THE UTILITY OF STANDARDIZED ACHIEVEMENT TEST SCORES AS A PREDICTOR OF GEOGRAPHIC KNOWLEDGE AND ABILITIES IN UNDERGRADUATES AT AN URBAN OHIO UNIVERSITY

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THE UTILITY OF STANDARDIZED ACHIEVEMENT TEST SCORES AS A
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ABSTRACT

In many elementary and secondary schools, geography has either been absorbed into social studies classes or been removed from the curriculum completely. However, introductory geography remains a staple in undergraduate general education curricula in many colleges and universities. Arguably, students are entering college underprepared for geography courses, and therefore existing higher education curricula in these introductory courses may not properly address possible deficiencies in geography skills. This research examined the utility of standardized achievement test scores as predictors of geography skills in an undergraduate population at an urban university. The relationship between a student’s component scores on an accepted knowledge of geography test (KOG) and on the ACT were explored. The results indicated that there are significant positive correlations between specific component scores on the KOG with specific component scores on the ACT. The relationship found between these two tests may provide opportunities to enhance student success in introductory geography courses.
DEDICATION

To my wife Keira,

whose patience reminds me to keep on task,

whose devotion reminds me to achieve my goals,

and whose love reminds me to follow my dreams.
ACKNOWLEDGEMENTS

I would like to thank the many people who made this research successful. First, I would like to give sincere thanks to my advisor, Dr. Linda Barrett. I am grateful for her countless hours spent reading my paper, helping to create a succinct research proposal and a sound thesis. I would also like to thank the rest of my committee, Dr. Robert Kent and Professor Deborah King, for their helpful comments and constructive criticism. Special thanks to all others who helped collaborate on this research and read the paper, especially Dr. Kevin Butler, whose expertise in statistics proved to be invaluable. Thanks must go to my undergraduate advisor and professor, Dr. John Kinworthy, whose expectation of excellence prepared me for undertaking this project. Finally, a big thank you goes to my family and friends for their constant support and encouragement during this process.
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CHAPTER I
INTRODUCTION

Background

Within the last several decades, the issue of academic preparedness and proficiency has been a public concern at the local, state and federal levels. One of the subjects to come under scrutiny for under-performing students is geography. Numerous studies have been employed to assess the quality of geographic literacy among American students. From elementary-age to graduate students, many of the results from these assessments have not been positive. For example, students have demonstrated poor map-reading skills and have scored low on internationally distributed geography surveys (Eve et al., 1994). American students continually fail to achieve basic levels of geographic literacy (Lawton, 1995; Holloway, 2002).

However, there have been efforts to mitigate these problems. The National Geographic Society, in one of the first major pushes for improving geographic education, created the initial series of geography standards for students. These standards were published in 1994 as *Geography for Life: National Geography Standards* (1994). Similar efforts have been employed in higher education. Unfortunately, many students, at all
levels – elementary, secondary, and even higher education – remain unsuccessful in situations where they are asked basic geographic questions.

In an attempt to understand why students struggle, researchers began to investigate the underlying causes of geographic illiteracy. Regrettably, focused research on this problem did not catch on until the late 1980s and more so in the early 1990s. Several studies have been conducted correlating explanatory variables with geographic skills, such as age (Cross, 1987), prior education (Cross, 1987; Beatty 1989; Eve et al., 1994; Nolan, 2002), traveling experience (Cross, 1987; Beatty, 1989; Eve et al., 1994), and the most researched variable, gender (Beatty and Troster, 1987; Eve et al., 1994; Henrie et al., 1997; Nelson et al., 1999; Nolan, 2002).

Very few researchers have looked at the usefulness of standardized tests scores as a predictor of basic geographic knowledge (Henrie et al., 1997; Nelson et al., 1999). Standardized test scores, such as ACTs and SATs, come with two types of scores, a total average or composite score, and sub or component scores for each section of the test. The research that has been conducted using standardized test scores only used the former. The only exception is one study (Nelson et al., 1999) that used the ACT science component score. However the study only correlated this component score to overall geographic knowledge. There is no indication that any research has correlated individual standardized test component scores with corresponding components of geographic knowledge.
Problem Statement

