterparts.

The objectives for the study were as follows:

1. Examine the psychological aspects of the educational system for the American, German, and Japanese cultures.
    a. Investigate the societal attitudes toward math in each culture.
    b. Explore the students' teachers' attitudes toward math in each culture.
    c. Inspect the students' parents' attitudes toward math in each culture.
    d. Canvass the students' attitudes toward math in each culture.

2. Identify the physical aspects of the educational system for the American, German, and Japanese cultures.
    a. Identify whether calculators are used at all grade levels in each culture and how they are used to impart the objectives of the lesson. How much importance and time is given to the use of calculators in each culture? Is calculator use related to deductive reasoning (imperative to the understanding of mathematics) in each culture?
    b. Determine if students' classrooms are separated by the primary language spoken by the teacher, by like students' mental abilities or by like students' physical abilities in each culture.
    c. Ascertain if math teachers are prepared and able to teach the level of mathematics their class is at in each culture.
    d. Examine the effect that discipline in the classroom, or lack thereof, affects students' abilities to learn math.

The significance of this study is important because, in a country where freedoms are a basic right, we may have overlooked the right to remain ignorant even in the face of education. However, in fact, it is knowledge that truly sets one free. In a country that is constantly bringing others to task for their shortcomings on human rights and other basic issues, it is unconscionable that America could do no less for its citizens. Education is truly a basic issue. However unintentional these oversights might be, it is hypocritical not to work to change them once they have been brought to light. This study will show that

teaching is a cultural activity and America can learn from the strengths and weaknesses of others' differences (Stigler & Heibert, 1997). It is through this teaching exchange that we can keep America's leaders of the future strong and competitive.

Table of Contents

List of Tables

Chapter I

Introduction

"Upon the subject of education, not presuming to dictate any plan or system respecting it, I can only say that I view it as the most important subject which we, as a people, can be engaged in" (Abraham Lincoln). The difference between a civilized society and an uncivilized one is education. Education is many things to many people. Lincoln was wise enough "not to presume to dictate any plan or system respecting it (education)" yet, in the same breath, let people know how important it (education) was. What is important to be taught, how it is taught, to whom it is taught, even where and when it is taught have been hotly debated issues for millenniums.

Over the years, teaching has filtered down to a fairly routine thing that takes place in school houses all over the world, all of the time. However, the debate over the who, what, where, when, why, and how still goes on, hotter than ever. It seems these days everyone has an opinion, there are more critics and educational reformers than there are schools in which to teach. Few of these people are as wise as Abe. What we do know about educational updates, reform, and change is that it lives or dies in the classroom (Bracey, 1998). Few of these so-called educational experts have had real time in a k-12 classroom, or have even consulted with a teacher that has. Is it a wonder that education in the United States is not keeping pace?

Newspaper articles, studies, and tests results are replete with examples of how American students are falling behind their international counterparts. Recently, the Third International Math and Science Study (TIMSS) test was given. The overall results for American students are somewhat dismal. In the fourth grade, American students were second to only one country in science and placed above average in math. The American eighth graders that were tested fell slightly above average in science and below in math. High school students in the United States ranked last among 16 countries in physics, and next to last in advanced math (TIMSS). It is clear from the results that American students do not start out behind their international counterparts, but rapidly lose the pace somewhere after the fourth grade (Valverde & Schmidt, 1997, 1998). A minority of American students can show competencies equal to levels of students from other developed countries (Stedman, 1990). America's school systems are, on a regular basis, under attack by the same publications that are claiming its educational systems are substandard by not only international comparisons, but by its own standards as well. The President and others have acclaimed shock and dismay at these showings, but are low math and science scores really surprising in a land where one-third of its adults are functionally illiterate?

> A country where semi- or complete illiteracy among large sectors of the adult population (15 years and over) has gone unrecognized. Some of these reasons are largely related to misconceptions about the basic functions of schools in our societies. The invisibility of the problem is

> related to the invisibility of the population affected by illiteracy. Another factor which has tended to hide the issue is the ambivalence of national commitment to ensure a literate society as either a basic human right, a social obligation or a necessary prerequisite for economic and social development (Limage, 1990, p.125-126).

There is great debate over the critics' claims that America is falling behind its previous standards. Those that argue against hold up the grade point averages of the k-12 system, and can even point to some increase over time as their main weapon against this charge. Their critics counter this with arguments that the curriculum has been diluted in order to maintain those levels. They point to convincing evidence that those same students can't pass, or do much worse, on standardized tests than students with similar grade point averages did ten years ago (Basinger, 1997).

The decreasing performance by our students has been referred to as dumbing down (Sykes, 1995). The following is a humorous example of dumbing down that has crossed this researcher's desk often in the past. While its intent is humorous, it is, chillingly, not far from the mark.

- 1950's math question: A logger has 800 lbs. of trees on a 20 sq. ft. flat bed truck. Find the pressure in lbs. per sq. inch on the flat bed truck.
- 1960's math question: A logger has 800 lbs. of trees on a flat bed truck. Each tree weighs 20 lbs. How many trees are on the flat bed truck?

- 1970's math question: A logger has 800 trees on a flat bed truck. He adds 20 more trees. How many trees does he have in all?
- 1980's math question: A logger cut down 800 trees. In your group determine the type of wild life displaced and write a paragraph on the environmental impact of the loggers' actions.
- 1990's math question: A logger cut down 800 trees. Draw a picture of a tree.

Grade inflation was said to be another of the causes of dumbing down. During the Viet Nam war many male students on deferment from the draft were given higher than deserving grades by sympathetic professors in order to keep their deferred status.

> No one denies that college grades are much higher on average than they were a generation ago. Although it appears that GPAs have remained somewhat stable over the past five to ten years, it is clear that they rose substantially (15-20%) from the mid '60s through the mid '80s (Basinger, 1997, p.88).

Passing students because of overcrowding and other detrimental conditions was common among poorer school districts, causing a 1974 Suma Cum Laude graduate from an inner-city Chicago school to sue the city because he could not read sufficiently to fill out a job application. It was later determined that he had achieved this status because, in a school of obnoxious troublemakers, drug addicts, and deviants he had been a quiet student that had never been arrested, threatened a teacher, or urinated in the hallway. Not exactly the qualifications for most institutions' awards of top honors.

It is generally believed by parents, students, future schools, and employers that grades are a reflection of the student's mastery of the subject matter (Walhout, 1997). Not so any more. Books such as How Children Fail, by Holt (1964); Enhancing Self Esteem, by Frey & Carlock (1984); and Motivation Theory for Teachers, by Hunter (1988), have convinced teachers that students will learn better by achieving success in school. The definition of achieving success is questionable at best. The admirable desire for teachers to raise students' self esteem is another reason for grade inflation. Giving younger students higher than deserving grades does raise their self-esteem, but is, at best, misplaced. Students' self-esteem can be positively affected by a good grade, but so, too, can it be adversely affected by poor showings on standardized tests (Knore, 1996).

The motivation for this study is to determine why American students appear to continue to fall behind their international counterparts in math, and what, if anything, can be done to reverse this disparaging trend. This study will focus on three countries from which to draw comparisons: Germany, Japan, and the United States. These countries were chosen for this study partly because there is a plethora of information about these countries, but also because they were chosen for studies by numerous other researchers for good reasons. "Germany and Japan were chosen because they are both viewed as important economic competitors of the United States. Japan is of special interest because its students have repeatedly scored near the top in international comparisons of mathematical achievement" (Stigler & Heibert, 1997).

Statement of the Problem

American students have trouble maintaining academic levels of English, math and science, compared to previous years, and in comparison to their international counterparts. The American educational system is clearly failing many of its customers. The problem is American high school students' math scores are falling in comparison to their international counterparts. Few studies have focused on a combination of the physical and psychological aspects of different international cultures, specifically the United States of America, Germany, and Japan.

Purpose of the Study

The purpose of this study is to compare the physical and psychological impact these differences can make in a student's overall performance. The findings of this study will have broad implications for the entire American educational system. It will contrast our successes and failures with those of other countries in order to expose a path of techniques that can be adapted or assimilated to ensure the continued accomplishments of American students.

Objectives

3. Examine the psychological aspects of the educational system for the American, German, and Japanese cultures.
    a. Investigate the societal attitudes toward math in each culture.

b. Explore the students' teachers' attitudes toward math in each culture.

c. Inspect the students' parents' attitudes toward math in each culture.

d. Canvass the students' attitudes toward math in each culture.

4. Identify the physical aspects of the educational system for the American, German, and Japanese cultures.

    a. Identify whether calculators are used at all grade levels in each culture and how they are used to impart the objectives of the lesson. How much importance and time is given to the use of calculators in each culture? Is calculator use related to deductive reasoning (imperative to the understanding of mathematics) in each culture?

    b. Determine if students' classrooms in each culture are separated by the primary language spoken by the teacher, by like students' mental abilities, or by like students' physical abilities.

    c. Ascertain if math teachers are prepared and able to teach the level of mathematics their class is at in each culture.

    d. Examine the effect that discipline in the classroom, or lack thereof, affects students' abilities to learn math.

5. Evaluate the results of the objectives, and report the findings.

Significance of the Problem

The significance of this study is important because, in a country where freedoms are a basic right, we may have overlooked the right to remain ignorant, even in the face of education. However, in fact, it is knowledge that truly sets one free. In a country that is constantly bringing others to task for their shortcomings on human rights and other basic issues, it is unconscionable that America could do no less for its citizens. Education is truly a basic issue. However unintentional these oversights might be, it is hypocritical not to work to change them once they have been brought to light. This study will show that teaching is a cultural activity and there is much to be learned from the strengths and weaknesses of each other's differences (Stigler & Heibert, 1997). It is through this teaching exchange that we can keep America's leaders of the future strong and competitive.

Wisconsin's own Governor has sung the need to be globally competitive, not only in the marketplace. but particularly in the school, in our increasingly technological society (WITCO Taskforce, 1998). The Governor and many other people have had sufficient foresight to realize that the educational system is not just one school, one district, or one city, but a global effort in recognizing strengths and weaknesses of many different cultures, particularly if we are to successfully compete for jobs, businesses, and opportunities in the future. With each new technological advancement, comes an increase in math skills and math awareness. This study is being conducted in an attempt to keep

the coming generations functional and globally competitive in an ever increasingly technological society.

Limitations

1. This study will confine its breadth to that of recently graduated high school students, over the age of 18, from the countries of Germany, Japan, and the United States of America.
2. This study will be put out in a survey format over the Internet and, therefore, will rely on the integrity of the respondents.
3. It has been the experience of this researcher that some students from foreign countries, where freedom of speech is limited, feel the need to give a politically correct answer, as opposed to a completely honest one. The survey will be worded in such a way as to keep this concern to a minimum.
4. It will be limited by potential respondents' access to computers.

Definitions

TIMSS: The Third International Mathematics and Science Study is the most ambitious cross-national educational research study ever conducted, comparing over one-half a million students' scores in mathematics and science across five continents and 41 countries. TIMSS is far more than the "Academic Olympics" that so many international comparative assessments have been in the past. It included a multiyear research and

development project that built on previous experience to develop measures of the processes of education. Classroom observations, teacher interviews, and many qualitative and quantitative information-gathering strategies played a part in this development effort. The result was a set of innovative surveys and analyses that attempted to account for the varying roles of different components of educational systems, and to measure how children are given opportunities to learn mathematics and science (TIMSS).