In many elementary and secondary schools, geography has either been absorbed into social studies classes or been removed from the curriculum completely. However, introductory geography remains a staple in undergraduate general education curricula in many colleges and universities. Arguably, students are entering college underprepared for geography courses, and therefore existing higher education curricula in these introductory courses may not properly address possible deficiencies in geography skills. This research proposes to examine the utility of standardized achievement test scores (ACT/SAT) as a predictor of geography skills in an undergraduate population. The relationships between a student’s component scores on an accepted knowledge of geography test (KOG) and on a previously administered general achievement test will be explored. It is expected that results will indicate strong correlations between certain component scores on the standardized achievement test and component scores on the KOG test. A better understanding of the relationships between standardized test component scores and geographic knowledge component scores (1) will contribute to existing academic research in geographic literacy, (2) may provide enhanced opportunities for advising students with predicted abilities, and (3) potentially allow for modifications in existing introductory geography curricula to accommodate student populations that lack basic geography skills.
Overview of Methodology

This research will use several statistical approaches to test, measure and determine the validity and usefulness of the collected data. Specifically, this research will use three steps:

1) testing for sample bias,

2) determining validity and reliability of the KOG instrument,

3) and measuring the predictive validity of the KOG instrument.
CHAPTER II
LITERATURE REVIEW

Initial Growth of Geographic Education in the U.S.

Geography has a deep history within the U.S. educational system. Before the Civil War, geography was commonplace within U.S. schools. Geography was thought to be a part of a universal education, and schools became the place for children to learn “everything essential” as citizens (Douglass, 1998, p. 9).

Within higher education, geography departments and their respective courses, while relatively new compared to other disciplines such as English or philosophy, were widely established during the inter-war years of the twentieth century. Before 1920, only 16 geography departments existed in all American colleges and universities. By the end of the 1960s, the number exploded to 123 departments nationwide (AAG, 1996). The sudden increase in geography departments and courses were a direct result of war involvement, as training and teaching the military and civilian sectors of society became a major public policy issue (Douglass, 1998).
Decline of Geographic Education

Over the past century, geography has experienced a decreased role in many elementary and secondary schools’ curricula across the nation. Geography classes, by the request of the National Education Association (NEA) in 1913, were slowly absorbed into the progressive pedagogy of social studies (NCGE, 2003). This preferred teaching method combined several subject areas, including geography, history, economics, political science, anthropology and sociology, and eventually became devoid of geographic knowledge building.

The role of geography-based curricula within primary and especially secondary schools has become less significant than other subjects, especially those which are annually used for standardized testing such as English, math, or reading (Douglass, 1998). Even in other developed nations, such as Great Britain, geography has fallen by the wayside in most classrooms (Lambert and Balderstone, 2000).

After the initial expansion of geography in universities and colleges, many institutions of higher education witnessed a dwindling number of geography courses offered and number of trained professionals available. Many institutions, which had introduced geography departments during the World War eras, discontinued their efforts. Many other institutions, especially those deemed prestigious (i.e. Princeton, Yale, or MIT), did not develop geography programs (Dorschner and Marten, 1990). Due to this drop, a similar scenario was felt throughout the elementary and secondary educational
systems, as fewer and fewer teachers came into contact with the subject during their training (Eve et al., 1994).

Many states do not mandate separate geography courses in secondary schools. According to the National Center for Educational Statistics (NCES), in 2002 only five states required students to take a world geography class as part of their graduation requirements, and seven states gave students a choice between world geography and world history (Holloway, 2002). As a result, many students have their first experience with geography in an introductory course during their first or second year of undergraduate studies. This first, and typically only, attempt at geography coursework has been described as the most important time for capturing students’ interest in and understanding of the discipline (Jones, 2006). Unfortunately, interest in geography coursework has steadily dropped in recent years, indicated by the 12 percent slump in the number of college students graduating with a B.A. or B.S. degree in geography between 1993 and 2002 (Estaville et al., 2006a).

The National Assessment of Educational Progress (NAEP) has administered several assessments of geography proficiency. The first assessment was in 1994. From this study, it was reported that 30 percent of high school seniors who took the test achieved a proficient or advanced level (National Center for Education Statistics, 1996; McDaniels, 1997). The NAEP again tested geography proficiency in a 2001 assessment. However, this study found that only 24 percent of high school seniors reached proficient or advanced levels, while nearly 30 percent fell below even the basic knowledge level (National Center for Education Statistics, 2002; Kosar, 2005). It should be noted that the NAEP geography test has received some criticism due to the fact the test uses items that
can be evaluated for meeting predetermined levels of completeness instead of the standard multiple-choice and true-false questions. Put simply, the move to more subjective questioning (although this requires a higher level of thought process) from objective questioning complicated the NAEP evaluation process of geographic literacy (Douglass, 1998).