Educational reform: Educational reform is more than just the changes to the basic curriculum and the tweaking of the competencies, it should also answer: 1) what the purpose of the proposed change is; 2) whether it will make children better learners; 3) how it will improve current practice; and 4) how many changes the school system is currently managing and why (Sturrock, 1997).

Competency: A competency is a major skill, knowledge, attitude or ability needed to perform a task effectively and efficiently. Course competencies are the intended outcomes of learning experiences. They describe what you want learners to be able to do, and they must be stated in observable, measurable terms (WIDS, 1997).

Curriculum: The curriculum is the script for a course. The script will contain the content, concepts, and performance standards for the course that will help to define the skill described in the competency and clarify required levels of performance. There are two types of performance standards. They are the observable and measurable criteria, and conditions for performance assessment (WIDS, 1997).

Grade inflation: Giving a student a grade based on something other than merit or successful demonstration of the competencies.

Deductive reasoning: The reasoning needed to draw logical conclusions from premises.

Chapter II

Review of Literature

The Third International Math and Science Study has raised many questions about the educational preparedness of America's students. Many of the criticisms are unfounded, as the comparisons are not apples to apples (Valverde & Schmidt, 1997, 1998). There are many differences between and across cultures that preclude exact comparisons. As our world becomes more and more integrated, the cultural lines need to melt so that we can all blend into one culture with many, many facets. While that time is quite a bit off, we will have to suffice today by being satisfied to have inside glances into the strengths and weakness of other nations. It is the purpose of this study to provide such a vehicle.

The premise of this study is based on the claim that American high school students' math scores are falling, not only in comparison to their international counterparts, but in comparison to its own previous standards (Bassinger, 1997). The literature reviewed for this study will focus on this research problem and will follow closely the objectives of the study. The purpose of all the literature reviewed is pertinent to the objectives of this study and has, therefore, been used to formulate the research hypotheses for this study. Several of the studies reviewed involved more than one of the stated objectives and are, therefore, difficult to categorize explicitly but all of the following reviews follow one, or more, of the objectives directly.

This study will show that teaching is a cultural activity and there is much to be learned from the strengths and weaknesses of each other's differences. Teaching is also an every day event that is so commonplace for most people, parents, students and teachers alike, that it is almost a nonevent. Yet, education is the single thing that keeps the world progressing in a positive direction. So if education is all so important, why isn't more attention and design given to it? There are many reasons for this. We tend to think about teaching in the same manner to which we have been taught.

> Teaching is an everyday event that occurs throughout all parts of American society. Over time, we have developed norms and expectations for teaching that are widely shared and passed along as one generation of students becomes the next generation of teachers. Because of our models of how teaching should look are so widely shared and so familiar, they become nearly invisible. When we observe teaching in other countries these accepted practices are brought to light (Stigler & Heibert, 1997, p.1).

In as much as this study is about change, it is not only appropriate but important as well, that we remember where we have been, in order to determine where we are headed. "Education developed from the struggle for survival and enlightenment" (Encarta; History I, 2000). The study of mathematics evolved from not only enlightenment, but also the desire for accountability. Prior to the thirteenth century few people were educated, usually only the upper classes had access to education, something

that for many countries is still true today. Even then, training did not usually extend beyond studies in one field, usually religion, trades, agriculture, and military tactics.

In the thirteenth century, Thomas Aquinas reconciled the overwhelming authority that religion had on education with the Greek tradition of reasoning, which Aristotle represented. He did this by "describing the teacher's vocation as one that combines faith, love and learning" (Encarta; History VII, 2000), an incredibly apropos description of teachers even today. Aquinas affected a minor change, but a significant one.

A more major change in education came during the arrival of the Renaissance period where "Humanist educators designed teaching methods to prepare well rounded, liberally educated persons" (Encarta; History VIII, 2000). A notable advance in education and literacy rates were made possible during this period by the advent of the printing press.

During the Age of Enlightenment in the eighteenth century, Americans like Ben Franklin and Thomas Jefferson proposed principles that thought of education as a tool of social reform and improvement, which are still characteristic of educational policies in America today. During this time most schools' standards were the responsibility of each state, and nearly all operated on private donations.

States have now started turning over control of educational standards to local districts (making the curriculum even more dissimilar between schools), and funding for public schools relies almost exclusively on property taxes. Because of this, American educational values often reflect the finances of the communities in which they are

located. "When students move from one community to another, they often encounter entirely different curriculums even though they are in the same grade. Even within a given school district, different neighborhoods often contain very different public schools" (Encarta; Public V, 2000).

Conversely, countries like France, Germany, and Japan have financed and regulated their school systems on a national level. They have, therefore, been able to regulate a relatively consistent school environment throughout their respective countries, despite the economic plights of various local communities. They also have mandatory examinations that can have direct implications for the students taking them. The ramifications of this test permits or denies access to continued higher education or employment.

State and local control of education in Germany, as in the United States, is an important tradition. Germany's constitution gives the country's 16 states individual authority over what to teach, evaluation, administration, teachers' qualifications, and other policy making decisions, such as higher education standards (ENC, German, Profile, p.1).

> Unlike the United States, however, Germany has a national body, the Standing Committee of the *Länder* Ministers for Schooling (the *Kultusministerkonferenz* or KMK), that encourages and enables consistency in education policy and educational standards across the different states (ENC, German, Profile, p.1).

In Japan, the Ministry of Education, the *Monbusho,* wields a substantial amount of national control over the entire official system of education, unifying what the country's school children should be taught and the manner in which to teach. They do this by:

- prescribing curricula, standards, and requirements;
- approving textbooks;
- providing guidance and financial assistance to the prefectures (local areas, similar to states in the U.S.) and municipalities;
- authorizing the establishment of colleges and universities;
- operating national education institutions, primarily universities, junior colleges, and technical colleges; (ENC, Japan, Governance).

The Monbusho even goes so far as to help regulate private and non-official schools:

- providing general supervision of private institutions of higher education;
- regulating establishment of private schools;
- investigating and issuing directives to local boards of education for corrective action, as occasion may demand (ENC, Japan, Governance).

The advent of the twentieth century has brought about fragmented regulations, a more stratified financing scheme, and a much greater number and diversification of students to cater to than ever before. Compounding these difficulties, the school system seems to be a catch all of expectations to cure all that ails society.

Today, formal education serves a greater percentage of the U.S. population than at any time in history. It has also assumed many of the responsibilities formerly reserved for family, religion, and social organizations. Most Americans expect schools to provide children with skills, values, and behaviors that will help them become responsible citizens, contribute to social stability in the country, and increase American economic productivity. The federal government also requires schools to correct social inequality among students of different racial, ethnic, social, or economic backgrounds.

Although the objectives assumed by formal education increased dramatically during the 20th century, the format and techniques of American schooling have remained, for the most part, quite stable and *resistant to change*. The practice of teaching and the process of learning in 1900 closely resembled that of today (Encarta; Public VII, 2000, p.2).

Psychological Aspects of Education

Examine the psychological aspects of the educational system for the American, German, and Japanese cultures. Investigate the societies', teachers', students' and parents' attitudes toward math in each culture.

How children should learn, and from whom, is an often debated issue. It is, unfortunately, not an uncommon opinion among many Americans that teaching second

grade requires only a third grade education. There is an erosion of respect for education in this country (Travis, 1995). Learning and education, to adults, has become inconsequential (Corpi, 1990).

> Children tend to imprint many adult values and attitudes during socialization, when they are learning and internalizing many of our social or cultural norms. Such learned attitudes and values related to school are significant influences on student achievement (Travis, 1995, p.99).

There is a much greater value put on not only education but on teachers themselves in other nations (Brandt, 1989; Heyneman, 1990). The teaching norms and eroding attitudes in the American society are part of the reason the scores of American students are falling in comparison to their international counterparts.

In Germany, attitudes toward school depend on what school system of which you are a part. In the Gymnasium, which is the highest level, attitudes of parents, teachers and students are quite good. In the Realschule and the Hauptschule, which are the lower levels, attitudes of parents, teachers and students are poor and resentful of the system. Germany's school system is separated into three main levels, by ability, at the fourth grade. The decision you make at this time is not permanent, but should be viewed as such as change from one school to another is available, however difficult and arduous (Nerison-Low, 1999).

> Individual differences in ability are overtly acknowledged by all participants in the education system in Germany, and the differentiated

> education paths in the German education system are a reflection of both the social and political acceptance of differences in individual ability and talent. The strictness in the separation of students into different forms of school emerges from the philosophy that to succeed and progress, a society must have an educated elite and a trained work force and that the educational needs of each group are quite different (Nerison-Low, 1999).

Societal attitudes in Germany toward education can be extremely negative. For instance, one German wonders how many people really know what they want to do and how hard they want to work in the fourth grade. Many feel that this system is extremely unfair. The Gymnasium and Hauptschule section teach only academic theory or practical application, respectively, which implies that many educated in Germany are Fachidiots, which literally means subject idiot. A Gymnasium student in the 13th grade said he "believes the German education system often produces individuals who are highly trained in one area and ignorant in many others," and he used the common expression "subject idiot" (Fachidiot) to describe such a person (Nerison-Low, 1999). Many are resentful of the education system for limiting their education and not making it more balanced.

The attitudes toward education in Japan are among the most positive. In Japan, education is a major step in a child's life and is treated reverently and seriously. Even parents of school children must go to school for meetings before their child is to attend school to be instructed as to what skills the child should already have before entering. "Families make much of the new first grader's symbolic entry into a more grown-up

world. Congratulations and gifts are in order (ENC, Japan, Elementary Schools).” The Japanese society supports these common attitudes by surrounding the ceremony given to first graders with much Pomp and Circumstance, which emphasizes the important journey upon which the students are about to embark.

The families’ and teachers’ attitudes toward education in Japan are very strong as well. Teachers are required to visit the home environment of each of their students and the parents are required to reciprocate by attending the classroom of their child. This is done several times a year in order to give each a more complete picture of the student’s life and to foster goodwill between and across each aspect of the child’s world. The home environment of Japanese students is so supportive and encouraging of education and the need for regular studying that ninety-eight percent of all Japanese school children have their own desk and separate study area (ENC, Japan, Home-School).

When students’ test scores fall, teachers are the first to be blamed. The simple fix for such problems is to improve the quality of teaching, but we must first inspect what we are trying to fix. Is the problem the teachers, or the teaching? Most believe that it is the teachers’ abilities and understanding of the subject that matters most, but is it? "We often approach it (improvement of teachers) in a backward fashion, trying to improve teaching without first "addressing the ‘what’ of teaching-- the subject matter" (Schmidt & Wang, 1999, p.5).

Compounding the problems of financing concerns, are the "recommendations" of so called experts, like the National Council of Teachers of Mathematics (NCTM), which

most schools are looking toward for enlightenment. In 1989, NCTM issued their "Curriculum Standards" and unleashed an unparalleled drop in math test scores and controversy ever since (Kremer, 1997). The "Standards," as they are set forth, do not discuss specific knowledge, concepts and abilities the students should know, as most people expect curriculum standards should. Instead they explain how the NCTM "experts" think math should be taught.

"Our premise is that what a student learns depends to a great degree on how he or she has learned it," say the NCTM standards. Most people agree emphatically with this statement and the theory behind it. It is in the specifics and the practice that those who have used it take exception. The NCTM standards goes on to say that teachers should instill positive attitudes and feelings about math rather "than upon teaching any specific skills or knowledge." An admirable and appropriate trait that is long overdue, but not at the expense of specific skills and knowledge. You might well then be asking yourself, how is it these so called experts expect American teachers to teach math?

> Teachers should spend less time teaching ‘symbol manipulation and computation rules’ . . . the Standards say, because such exercises ‘do not fit the natural learning patterns of children.’ The Standards insist ‘Calculators must be accepted at the K-4 level’ and that any ‘further efforts at mastering computation skills are counterproductive.’
>
> The NCTM Standards might just be another mildly humorous but misguided ivory tower pamphlet were it not for the influence they have had

> on math education reform in the United States. But the fact is, the Standards serve as the philosophical underpinnings for math reform all over the U.S. State after state have reformed their math curriculum based on NCTM 'Standards,' and mandated that schools adopt their methods (Kremer, 1997, p.4).

Calculators are the bane of mathematics in this country, robbing students of some of the most fundamental concepts in elementary math. Inexpensive calculators are on the supply list as early as kindergarten, and usually by third grade. The use of calculators in the Japanese classrooms is practically nonexistent (Valverde & Schmidt, 1997, 1998). In light of this confusing and misguided direction, is it any wonder that math in American schools is floundering? Is it any wonder that children aren't learning and teachers aren't teaching?

All the while, the demand for higher "standards" continues to increase, leaving American teachers with the arduous task of explaining future failures based on this reform. Is it higher "standards" or higher expectations that reformers are calling for? It leaves this researcher wondering, particularly in the light of this "non skills, non knowledge" approach to math suggested by the NCTM and adopted by most states.

Another problem math reform has encountered is that most of society has not adapted these higher expectations at a personal level.

> The common belief that mathematics, the sciences, and foreign languages are too difficult for my own children because I had a hard time with these

> subjects when I was in school leaves teachers with a most difficult task of turning around public opinion **(**Pipho, 1998, Public, p.1).

And yet again, we run into the attitudinal myth of society that math is difficult. Schools now have the additional tasks of re-educating parents to embrace these higher standards and convincing the public they are getting somewhere in their reforms. Changing attitudes and convincing the public sounds like a job for the media, newspapers or a public relations firm.

Unfortunately, America's largest group of naysayers is the press. On the subject of negative reporting on school subjects, a Washington Post Science writer observed "journalists looking for quick answers (out of Jonesboro) seemed to have brought them along in their luggage. On a nightly deadline, chaos was molded into compelling story lines. Tragedy was repackaged as entertainment, and authority became a substitute for insight" (Bracey, October, 1998). John F. Jennings observed the same thing about the media's coverage of schools in America, "Everywhere I went I found the major news media to be extremely negative about public schools" (Jennings, 1996). More importantly, he concluded that the impact of this was significant since "three out of four American households do not have children of school age" (Jennings, 1996). Therefore, the majority of the public has no direct contact with the public schools and would get all of the information they do about schools exclusively through the media reports on television and the newspaper. Not only does this negative reporting have an adverse reaction on support of the public school system, but it also undermines the faith that

educators have in their own work and the success of the positive changes they are making. The overall effect is that citizens are starting to lose faith in their public school systems.

The 31st Annual Phi Delta Kappa Gallup Poll of the Public Attitudes Toward the Public Schools indicated that 71% of Americans would prefer to work on the current system rather than finding an alternative one. More importantly, they found "*The closer people are to the public schools, the better they like them*" (Rose, Gallup, 1999). In other words, the more contact a member of the public has with the schools, the more positive their opinion of them becomes.

It is also interesting to note that the same poll shows of factors concerning people about choosing a local school are: first, quality of teachers, rated 98% as very important; followed by student discipline and curriculum, rated 89% as very important; and then by size of class, rated at 75% as very important. The number of students is not necessarily the concern, but that the number of students in a classroom is usually directly proportional to the number of disciplinary problems. Also, when respondents were asked to identify the number one problem facing schools today, they noted that the "lack of discipline/more control has moved to the top of the list this year"(Rose, Gallup, 1999). Larger numbers of students compounds the problems teachers already have with students who do not speak the same language, and with severely handicapped students in the classroom. The problems are often entwined and difficult to distinguish between.

Information of students in Japanese schools that do not speak the same language is unavailable mainly due to the fact that only Japanese citizens are educated in their public schools. Therefore, 100% of the students speak the same language as the teacher in the Japanese public schools. As far as separating students by abilities, the 1947 Japanese constitution provides for free mandatory schooling for all students "correspondent to their ability" (ENC, Japan, Overview). However, the word "abilities" is relative here, and in the Japanese school system its use can be confusing.

> During the compulsory school years Japanese education assiduously avoids making distinctions between students on the basis of ability or achievement. There are no separate tracks, ability groupings, remedial programs, or student electives. Promotion from grade to grade is virtually automatic as long as the student is attending classes. Students are almost never retained in grade or skipped ahead (ENC, Japan, Overview, Compulsory).

The previous statement only applies to students with differing mental abilities, not differing physical abilities. In 1948, Japan first required schooling for blind and deaf students. In 1979, Japan increased its schooling to provide for students with other disabilities. Children with disabilities are educated in special schools, the majority of which are public. Few are educated in regular schools, in separate classrooms or by mainstreaming, the way it is in most American schools (ENC, Japan, Overview, Compulsory).

After the ninth grade, schooling in Japan is neither free nor guaranteed. Unlike the American school systems, students after the ninth grade are not required to continue their education and must pass a high school entrance exam if they wish to continue. Failure of the entrance exam means failure to continue your education. “Educational uniformity diminishes beyond compulsory schooling, and there is some ability grouping at the upper secondary level. There are growing costs for parents at the senior high school level and beyond and restricted enrollment opportunities in public higher education” (ENC, Japan, Overview, Upper).

Germany is just starting to deal with non-German speaking students. “Recent demographic changes, including an increasing number of foreign students whose first language is not German, have introduced an element of heterogeneity into Germany's schools (Educational System in Germany, Chapter 2, 1999).” Because of the restrictive citizenship laws, many of the foreigners realize they will never become German citizens and make no move to learn the language. The breakup of Russia and the fighting among Middle Eastern countries has brought immigrants with many different native tongues, making dual-language classes a non-option (Wolf & Wolf, 1998).

Until recently, nothing was done to help these students and, because of the language barrier, almost all minorities went to Hauptschule, the lowest ability level of schooling and have little chance of receiving higher education. Germany has recently realized the problem this is creating and is going to form classes with non-German speakers and teach immigrants the German language first (Wolf & Wolf, 1998). Germany

Grundschule (grades 1-4) teachers often find it impossible to teach and difficult to keep discipline when students of vastly differing levels are in the same class. Problems of this nature were summed up by one Grundschule teacher as follows:

> Referring to a class of 22 students in which 15 have behavioral problems and 6 are emotionally disturbed, she asked rhetorically "what good are curricular guidelines from a Ministry of Education bureaucracy which has long since lost touch with the day-to-day reality of schools?" (Educational System in Germany, Chapter 2, 1999).

Germany is just realizing some of the problems that American teachers have been dealing with for decades. Because German schools beyond the fourth grade are separated by abilities, and in a large part by language, learning problems are kept to a minimum.

Physical Aspects of Education

Identify the physical aspects of the educational system for the American, German, and Japanese cultures. Identify what use, if any, calculators play in the classroom. Determine if students' classrooms are separated by the primary language spoken by the teacher, by like students' mental abilities, or by like students' physical abilities in each culture. Ascertain if math teachers are prepared and able to teach the level of mathematics their class is at in each culture. Examine the effect that discipline in the classroom, or lack thereof, affects students' abilities to learn math.

The schools in Japan have few, if any, problems with classroom discipline. One reason for this is that teachers designate much responsibility for classroom supervision and obedience to the students themselves. School organization, conformity to the school rules, and obedience to teachers and authority figures is taught repeatedly in the first years of school, until the students can come to order and be prepared for the day's lessons with little or no instruction from the teacher (ENC, Japan, Classroom). "These routines allow students to see themselves as responsible for their own behavior and help them develop pride in conducting themselves in an orderly, efficient manner" (ENC, Japan, Classroom). This concept of individual responsibility is sorely lacking for American Schools, and American society as well.

> While Japanese classes are larger than American ones, Japanese classrooms are more orderly. Students are more attentive and better behaved and transitions between activities are more rapid and orderly. The net result is significant: Japanese students spend about one-third more time during a typical class period engaged in learning than American students do during a typical class period. It is important to note that this high level of organization and discipline is achieved without strong direct exercise of authority by the teacher" (ENC, Japan, Classroom).

A problem with discipline in German schools varies with the school system, which differs significantly from American ones. Germany, after grade four, is divided into primarily three different types of education, distinguished by levels of test scores and

mental abilities (ENC, German, Profile). The discipline that is encountered in each is very different. Discipline problems in the Gymnasium (the highest level of abilities) is uncommon and usually stems around kids' attitudes that don't want to be at school at all. However, discipline problems in the Hauptschule (the lowest level of abilities), are not only common, but much more sever than those of the Gymnasium students. Hauptschule teachers often have unruly (getting out of their seat, running in the hall), inattentive, disruptive (talking out of turn), and disrespectful (not being quiet when told to) students that cause the quality of learning for all to deteriorate. It is interesting to note that teachers complaints of discipline problems in Germany are what American teachers' discipline complaints were 25 years ago. American school discipline polices of today focus on violent actions and how to adequately protect the rights of victims, perpetrators, and witnesses involved in such actions, as well as how to protect against such violence and what to due when it occurs (Lee, 1997).

Inability to control students and maintain levels of discipline is a direct result of the American publics' eroding opinion of schools and teachers, which is mirrored in their school children. Even though the public does not seem to think much of the teaching profession, it is still their number one concern when choosing a school (Rose, Gallup, 1999).

When looking at the quality of a teacher, it is often difficult to separate the quality of the teacher from the quality of the teaching, meaning the quality of the curriculum. The curriculum is usually set out in advance for a teacher and they do their best to

accommodate it. The seemingly fractured and inconsistent curriculum can make the best of educators look ineffective. However, what needs to be focused on now is the teacher that is out of their depth, teaching above their level of comfort with the subject matter. It is difficult to get an exact feel for this or for how prevalent this is, but is necessary to look at, in order to obtain a complete picture of the American mathematics scene. Very few professions are comfortable pointing at their peers and making claims of incompetence, but the fact remains that in all professions this is true of certain individuals. Put bluntly, teachers who are unprepared to teach because they don't understand the subject matter themselves.

There are certifications teachers must have to check this sort of thing, but they are often too general to prevent this from happening, particularly in the fields of math and science (Schmidt & Wang, 1999). Teachers' certification are often not enforced or difficult to check because of alternative certification used in hard to staff inner-city schools and differences between state certifications (Pipho, 1998, New). So what actually happens in the classroom when the teacher can't teach? What ends up happening when a teacher whose background content is weak, is a detachment of content and pedagogy (or the associated processes). These types of teachers understand enough of the process to employ students in "instructional activities that have children engaged in 'neutered' processes, such as cooperative learning or manipulating physical objects" (Schmidt & Wang, 1999). These types of learning processes are usually devoid of any real learned content. When these processes are detached from real content, the assignments appear to

be pointless to parents and students alike, increasing their disappointment and frustrations with schools, since their children do not appear to be learning anything real or meaningful. Schmidt and Wang set forth some important conditions for improving instruction.

> . . . decide upon a focused, coherent, challenging, and rigorous vision or set of standards, as we lay out in the first implication of TIMSS findings. Those standards must clearly articulate what all students at each grade level need to know and understand conceptually. Additionally, we must help teachers understand the content undergirding, the standards as well as the ways in which the subject matter can be meaningfully communicated to students so that they can conceptually understand it, solve problems with it, and be able to use theories, principles, and facts derived from it. The latter must, however, proceed from the former (Schmidt & Wang, 1999, p.4).

The methods used to ensure quality teacher training and requirements differ throughout the three cultures. Aspiring teachers in America usually enroll in a liberal arts program for the first two years and eventually enlist in a specific department or the college of education to finish their undergraduate work. A future teacher may take a minor or major in the subject that they wish to specialize in, but "Others, especially those planning to become elementary school teachers, must complete only a minimal number of courses in the subjects for which they will be responsible" (Stevenson, 1998). In

Germany, the Conference of Ministers of Education of all German states determines the basic conditions for becoming a teacher, even though each of the 16 German states handles its own methods of teacher training individually. After being successful in four to five years of education at the University level, teachers in training must complete the first of two State examinations. If you pass the first state exam, you then complete two years of training as a student teacher, after which you then must pass the second examination before sending out resumes in hopes to acquire a regular teaching job.

> In Japan, those who want to be teachers must take education courses and choose an academic area in which to specialize. Those who find a teaching position are assigned a mentor, a master teacher. The mentor visits the new teacher's classroom frequently and then discusses the strengths and weaknesses of the practices observed. The new teacher is also expected to visit a teachers' resource center a certain number of days each week (Stevenson, 1998, p.4).

Cultural differences exist not only in teacher regulations and financing but in methodologies as well, which plays its own role in this conundrum. Using the video taped studies of mathematics lessons from the TIMSS study, mathematicians were able to find major differences in the lessons, even after all indications of the countries' origins were removed!

> Mathematicians rated each lesson according to the overall quality of the mathematical content presented in them. Coherence of the content, that is,

> the establishment of clear, disciplinarily valid linkages among the topics and skills in the lesson was an important part of the rating. It is apparent that U.S. instructional practices mirror the incoherent presentation of mathematics that characterizes our intended curriculum (Valverde & Schmidt 1997-98, p.3).

There are many other cultural variances that seem to make a difference in the way children learn and perform. The team of TIMSS investigators had determined that the ability to use deductive reasoning was an important activity of mathematics and that "62% of the Japanese lessons, 21% of the German lesson and 0% of the American lessons" contained examples of deductive reasoning (TIMSS, 1997). Also, American schools just talked about procedures and concepts, which were demonstrated and developed far more in Japanese and German schools. Japanese students spent more time "inventing, analyzing and proving" and little time on drills and conventional practice, which was not the case in the German and American schools (TIMSS, 1997).

Another noticeable cultural difference was the amount of topics and the time spent on each. The TIMSS study uncovered that the same core content that was present in the fourth grade American classes was repeated over and over again in the higher grades. From the fourth grade on, the new content that did appear was rarely taught in any intensity or in the abundant quantities of instruction that other countries gave to new material.

> In fact, on average we (American teachers) introduce only one content with this type of focused instructional attention between fourth and eight grades in either mathematics or science. Most TIMSS countries introduce 15 topics with intense curricular focus during this period. The highest-achieving TIMSS countries introduce an average of 20 topics in this way. In the U.S. curriculum guides and textbooks, about 25 percent of the topics covered in the eighth grade are new since the fourth grade. For most other TIMSS countries, about 75 percent of the topics are new (Valverde & Schmidt 1997-98, p.4).

A common comment of articles on this subject is the unfocused or fractured approach of most American curriculums. With all the taxes Americans seem to be paying, most people in this country find this assessment hard to swallow. Following the decisions of how curriculums are developed makes it easier to see how this disjointed means comes to be. When we understand that the determination of curriculum content and objectives are made by many states, and now more frequently by local districts, it is easier to understand that a disparity might exist. Compounding the problem are the writers and publishers of school textbooks. Educators rely heavily in their decisions about curriculum on the availability of textbooks. Most textbooks come with standardized tests and are available nationally. The problem lies in the crafty marketing strategies of these publishers. They make the textbooks so generic that the same book will appeal to a wider audience. In doing this, they include so many topics and concepts that many teachers take

on the Herculean task of trying to teach it all. In effect, giving us no real focus to the purpose of a class.

> This is likely the consequence of the U.S. practice of dispersed decision-making. The consequences of such decisions may well be the 'mile wide inch deep' curriculum, the largest textbooks in the world and a splintered vision of what children should learn (Schmidt & Wang 1999, p.4).

In sharp contrast is the Japanese system of selecting textbooks. The Monbusho, which is the Ministry of Education, Science Sports and Culture, has absolute say-so on what books go into the Japanese schools. In Japan, commercial publishers write and distribute textbooks where the content is based closely upon Monbusho guidelines. "After careful review to assure conformity with the prescribed courses of study, the Ministry of Education approves textbooks for use in elementary schools" (ENC, Japan, curriculum).

> The Ministry of Education, Science Sports and Culture (*Monbusho*) has complete authority over the content of the curriculum, to the point of determining which textbooks should be used for each grade and subject. Some criticize the Japanese system for being too rigid and too demanding, but the impressive levels of achievement reached by their students make their curriculum and assessments worthy of close attention (ENC, Japan Profile, p.1).

More of a middle ground on textbooks and intended curriculum are the German schools. "Since textbooks in Germany must meet curriculum guidelines provided by the

state's Ministry, teachers said these textbooks could be seen, at least in theory, as a reflection of the curriculum guidelines" (Educational System in Germany, Executive, 1999). Teachers and states in Germany still are able to choose their own textbooks from the list and often do it as a collaborative effort that lasts for months. The state Ministries provide the regulations for texts, guidelines on how they should be introduced and applied, and regulations on the criteria used by examiners. The central control remains at the state level and the role of the Conference of Ministers of Education (KMK), a branch of the federal government, is nominal. "However, KMK resolutions for textbook usage stipulate that textbooks may be approved if they are consistent with federal laws and the constitution and meet the prevailing content, didactic and methodological demands of the respective state Ministry of Education (Educational System in Germany, 1999)."

The findings of this study can have far reaching effects on the American school children of tomorrow. The intent of this study is not to just make a surface impact on the way mathematics is viewed in America, but a direct hit that goes to the heart of the mater and changes the way teachers and students alike feel, think and act about mathematics, so that they, and the rest of society, can come to share some of this researcher's passion of the subject of mathematics.

This literature review exhibits a number of articles related to the objectives and hypothesis explained herein. Even though none of the articles examined contained a study detailing the exact hypothesis and objectives of this one, there is sufficient

information available about the individual objectives and hypothesis to enable specific analysis of each.

Chapter III

Methodology

The methodology in this study was implored to achieve the intention of this study. American students can no longer maintain academic levels of school subject matter compared to preceding years and in contrast to their international complement. The problem is American high school students' math scores are declining when judged against their international counterparts. This study focused on a combination of the physical and psychological aspects in the differences of the international educational society, specifically the United States of America, Germany, and Japan. The purpose of this study was to compare what these physical and psychological differences can make in a student's overall performance. The findings of this study will have broad implications for the entire American educational system. It will contrast our successes and failures with those of other countries in order to expose a path of techniques that can be adapted or assimilated to ensure the continued accomplishments of the American student.

Subjects

The sample for this study was comprised of participants unknown to the researcher because of a blind survey given on the Internet. The conditions of the survey were that the respondents be over the age of 18, and that they received most of their

pre-college education in the United States, Japan or Germany. Because the participants are over the age of 18, there were no parental consent forms necessary. No records were kept or identifying questions asked; therefore, anonymity is assured. A total of 46 respondents answered the survey. The respondents consisted of 20 people from the United States, 16 people from Japan, and 10 people from Germany.

Instrumentation

In an attempt to measure the factors that impact students' abilities to learn the subject of math, a researcher-designed web survey was used. To read the instrument used and the accompanying instructions that were on the web, please see the Appendix. Through consultation with the research and design consultant at UW-Stout, Barbara Button, a Likert-scale type survey was used. The design of the survey was intended to cover specific areas that research suggested might impact the learning of the subject of mathematics, and where research indicted there might be some cultural differences. The instrument was also created to meet the objectives as described in Chapter 1. Questions were developed to address each objective, see Table 1, next page.

Table 1

Matrix of Category of Objectives Against Questions

	Questions																
Objectives	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Objective 1-Psychological Aspects Part A-Societal Attitudes														x			
Objective 1-Psychological Aspects Part B- Teachers' Attitudes													x				
Objective 1-Psychological Aspects Part C- Parents' Attitudes												x					
Objective 1-Psychological Aspects Part D - Students' Attitudes											x						
Objective 2-Physical Aspects Part A - Calculator Usage	x	x	x														
Objective 2-Physical Aspects Part B - Classroom Division				x	x	x	x	x	x	x							
Objective 2-Physical Aspects Part C – Teachers' Training															x	x	
Objective 2-Physical Aspects Part D - Discipline																	x

The research led to a number of supposed educational differences between the separate cultures that helped to create the objectives of this survey in order to facilitate the purpose (see Chapter II). These supposed differences were reduced to seven different topics that lead to the creation of the objectives and, by extension, the composition of the seventeen questions on the instrument. These differences are:

- calculator usage;
- language differences between teacher and students;
- significantly different mental abilities between students;
- teachers' qualifications;
- attitudes about the subject of math;
- significantly different physical abilities between students;
- school discipline.

Survey questions were written so that responses could be given from a reasonable range of responses: Never, Sometimes, Usually, Almost Always, or Always. A point value of one for Never, a two for Sometimes, a three for Usually, a four for Almost Always, and a five for Always was assigned so that numerical analysis could be used.

The research brought to light the diversity of the different countries' strategies about education, not only about the way schools are funded, but about their standards for curriculum, as well as for teachers' qualifications. Other nations are also unified for the entire country, regardless of wealth or poverty of individual districts or states. The range of physical and psychological differences of the other countries helped to yield a path of

investigation that lead to the development of the survey questions. Each one of these diversities helped to expand the instrument based on how they would affect the students' abilities to learn the subject of mathematics.

Implementation of the Survey

Individuals over the age of 18, that received the majority of their education in Japan, Germany, or the United States took the survey. The instrument was implemented through the World Wide Web, asking 17 questions aimed at determining important cultural differences in the instruction of mathematics and the circumstances surrounding students' abilities to learn the subject of mathematics. UW-Stout assistant web master, Michael Smith, collected the results of the survey, and numerical response information was forwarded to the researcher. The survey ran over the course of about six months, and respondents were referred to the survey by an assortment of associations of networking through foreign exchange students, instructors and foreign web contacts. Many of the foreign contacts were made through the international emails and bulletin boards. A title of "Looking to learn from other cultures" was the heading used with a text of the following:

Hi,

I am a student at the University of Wisconsin USA, doing my thesis research in cultural differences in education. Anybody who received their education in Japan/ Germany is who I am looking for to take this survey. You do not need to be a math educator nor do you need to be in the education field. This survey is about people's opinion on how they were taught the subject of math. Everybody, no matter what position they hold, has an opinion, I am just looking for people who received their education in Japan or Germany to share their opinion with me. I need people who received their education in Japan or Germany to take my thesis survey, which is on the web. If you know of any people that would qualify, I would appreciate if you could send the web address along to them and ask them to take this survey for me. No personal information is required and the survey asks only for opinions on their math education, and only takes a few minutes to complete. Please help! http://www.uwstout.edu/survey/math.html.

If you have any suggestions about how to contact people educated in Japan and/or Germany that you think would be useful, I would be very, very, grateful if you would be so kind as to send a reply email to me with that information.

Sincerely,

Ilona Ridgeway

About 50 or 60 emails were sent out and about 30 to 40 bulletin boards were used until sufficient responses were received. The researcher did not have personal contact with the respondents, thereby guaranteeing the respondents' anonymity.

Some of the problems that occurred during the process of this survey were due to the recent improvement of software that makes the development of an online survey easy to write and implement on the web, only to find that the collection of the survey results can be quite complex and difficult to do. Expert help was needed in order to do collection of the results directly from the web. The solution to this problem was help from the assistant webmasters at UW-Stout. They were invaluable in this effort.

Other problems that can have an impact on this survey were foreign respondents' access to not only a computer but also to the World Wide Web in a format that was compatible with the format of the survey. This problem also includes the researchers' ability to encourage responses from foreign students. The resolution of these complications were assisted by advice from the UW-Stout program advisor, Dr. Howard D. Lee.

Chapter IV

Data Analysis

The survey hypothesis was formulated on the concept that there are cultural and circumstantial differences in the instruction of mathematics that make a difference in the way students learn mathematics. The 17 questions asked were aimed primarily at seven areas of concern suggested by the research:

- calculator usage;
- language differences between teacher and students;
- significantly different mental abilities between students;
- teachers' qualifications;
- attitudes about the subject of math;
- significantly different physical abilities between students;
- school discipline.

There were a total of 47 respondents. Sixteen respondents were from the USA, which was 34.0% of the total. Ten of the respondents were from Germany, or 21.3% of the total. There were 21 respondents from Japan, which is 44.7% of the total. The respondents' return rates are shown in Table 2.

Table 2

Respondents

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 USA	21	44.7	44.7	34.0
	2 Germany	10	21.3	21.3	55.3
	3 Japan	16	34.0	34.0	100.0
	Total	47	100.0	100.0	

The research hypothesis was that a cultural relationship exists between the seven different topics above and the way a student learns the subject of mathematics. Specifically, a relationship exists between the students' use of calculators and their conceptual ability to learn the subject of mathematics. A relationship exists between the students' abilities to communicate to the teacher in his or her own language, and their ability to understand mathematical instruction. A relationship exists between non-homogeneous class intelligence and/or physical abilities and the students' abilities to learn math. A relationship exists between a teachers' qualifications and/or the teachers' preparedness to teach the subject of math and the students' abilities to learn it. A relationship exists between attitudes toward math and the students' abilities to learn it.

Also, that a relationship exists between the teachers' abilities to keep order in the classroom (classroom discipline) and the students' abilities to learn the subject matter.

Table 3

Usage of Calculators

Rating	Grades 1-4				Grades 5-8				Grades 9-12			
	USA	Ger	Jap	Total	USA	Ger	Jap	Total	USA	Ger	Jap	Total
Never	52.4%	70.0%	73.3%	63.0%	14.3%	10.0%	50.0%	25.5%	9.5%	0%	50.0%	21.3%
Sometimes	23.8%	20.0%	13.3%	19.6%	47.6%	50.0%	31.3%	42.6%	14.3%	30.0%	12.5%	17.0%
Usually	19.0%	10.0%	6.7%	13.0%	23.8%	30.0%	12.5%	21.3%	14.3%	20.0%	0%	10.6%
Almost Always	4.8%	0%	6.7%	4.3%	9.5%	0%	6.3%	6.4%	28.6%	20.0%	18.8%	23.4%
Always	0%	0%	0%	0%	4.8%	10.0%	0%	4.3%	33.3%	30.0%	18.8%	27.7%

The most pronounced differences came with the usage of calculators. See Table 3, Usage of Calculators. If the percentages are looked at in grades one through four, the percentages of students that usually use calculators in school from the United States (19%) are almost triple what they are in Japan (6.7%) and almost double what they are in Germany (10.0%). About one-half of the United States (52.4%) students in this group indicated they never used calculators, compared to about three quarters of the students in Japan (73.3%) and Germany (70.0%). Even though the United States had its highest showing on the TIMSS test in the first through fourth grades, this statistic indicates that perhaps calculator usage at an early age is not necessarily a good thing, as students do not learn the simple fundamentals on which to base future knowledge.

In grades five through eight, the percentages of students that usually use calculators in school from the United States (23.8%) are almost double what they are in Japan (6.3%), and close to, but less than, what they are in Germany (30.0%). The amount of students from the United States (14.3%) in this group that indicated they never used calculators was three and one-half times greater than the number of Japanese students (50.0%), and about the same, but greater than the students in Germany (10.0%). This shows that there is an important difference in calculator usage between the United States and Japan in grades five through eight.

In grades nine through twelve, the percentages of students that usually use calculators in school from the United States (14.3%) are much higher than what they are in Japan (0.0%), and close to, but less than, what they are in Germany (20.0%). The

amount of students from Japan (50.0%) in this group that indicated they never used calculators was more than five times greater than the number of United States' students (9.5%), and higher than the students in Germany (0.0%). This shows that there is even a larger difference in calculator usage between the United States and Japan in grades nine through twelve than in the previous four years of school. Perhaps the apparent discrepancies between the United States and Germany are due to the fact that only a small percentage of German students go on to Gymnasium, primarily the students who take the TIMSS test.

Table 4

Primary Language Differences

Question 4
How often did you feel that your primary language was different from that of your math teachers?

	Never	Sometimes	Usually	Almost Always	Always	Total
USA	57.1%	38.1%	4.8%	0%	0%	100.0%
Germany	60.0%	30.0%	10.0%	0%	0%	100.0%
Japan	87.5%	12.5%	0%	0%	0%	100.0%
Total	68.1%	27.7%	4.3%	0%	0%	100.0%

When respondents were asked if different primary languages existed between themselves and their teacher, they were three times more likely to say sometimes, if they were educated in the United States (38.1%) than if they were educated in Japan (12.5%) (see Table 4, Primary Language Differences). In Japan, the language difference between teacher and respondent almost never existed (87.5%), compared to the United States (57.1%). The primary language difference between teachers and respondents that sometimes / never existed in the United States (38.1%) / (57.1%) was similar to that in Germany (30.0%) / (60.6%).

Table 5

Classmates' Language Differences

Question 5
How often did you feel that your classmates' primary language was different from that of your math teachers?

	Never	Sometimes	Usually	Almost Always	Always	Total
USA	52.4%	47.6%	0%	0%	0%	100.0%
Germany	50.0%	40.0%	10.0%	0%	0%	100.0%
Japan	73.3%	26.7%	0%	0%	0%	100.0%
Total	58.7%	39.1%	2.2%	0%	0%	100.0%

When respondents were asked if different primary languages existed between their classmates and their teacher, they were almost twice as likely to reply sometimes if they had been educated in the United States (47.6%), than if they were educated in Japan (26.7%) (see Table 5, Classmates' Language Differences). The language difference between teachers and classmates seldom existed in Japan, since 87.5% responded, "never," to question number 5, compared to that of only 57.1% of respondents in the United States who thought that such a difference never existed. The primary language difference between teachers and classmates that sometimes / never existed in the United States (47.6%) / (52.4%) was similar to that in Germany (40.0%) / (50.0%).

Table 6

Language Problems Between Teachers and Students

Question 6
How often did you feel that primary language communication between your math teacher and the students created a problem?

	Never	Sometimes	Usually	Almost Always	Always	Total
USA	47.6%	52.4%	0%	0%	0%	100.0%
Germany	50.0%	40.0%	10.0%	0%	0%	100.0%
Japan	75.0%	25.0%	0%	0%	0%	100.0%
Total	57.4%	40.4%	2.1%	0%	0%	100.0%

Respondents were more than twice as likely to respond that such a language difference sometimes caused a problem if they had been educated in the United States (52.4%), than if they had been educated in Japan (25.0%) (see Table 6, Language Problems Between Teachers and Students). There was still a noteworthy difference from the United States (52.4%) to Germany (40.0%) when language differences were sometimes a problem. The similarity between the language issue raised in question 5, between the United States and Germany, can be attributed to liberal immigration polices of both the United States and Germany that do not exist in Japan.

Questions 7 and 8 both ask respondents about students of lower mental abilities in their math experience. The data is shown in Table 7, Negative Impact of Lower Mental Abilities, and in Table 8, Teachers' Time With Lower Mental Abilities.

Table 7

Negative Impact of Lower Mental Abilities

Question 7
How often did you feel that students of significantly lower mental abilities negatively impacted your learning experience in math class?

	Never	Sometimes	Usually	Almost Always	Always	Total
USA	58.8%	41.2%	0%	0%	0%	100.0%
Germany	55.6%	44.4%	0%	0%	0%	100.0%
Japan	66.7%	33.3%	0%	0%	0%	100.0%
Total	61.0%	39.0%	0%	0%	0%	100.0%

Table 8

Teachers' Time With Lower Mental Abilities

Question 8 How often did you feel that your teachers spent considerably more time with students of significantly lower mental abilities in math class?						
	Never	Sometimes	Usually	Almost Always	Always	Total
USA	15.0%	45.0%	35.0%	5.0%	0%	100.0%
Germany	10.0%	50.0%	40.0%	0%	0%	100.0%
Japan	26.7%	40.0%	33.3%	0%	0%	100.0%
Total	17.8%	44.4%	35.6%	2.2%	0%	100.0%

The negative impact that students of significantly lower mental abilities had on the respondents' learning experience in math was similar throughout all three countries, where Japan at 33.3%, United States at 41.2%, and Germany at 44.4% of the respondents thought it sometimes negatively impacted their learning experience. Also very similar throughout all three countries were the responses to question number 8, where the United States at 45.0%, Japan at 50.0%, and Germany at 40.0% of the respondents thought that sometimes teachers spent considerably more time with students of significantly lower mental abilities in math class. Neither questions 7 nor 8 had a sufficient statistical

significance to indicate that there was a cultural difference between the United States and either Germany or Japan in these areas.

Questions 9 and 10 both ask respondents about students of lower physical abilities in their math experience (see Table 9, Teachers' Time with Lower Physical Abilities, and Table 10, Negative Impact of Lower Physical Abilities).

Table 9

Teachers' Time With Lower Physical Abilities

Question 9
How often did you feel that your teachers spent considerably more time with students of significantly lower physical abilities in math class?

	Never	Sometimes	Usually	Almost Always	Always	Total
USA	38.1%	52.4%	9.5%	0%	0%	100.0%
Germany	80.0%	20.0%	0%	0%	0%	100.0%
Japan	33.3%	60.0%	6.7%	0%	0%	100.0%
Total	45.7%	47.8%	6.5%	0%	0%	100.0%

Table 10

Negative Impact of Lower Physical Abilities

Question 10
How often did you feel that students of lower physical abilities negatively impacted your learning experience in math class?

	Never	Sometimes	Usually	Almost Always	Always	Total
USA	57.1%	33.3%	4.8%	4.8%	0%	100.0%
Germany	60.0%	30.0%	10.0%	0%	0%	100.0%
Japan	73.3%	26.7%	0%	0%	0%	100.0%
Total	63.0%	30.4%	4.3%	2.2%	0%	100.0%

Comparable findings were received when respondents were asked if students of significantly lower physical abilities negatively impacted their learning experience in math. Between Germany and the United States, 30.0% of Germany's respondents though it sometimes had an impact, and 60.0% of Germany's respondents thought it never had an impact, compared to 33.3% of the United States' respondents thought that it sometimes had an impact, and 57.1% thought it never had an impact. The comparison between Japan and the United States on this question had a different relationship, with 57.1% of all respondents from the United States answering that they thought students of significantly

lower physical abilities never negatively impacted their learning experience in math class; whereas, a much higher margin (73.3%) of Japanese respondents thought the same thing. In the sometimes, usually, and almost always responses to question 10, answers from the United States were 42.9% (33.3%, 4.8%, and 4.8% respectively), in comparison to only 26.7% of replies from Japan (26.7%, 0%, and 0% respectively).

Table 11

Is Math More Difficult than Other Subjects

Question 11
Do you believe that math is a more difficult subject than your other subjects in school?

	Never	Sometimes	Usually	Almost Always	Always	Total
USA	14.3%	52.4%	14.3%	9.5%	9.5%	100.0%
Germany	0%	70.0%	20.0%	0%	10.0%	100.0%
Japan	20.0%	53.3%	13.3%	6.7%	6.7%	100.0%
Total	13.0%	56.6%	15.2%	6.5%	8.7%	100.0%

Most respondents felt that learning mathematics was sometimes / usually more difficult than the rest of their subjects in school. A total of 66.7% of respondents of the survey from the United States felt math was sometimes / usually more difficult than the

rest of their subjects in school, 80% from Germany felt this way, and 66.6% from Japan agreed (see Table 11, Is Math More Difficult than Other Subjects).

Table 12

Parental Attitudes About Math

Question 12
Do your parents think that math is more difficult than other subjects?

	Never	Sometimes	Usually	Almost Always	Always	Total
USA	4.8%	47.6%	23.8%	19.0%	4.8%	100.0%
Germany	0%	44.4%	22.2%	22.2%	11.1%	100.0%
Japan	33.3%	40.0%	13.3%	13.3%	0%	100.0%
Total	13.3%	44.4%	20.0%	17.8%	4.4%	100.0%

Participants' parents, on the other hand, had different ideas, particularly if you were from the United States or Japan (see Table 12, Parental Attitudes About Math). Fourteen and three-tenths percent (14.3%) of students from the United States indicated that they thought math was never harder than their other subjects, compared to only 4.8% of their parents on the same subject. Twenty percent (20%) of students from Japan indicated that they thought math was never harder than their other subjects, compared to one third (33.3%) of their parents. When comparing the two countries, respondents from

the United States were almost twice (42.8%) as likely to feel that their parents' opinions were that math is usually or almost always more difficult than other subjects, compared to only 26.6% of the Japanese respondents' opinions of their parents' feelings on the same subject.

Table 13

Teachers' Attitudes About Math

Question 13
Do your teachers think that math is more difficult than other subjects?

	Never	Sometimes	Usually	Almost Always	Always	Total
USA	23.8%	42.9%	23.8%	9.5%	0%	100.0%
Germany	11.1%	55.6%	22.2%	11.1%	0%	100.0%
Japan	31.3%	50.0%	6.3%	12.5%	0%	100.0%
Total	23.9%	47.8%	17.4%	10.9%	0%	100.0%

Similar results were found between these two countries, as was in question 12, about their ideas of their teachers' opinions (see Table 13, Teachers' Attitudes About Math). The responses that students thought their teachers usually or almost always thought that math was more difficult than other subjects almost doubled (33.3%) if you were from the United States, rather than from Japan (18.8%). The United States and

Germany had the same response on the subject of whether or not their teachers felt that math was more difficult than other subjects.

While it is interesting that questions 12 and 13, about parents' and teachers' attitudes about math, were answered similarly. When the responses from the United States to Germany (though Germany's responses were consistently slightly higher) are compared, responses from these two countries on question 14, does your society believe that math is a more difficult subject, were much different.

Table 14

Societal Attitudes About Math

Question 14
Does the society you live in, on a whole, believe that math is more difficult than other subjects?

	Never	Sometimes	Usually	Almost Always	Always	Total
USA	4.8%	42.9%	38.1%	4.8%	9.5%	100.0%
Germany	0%	33.3%	22.2%	33.3%	11.1%	100.0%
Japan	12.5%	37.5%	25.0%	18.8%	6.3%	100.0%
Total	6.5%	39.1%	30.4%	15.2%	8.7%	100.0%

While it appears that all three countries had differing societal concepts on the difficulties of math, the responses between the United States and Germany are the most pronounced, with 44.4% of German students answering almost always or always that their society thinks math is a more difficult subject than others (see Table 14, Societal Attitudes About Math). Only 14.3% of responses from the United States felt this way, and 25.1% of Japanese respondents felt this way.

Table 15

Teachers' Abilities to Explain Confusing Concepts

Question 15
Was your math teacher always able to explain confusing concepts to you if you asked?

	Never	Sometimes	Usually	Almost Always	Always	Total
USA	0%	28.6%	28.6%	23.8%	19.0%	100.0%
Germany	1.0%	40.0%	30.0%	20.0%	%	100.0%
Japan	0%	18.8%	18.8%	25.0%	37.5%	100.0%
Total	2.1%	27.7%	25.5%	23.4%	21.3%	100.0%

Students from Japan thought that their teachers were better prepared to explain confusing concepts to them than students from other countries, with the United States coming second and Germany last (see Table 15, Teachers' Abilities to Explain Confusing

Concepts). Japanese students were more than three times (62.5%) as likely to believe that their teachers could, almost always or always, explain confusing concepts than students from Germany (20%). Students from the United States were twice (42.8%) as likely to believe that their teachers almost always or always could explain confusing concepts than students from Germany (20%). When comparing responses from students from the United States and Japan, Japanese students said that 62.5% of the time they thought that that their teachers could, almost always or always, explain confusing concepts, where as a much lower percentage, only 42.8%, of American students felt the same way.

Table 16

Teachers Had Understanding of Math Concepts

Question 16
Do you feel that your teachers always had a clear understanding of the concepts they were presenting in math class?

	Never	Sometimes	Usually	Almost Always	Always	Total
USA	0%	19.0%	38.1%	23.8%	19.0%	100.0%
Germany	0%	20.0%	30.0%	40.0%	10.0%	100.0%
Japan	0%	12.5%	18.8%	25.0%	43.8%	100.0%
Total	0%	17.0%	29.8%	27.7%	25.5%	100.0%

Japanese students felt that 43.8% of their teachers always had clear concepts of the mathematical processes they were presenting in comparison to only 19.0% of American students (see Table 16, Teachers Had Understanding of Math Concepts). Whereas, about half (10.0%) of the German students felt that their teachers always had a clear concept of the mathematical concepts they were presenting, in comparison to 19.0% of the American students that felt the same.

Table 17

Discipline in the Classroom

Question 17
Do you feel that classroom discipline, or the lack there of, negatively impacts your ability to learn math?

	Never	Sometimes	Usually	Almost Always	Always	Total
USA	9.5%	47.6%	14.3%	19.0%	9.5%	100.0%
Germany	11.1%	22.2%	22.2%	22.2%	22.2%	100.0%
Japan	31.3%	50.0%	0%	12.5%	6.3%	100.0%
Total	17.4%	43.5%	10.9%	17.4%	10.9%	100.0%

More than three times (66.6%) as many students from Germany said that discipline, usually to always, had a negative impact on their ability to learn math, than

Japanese students did (18.8%) (see Table 17, Discipline in the Classroom). Respondents were more than twice (42.8%) as likely to feel that discipline, usually to always, had a negative impact on their ability to learn math if educated in the United States, than if educated in Japan (18.8%). Even though the difference between the United States and Japan is not large enough to make a statistical significance at the .05 level, it is statistically significant at the .2 level and is still large enough to make a considerable difference, that should be considered, when looking at a course of change for the United States' school systems to follow. Students from the United States felt that 42.8% of the time discipline, usually to always, had a negative effect on their ability to learn math, whereas German students felt more strongly (66.6%) that discipline, usually to always, had a negative effect on their math classes. While there is not a significant cultural difference here, it is interesting to note that culturally different students share the opinion that lack of discipline can negatively impact their ability to learn math.

Results

Most of the thesis hypothesis held up under the scrutiny of undergoing a T-test. The initial hypothesis about the calculator usage was the strongest indicator that there is a cultural difference between the United States and Japan in the students' abilities to learn math and how the calculator is used. This correlation yielded a T-test coefficient of -2.099 at the fifth through eight-grade level, and a T-test coefficient of –2.342 at the ninth

through twelfth grade level, which is statistically significant at the .05 level of significance.

A cultural difference between the students' abilities to communicate to the teacher in his or her own language proved to have a sufficient statistical coefficient to indicate there is a substantial cultural difference here between the United States and Japan. This correlation yielded a T-test coefficient of –2.243, which is statistically significant at the .05 level of significance. There was also a close statistical significance between the students' abilities to communicate to their teacher in their own language and whether or not this caused a problem with their abilities to learn math. This correlation yielded a T-test coefficient of -1.733, although not statistically significant at a .05 level of significance, it was close and was statistically significant within a .1 level of significance.

The math attitudes hypothesis also held up under statistical analysis, as it showed that there exists a statistical significance to support, in favor of the hypothesis, that a relationship exists between attitudes and the students' abilities to learn math, particularly where the students' parents thought math was a more difficult subject than their other ones in school. This correlation yielded a T-test coefficient of –1.882, although not statistically significant at a .05 level of significance, it was close and was statistically significant within a .1 level of significance. This cultural difference was found when comparing the United States to Japan.

While there is a strong significant correlation between the cultural differences of the United States and Germany, that teachers spend considerably more time with students

of significantly lower physical abilities, it did not seem to correlate with the students' opinion that it had a negative impact on their ability to learn math. It did take away some of their learning time in class. This correlation yielded a T-test coefficient of –2.656, which is statistically significant at the .05 level of significance

There was also a cultural difference between the United States and Germany, in the teachers' abilities to explain confusing concepts when asked. This correlation yielded a T-test coefficient of –1.881. Although not statistically significant at a .05 level of significance, it was close and was statistically significant within a .1 level of significance.

The results of this study indicate that there is significant statistical correlation between several of the research hypotheses, but not all. The results show that there is an important statistical relationship connecting calculator usage in the schools, students' abilities to communicate to the teacher in his or her own language, the students' parental attitudes toward math, teachers who spent considerably more time with students of significantly lower physical abilities, the teachers' abilities to explain confusing concepts, and the students' abilities to learn the subject of mathematics. The results of this study also indicated that there was little or no significant statistical correlation between classmates with significantly lower mental abilities, school discipline, and the students' abilities to learn the subject of math. Perhaps with a larger sample size, these hypotheses might have had more of a statistical significance. The research hypothesis of this study was supported by five of the seven areas of concern.

Chapter V

Summary, Conclusions, and Recommendations

This chapter will provide a summary, conclusions, and recommendations of the study. The purpose of this study is to compare the physical and psychological differences in math education between students of the United States, Germany, and Japan and to determine what, if any, impact these differences can make in a student's ability to learn math.

Summary

This study was undertaken for the purpose of comparing and contrasting the physical and psychological impact international differences in math classrooms can make in a student's overall performance. The study will evaluate our successes and failures with those of other countries in order to expose a path of techniques that can be adapted or assimilated to ensure the continued accomplishments of American students. The significance of the findings in this study will have broad implications for the entire American educational system.

To accomplish the purpose, the following objectives were developed:

1. Examine the psychological aspects of the educational system for the American, German, and Japanese cultures.
    a. Investigate the societal attitudes toward math in each culture.

b. Explore the students' teachers' attitudes toward math in each culture.

c. Inspect the students' parents' attitudes toward math in each culture.

d. Canvass the students' attitudes toward math in each culture.

2. Identify the physical aspects of the educational system for the American, German, and Japanese cultures.

   a. Identify whether calculators are used at all grade levels in each culture and how they are used to impart the objectives of the lesson. How much importance and time is given to the use of calculators in each culture? Is calculator use related to deductive reasoning (imperative to the understanding of mathematics) in each culture?

   b. Determine if students' classrooms are separated by the primary language spoken by the teacher, by like students' mental abilities, or by like students' physical abilities in each culture.

   c. Ascertain if math teachers are prepared and able to teach the level of mathematics their class is at in each culture.

   d. Examine the effect that discipline in the classroom, or lack thereof, affects students' abilities to learn math.

To accomplish the purpose and objectives of the study a review of literature was conducted. It was found that the following were important in learning the subject of math:

- calculator usage;

- language differences between teachers and students;
- significantly different mental abilities between students;
- teachers' qualifications;
- attitudes about the subject of math;
- significantly different physical abilities between students;
- school discipline.

A survey was developed which addressed the literature findings and correlates with the research objectives. A survey was placed on the World Wide Web and a total of 47 respondents from the United States, Germany, and Japan replied. To review the instrument used and the accompanying instructions that were on the web, please see Appendix. A statistical analysis of the findings was compiled and can be found in Chapter IV.

Conclusions

Each research objectives will be restated and answered.

Objective 1a

1. Examine the psychological aspects of the educational system for the American, German, and Japanese cultures.
   a. Investigate the societal attitudes toward math in each culture.

      The results of the study indicated that a relationship did not exist for this objective. There was not a statistically significant difference in the survey results

on this objective. There appeared to be little correlation between cultural differences of the psychological aspects of the societal attitudes toward the subject of math. This would indicate that societal attitudes did not play a role in the cultural differences between students' math performances.

Objective 1b

1. Examine the psychological aspects of the educational system for the American, German, and Japanese cultures.

   b. Explore the students' teachers' attitudes toward math in each culture.

When the assessment of objective 1b was undertaken, the results of the study indicated that a relationship did not exist for this objective. There was not a statistically significant difference in the survey results on objective 1b. This would indicate that teachers' attitudes did not play a role in the cultural differences between students' math performances. It is interesting to note that, even though there was not a statistical difference in objective 1b, participants were four times more likely to respond that teachers usually thought math was more difficult than other subjects if they were educated in the Untied States and Germany, than if they had been educated in Japan. What do Japanese teachers feel about the subject of math that could not be conveyed to teachers in America? Particularly in younger grades, the opinion of the teacher is a strong signal to the students on the subject. Math is only more difficult to learn than other subjects if it is taught that way.

Objective 1c

1. Examine the psychological aspects of the educational system for the American, German, and Japanese cultures.
    c. Inspect the students' parents' attitude toward math in each culture.

The survey shows a difference between attitudes and the students' abilities to learn math, particularly, where the students' parents thought math was a more difficult subject than their other ones in school.

One conclusion to investigate would be educating parents to the findings of this study and to demonstrate to them the impact that it has on their children's learning experience. When a child asks for help with homework, few subjects send parents running for cover faster than math (Randal, 2002). One of the reasons parents feel this ways is because math is one of the truly objective subjects and they feel that you either 'get it,' or you don't. There's not much middle ground (Randal, 2002). One of the things this researcher finds amusing is that there is a cultural difference in this attitude. What is it that parents in Japan think that could be so different from what parents think in the United States? Now, to alleviate the attitude problem of students, parents' education is probably the most important. There have been many studies done on the negative attitudes toward math, and also many methods developed to try to counteract this affect. There are many techniques designed to reverse this problem that might be taught

at school. One teacher even suggested that parents' participation in a math refresher course should be a prerequisite to any child's enrollment in a school math program (Randal, 2002). While difficult to mandate, it is an excellent idea to offer. There is a plethora of information to help parents help themselves, but not much of it is made available at school.

> If you shy away from math and science activities with your children because you're afraid you don't know much about them, read on. There's lots you can do to encourage your children's interest in these areas, and you don't have to be a statistician or microbiologist to do it! In fact, it's better if you don't give them knowledge by telling them answers; instead, nurture their love for these subjects by watching and learning right along with them (McBrien, 2002, p.1).

Perhaps a bulletin board posted in a prominent place within the school, or a math newsletter that contains information on math web links, study groups and perhaps some tutoring options available for both the parents and students. Schools might even encourage parents to take the job of starting a math club, just like they do book clubs, where parents and students attend.

Objective 1d

1. Examine the psychological aspects of the educational system for the American, German, and Japanese cultures.
   d. Canvass the students' attitudes toward math in each culture.

The results of the study indicated that a relationship did not exist for this objective. There was not a statistically significant difference in the survey results on objective 1d. The results from the United States to Japan were almost identical. The results from the United States to Germany were very close, but Germany's responses were higher, indicating that students educated in Germany thought math was slightly harder than American students did. This would indicate that students' attitudes do not play a role in the cultural differences between students' math performances.

Objective 2a

2. Identify the physical aspects of the educational system for the American, German, and Japanese cultures.
    a. Identify whether calculators are used at all grade levels in each culture and how they are used to impart the objectives of the lesson. How much importance and time is given to the use of calculators in each culture? Is calculator use related to deductive reasoning (imperative to the understanding of mathematics) in each culture?

The results of the study indicated that a relationship does exist between the students' use of calculators and their conceptual ability to learn the subject of mathematics. This objective offers strong direction in the usage of calculators in our schools from other cultures.

The most compelling conclusion that can be made from this study is that a cultural difference exists in calculator usage between Japan, which consistently places near the top of the TIMSS studies, and the United States, which does not. As the study and research illustrates, the usage of calculators in the Japanese school district is almost completely absent. It also demonstrates that the National Council of Teachers of Mathematics (NCTM) may be misguided in their adamant insistence that calculators be used in all levels of school and, at worst, a serious mistake that will negatively impact generations of school children from learning the important concepts in mathematics. When schools have tried to incorporate this ideology into their curriculum, it almost always came with a warning label, such as, "Besides teaching when and how to use the calculator, the article notes that calculator usage requires students to be effective estimators as well as judges of the reasonableness of an answer" (ENC, National, Calculators). If students ever learn this, they seem to quickly forget it. The answer returned at the top of the calculator screen is tantamount to a message straight from God for most students, regardless of the logic of the response. "California was the first state to use NCTM philosophies to redesign its math curriculum. In 1992, the state unveiled its "Math Framework," a set of guidelines with which every district's math curriculum had to comply." When these standards where adopted in the California school district it unleashed an unparalleled drop in math test scores and

controversy ever since (Kremer, 1997). Since then, California educators have scrambled for better methods to follow.

In order for publishers to prepare materials for the 2001 adoption, the state department of education sponsored a meeting highlighting the California standards and framework. Mathematics professors Hung-Hsi Wu of the University of California, Berkeley, and James Milgram of Stanford University, principal authors of the 1998 framework, were featured. They raised three of their pet concerns: calculators, computation, and mathematical proof.

Professor Milgram spoke forcefully against the use of calculators. . . . With regard to calculators, he stated, "When calculators are used, students do not learn basic skills. They learn basic button-pressing skills." Milgram continued, "This is the research of David Geary, and there are numerous other studies that tend to show the same thing" (Reys, 2001).

The NCTM standards discuss that the use of calculators does not eliminate the need for students to learn algorithms, and indicate that skill with paper-and-pencil computational algorithm still needs to be demonstrated. The calculator standard tries to put aside fears that calculators make students dependent on them for simple calculations. It claims "students should be able to decide when they need to calculate and whether they require an exact or approximate answer. They should be able to select and use the most appropriate tool" (Suydam, 1990). In the

face of this study and the dropping tests score from school districts around the nation that have tried this NCTM quick fix, it does not seem to hold true.

When discussing the cultural difference in the use of calculators it is important to remember that calculators may be robbing students of some of the most fundamental concepts in elementary math. In the United States, inexpensive calculators are on the supply list as early as kindergarten, and usually by third grade. This is in direct cultural opposition to Japanese students, where the use of calculators in the Japanese classrooms is practically nonexistent (Valverde & Schmidt, 1997, 1998). Students seem to lose the reasoning and problem solving skills that mathematics requires when they use the calculator, thinking that the calculator does the thinking for them.

Objective 2b

2. Identify the physical aspects of the educational system for the American, German, and Japanese cultures.
    b. Determine if students' classrooms are separated by the primary language spoken by the teacher, by like students' mental abilities, or by like student's physical abilities in each culture.

The objective looked at three distinct methods by which a classroom can be separated, specifically, by the primary language spoken, by students' mental abilities, and by students' physical abilities. This study pointed to a relationship in the first of those three objectives, that there is a cultural difference between the

students' abilities to communicate to the teacher in his or her own language and their abilities to understand mathematical instruction.

From this conclusion it can be determined that another possible avenue to explore, as indicated by the findings of objective 2b, would be the unification of language in schools. In Germany's schools, non-German speaking students are required to learn the language first. In Japan, where the study indicates there is the most statistical difference, only Japanese citizens are educated in Japanese schools. For a foreigner to become a Japanese citizen, they must demonstrate proficiency in the Japanese language. Therefore, only Japanese is spoken in the schools in Japan, and inability to understand the instruction because you cannot understand the teacher has been eliminated. It is imperative for students to be able to at least understand the words the teacher is speaking in order to even have a chance to understand.

The United States and Germany have much of the same problem today of trying to educate students whose only language is not the same as the teachers, or the other students. One of the major differences is that for Germany, this is a recent problem. The United States has been dealing with this dilemma for many decades now, mostly unsuccessfully. One of the reasons for this is the liberal immigration polices of these two nations, which their educational system now has to deal with. Because of the restrictive citizenship laws, many of the foreigners realize they will never become German Citizens and make no move to learn the

language. The breakup of Russia and the fighting among Middle Eastern countries has brought immigrants with many different native tongues, making dual-language classes a non-option (Wolf & Wolf, 1998). In recognizing the problem, Germany has now created required classes to teach non-German-speaking immigrants the language first.

The United States has reached no such conclusion and the problem is now reaching epidemic proportions in some of our nations schools. In California's 1999 Language Census, schools enroll 2,271,283 students with a native language other than English, which comprises 38 percent of California's students (CDE, Education). In smaller towns like Wausau, Wisconsin, this problem has become an impossible circle of decreased educational skills for all Wausau's students.

> Problems in Wausau, which has experienced a large influx of Hmong children, many of whom have limited English skills . . . the district has been deprived of funds necessary to deal with its externally imposed educational problems, he said. As a result of the dramatic increase in high-needs students, it has had to cut regular education programs. Which suggests the possible onset of a vicious cycle of increasing difficulties and lowered performance for Wausau students (WEAC, Finance p.2).

One solution might be to mandate one language, one-classroom policies. To do this, schools in the United States must employ educators who speak the

language of the children to be educated, or have classes to teach the students the language of the teacher before entry into the classroom is allowed. As with all changes of this nature, funding is the first thing discussed. Since the federal government is often responsible for these language problems, as it was in Wausau, Wisconsin, it seems, therefore, logical that solutions and funding need to come from the same source.

The findings of this study did not indicate that there was a statistically significant correlation between separating classes by students' mental abilities, objective 2b, and for that reason it will not be considered as a prospect for school reform here.

The instrument did indicate a strong correlation of differences in objective 2b, between cultures, that a relationship does exist between non-homogeneous classes' physical abilities and the students' abilities to learn math. This correlation will not have implications in the recommendations of this study because the relationship showed that, in Germany, teachers spend considerably more time with students of significantly lower physical abilities, but the students did not feel that it had a negative impact on their abilities to learn math. Since the statistical significance indicated that Germany had more of a problem with this than the United States did and since the respondents did not seem to feel that this had a negative impact on their math learning experience, this might not be an avenue to pursue for school reform in the United States as a result of this study.

Objective 2c

2. Identify the physical aspects of the educational system for the American, German, and Japanese cultures.
    c. Ascertain if math teachers are prepared and able to teach the level of mathematics their class is at in each culture.

The survey demonstrated that a relationship does exist between a teachers' qualifications and/or the teachers' preparedness to teach the subject of math and the students' abilities to learn it. In this objective, results yielded a strong distinction separating the United States and the other two countries. American respondents thought their teachers did not have a clear concept of the mathematical principles being presented and that they were not properly prepared to teach math.

One of the conclusions to draw from this study is the need to have better qualified math teachers in the United States. Teachers should have a deep knowledge base from which to draw, and an extreme comfort level with the subject matter. If changes are made, they will live or die in the classroom, and the teachers must first understand and assimilate these changes if they are to teach them (Bracey, 1998). The classroom, in essence, is the teacher. The teacher is not only the head of the classroom, but also choreographs the learning and shapes the attitudes of the students' learning. While the research cries out for better-trained teachers, unfortunately the trend is just the opposite.

> New college graduates with teacher education training have traditionally been the largest source of newly hired teachers each year in the nation's elementary and secondary schools. In the 1960s, for example, 67 percent of newly hired teachers in public schools were new college graduates. By the mid-1980s, however, this proportion had fallen to only 17 percent (National Education Association, 1987). For example, school enrollments continue to increase, the numbers of new college graduates with education degrees are still smaller than in the past (Snyder, 1999, p.326), and the continuing practice in several states of waiving standard teacher credentials when hiring new teachers suggests that some adjustments in teacher qualifications are being made, possibly in response to shortages. In 1993–94, for example, almost half of public and three-fourths of private (teachers) delayed entrants lacked a major or minor plus certification in their primary assignment field (ESQ, Elementary)**.**

This disparaging trend continues to grow as teacher shortages, particularly in math and science, leaves the United States facing the largest teacher shortage in its history (CTF, Teachers 2000). The only group that has a larger teacher shortage than math and science is special education. Leaving school systems to fend for themselves brings about statistics where almost one-quarter of newly hired teachers in 1994 had no license, or a substandard one, in the subject they

were asked to teach (CTF, Teachers 2000). While the governing bodies are "mandating" tougher certification/testing standards for new teachers, it is but lip service to a growing problem. While the mandates continue, this is what is happening in our nation's schools:

> Kentucky: State agency gave some school districts permission to hire people with only a high school diploma due to a high demand for substitute teachers. California: Entrance into the teaching force to be made easier for those who have degrees but no teaching credentials and for those who have not completed their degrees. (Also) to shorten the coursework required for a teaching credential from two years to one year. Maryland: Only 57% of teachers hired in Prince George's County were fully certified in their teaching areas (ESQ, Elementary 2000).

Mandating higher standards for teachers does not mean the schools can afford to pay for them. Each state is responsible for deciding how to fund its schools and to pay its teachers; they need to understand that like any professional job, they get what they pay for. More and more now, teachers also need to have computer and technology skills to keep up with other countries. These additional skills have not even begun to be addressed.

Objective 2d

2. Identify the physical aspects of the educational system for the American, German, and Japanese cultures.

   d. Examine the effect that discipline in the classroom, or lack thereof, affects students' abilities to learn math.

      The results did not show a statistical difference between the cultures on this subject. Even though the statistical analysis did not show a difference in objective 2d, it is important to note that all participants thought that lack of classroom discipline negatively impacted the students' abilities to learn. Just because there was not a statistical difference here does not mean that it should not be addressed as a method of change to improve all school systems.

Recommendations

The following are recommendations that were determined as a result of this study:

1. As a specific recommendation on the subject of calculators, they should be removed almost entirely from our school system. This is a change, not back to where the United States once was, but forward to an enlightened place of learning that realizes the advancement of the computer age, and does not replace the well-set perceptions of mathematical concepts which seem to be lost with the usage of the calculator. While to many this seems like an overstatement, the calculator has gone from being an aid to the teachers and students to being a crutch, which atrophies the concepts that are so important for the students to retain. It is unfortunate that the teachers are as much

dependant upon the calculator, as the students themselves. To be really effective and to avoid the resentment of students, because they get to use calculators sometimes but not others, calculators should be eliminated. It would demonstrate to our nation's teachers, students and parents that there are genuinely important mathematical concepts that need to be assimilated into our thinking patterns that cannot be done with the use of a calculator. If these skills are learned and then not used, they deteriorate until the students may as well have not bothered learning them in the first place. To make curriculum changes of this nature an appropriate funding source must precede the changes.

2. Mandate one language, one-classroom policies. The United States must employ educators who speak the language of the children to be educated, or have classes to teach the students the language of the teachers before entry into the classroom is allowed. Addition of such classrooms is an expensive solution and must be preceded by an appropriate funding source. As this recommendation seems to be most needed in poorer ethnic neighborhoods, funding will be a challenge.
3. Enforce the requirements currently in place that teachers must have certain levels of education, and specific education in given areas. Spending the time and money to develop new ones is a waste of both if they will be ignored like all the rest. Fund teachers for these educational requirements and pay teachers commensurate with their educational levels, as in other professional areas.

4. Require teachers to demonstrate their continued enthusiastic fitness for their profession. Teacher burn out is an unfortunate side effect of many of the overwhelming problems in today's schools. Burnt out professionals exude negativity, and students can't learn math if teachers don't teach math.
5. Control discipline/violence in the school, thereby giving teachers something to be enthusiastic about. Fear of violence is never conducive to anything productive. Discipline/violence problems distract teachers from teaching, and students from learning.
6. Educating parents about how their attitudes affect their children is vital. Showing parents how they can help their children learn through a math refresher course, site specific web address, a bulletin board, math newsletter, or by the formation of a math club, just like they do book clubs, where parents and students attend.
7. While many variables became factors in a study of this nature, the results indicate that there is statistical evidence to pursue school reform in the avenues of calculator usage, teachers' qualifications, primary language communications between students and teachers, and how the attitudes parents have impact their children's learning experiences in math class.
8. It is important to realize that this study is not sufficiently large enough to be valid except in generalizations, but is large enough to be taken at face value.

9. A repeat of this study over time, taking into account differing geographical areas within the three countries and differing economical circumstances, would be interesting and worthwhile. Also, it is important to note that because of the size of this study, the variables tested show a connection to, but not necessarily a direction causation, of the problems discussed in this paper.

This researcher hopes that more will be helped by this research and firmly believes that dedication to beliefs is the cornerstone of life's performance.

Human capacity development is a fundamental building block of any stable society. Education and training are required to enable full participation in community, national and global development. A nation's ability to contribute to the world economy, as well as to manage its own, is directly related to the development of its human resources (USAID, Education, p.1).

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Appendix

The Instrument

Welcome! Let me introduce myself. My name is Ilona Ridgeway and I am a graduate student of the University of Wisconsin-Stout, working on my theses. This survey is a part of that thesis. As a teacher of mathematics myself, I have come to realize that the educational system is not just one school, one district, or one city, but a global effort in recognizing strengths and weaknesses of many different cultures. The purpose of this study is to compare the physical and psychological impact these differences can make in a student's overall performance. The questions in this survey deal with math delivery and math attitudes in different cultures. Few studies have focused on a combination of the physical and psychological aspects of different international cultures, specifically the United States of America, Germany, and Japan. You will not be required to give any personal information or identify yourself in any other way than to determine the country in which you were educated.

The survey you are about to take consist of 17 questions utilizing a 5-point Likert-scale, ranging from never to always depending on how likely an event or attitude occurred, and only takes a minute or two.

The intent of this study is not to just make changes in the way teachers and students alike feel, think and act about mathematics, but to change the way that mathematics is learned and applied, so that they and the rest of society can come to share some of this researcher's passion of the subject of mathematics.

You are eligible to take this survey only if you can answer 'yes' to the following two questions? The following survey is written in English.

Are you 18 years of age or older? ☐ Yes ☐ No

Were you educated for most of your non-college-level education in

☐ Yes in Japan

☐ Yes in Germany

☐ Yes in The United States Of America

Did you use calculators for math in grades 1 through 4?

☐ Never ☐ Sometimes ☐ Usually ☐ Almost Always ☐ Always

Did you use calculators for math in grades 5 through 8?

☐ Never ☐ Sometimes ☐ Usually ☐ Almost Always ☐ Always

Did you use calculators for math in grades 9 through 12

☐ Never ☐ Sometimes ☐ Usually ☐ Almost Always ☐ Always

How often did you feel that your primary language was different from that of your math teachers?

☐ Never ☐ Sometimes ☐ Usually ☐ Almost Always ☐ Always

How often did you feel that your classmate's primary language was different from that of your math teachers?

☐ Never ☐ Sometimes ☐ Usually ☐ Almost Always ☐ Always

How often did you feel that primary language communication between your math teacher and the students created a problem?

☐ Never ☐ Sometimes ☐ Usually ☐ Almost Always ☐ Always

How often did you feel that students of significantly lower mental abilities negatively impacted your learning experience in math class?

☐ Never ☐ Sometimes ☐ Usually ☐ Almost Always ☐ Always

How often did you feel that your teachers spent considerably more time with students of significantly lower mental abilities in math class?

☐ Never ☐ Sometimes ☐ Usually ☐ Almost Always ☐ Always

How often did you feel that your teachers spent considerably more time with students of significantly lower physical abilities in math class?

☐ Never ☐ Sometimes ☐ Usually ☐ Almost Always ☐ Always

How often did you feel that students of lower physical abilities negatively impacted your learning experience in math class?

☐ Never ☐ Sometimes ☐ Usually ☐ Almost Always ☐ Always

Do you believe that math is a more difficult subject than your other subjects in school?

☐ Never ☐ Sometimes ☐ Usually ☐ Almost Always ☐ Always

Do your parents think that math is more difficult than other subjects?

☐ Never ☐ Sometimes ☐ Usually ☐ Almost Always ☐ Always

Do your teachers think that math is more difficult than other subjects?

☐ Never ☐ Sometimes ☐ Usually ☐ Almost Always ☐ Always

Does the society you live in, on a whole, believe that math is more difficult than other subjects?

☐ Never ☐ Sometimes ☐ Usually ☐ Almost Always ☐ Always

Was your math teacher always able to explain confusing concepts to you if you ask?

☐ Never ☐ Sometimes ☐ Usually ☐ Almost Always ☐ Always

Do you feel that your teachers always had a clear understanding of the concepts they were presenting in math class?

☐ Never ☐ Sometimes ☐ Usually ☐ Almost Always ☐ Always

Do you feel that classroom discipline, or the lack there of, negatively impacts your ability to learn math?

☐ Never ☐ Sometimes ☐ Usually ☐ Almost Always ☐ Always