Resurgence of Geographic Education

The first major movement toward improving geographic teaching and learning came through the work of the Geography Education Standards Project in the early 1990s. This project was conceived after geography was included as one of the core subjects in ‘Goals 2000: Educate America Act.’ The project aimed at producing the first series of national geography standards for American students. The culminating report, Geography for Life: National Geography Standards (1994), set “voluntary benchmarks” for schools and school districts to use as guidelines for curriculum building (p. 9).

Although geography was not a part of the first No Child Left Behind (NCLB) legislation in 2002, a bill aimed at enhancing geographic literacy in students was introduced and passed by the U.S. Senate in the summer of 2005 (Hinde and Ekiss, 2005). The bill allocates funds for the purpose of “improving professional development” of all teachers through seminars and workshops (NCGE, 2006, p. 5). Unfortunately, as of December 2007, Congress shelved both this bill, along with the Teaching Geography is Fundamental (TGIF) bill, until 2008 (Crews, 2007).
For decades introductory courses in geography have fulfilled the general education elective requirements of social sciences, physical sciences, or non-Western cultures in many universities and colleges scattered across the country. Due to the recent interest in geographic illiteracy, an increased number of introductory geography courses are now offered in higher education (Brown, 1994). Over the past 15 years, studies have shown an increase in student numbers in geography courses, the expansion of existing departments, and the launch of numerous masters and doctoral programs (Murphy, 2007). For those universities and colleges lacking in funds for additional professors or course sections, the common response is an increase in class size in response to the growing numbers (Hardwick, 2001).

Several studies and reports to offer insight into how to improve introductory geography courses. Such studies have addressed teaching techniques and activities (Hertzog and Lieble, 1996; Fouberg, 2000; Oldakowski, 2001; Fournier, 2002), the management of large numbers of students (Brown 1989, 1994), skill-development seminars (Dyas and Bradley, 1999), and improving retention (Sommers, 1997; Estaville et al., 2006b).

Skills Assessment

Assessment of a student’s knowledge is not a recent phenomenon. It has been in constant use since the ancient schools of Greece and China. Historically, assessments have served the purpose of “sorting” or “ranking” students according to their success (Stiggins, 2007). Skill assessments or achievement tests act as a gauge of a student’s
progress relative to specified learning goals or standards (Cangelosi, 1990). There are two forms of skills assessment used within the educational sphere: general and discipline specific.

General skills tests, or standardized achievement tests, are those that broadly examine a wealth of subject matter across several fields of study. The most commonly used general skills tests include the ACT and SAT, the two widely-used college admissions tests in the United States. After the No Child Left Behind Act (2001) was signed into law, states were required to examine student achievement on a yearly basis, typically in the form of standardized tests, which also fall into the general skills test category (Lord, 2002). Standardized achievement tests are typically based on standardized conditions, idealized curriculum, or school district, state, and/or federal standards (Haladyna, 2002). These tests may vary in style (i.e. multiple-choice, essay format) and length (although many standardized achievement tests involve long periods of time for completion).

The ACT test has been used as an accepted college admissions test in the United States since 1959. The ACT test measures four distinctive tests or components, including English, mathematics, reading, and science. According to The ACT Technical Manual, the purpose of the exam is to “measure students’ academic readiness for college in key content areas” (ACT, 2006, p. 1). The scores reported from this exam intend to show what students are able to accomplish from their education, not a measure of intelligence or aptitude. While the ACT tests general educational achievement, it does not examine knowledge of specific course information (such as geography) because those types of tests do not provide a “common baseline” for comparing students from different
educational backgrounds and styles, and also fail to measure students’ problem-solving ability across a variety of disciplines (ACT, 2006, p. 3). In terms of geography concepts being tested in the ACT, the only portion of the test with some geography-related material is within the Science test, which partly examines “Earth science” (see Table 2.1).

<table>
<thead>
<tr>
<th>Test Component</th>
<th>Description of Measurement</th>
<th>Test Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>English</td>
<td>Measures understanding of the conventions of standard written English and rhetorical skills.</td>
<td>Punctuation; grammar and usage; sentence structure; strategy; organization; and style.</td>
</tr>
<tr>
<td>Math</td>
<td>Assesses the reasoning skills to solve practical mathematical problems.</td>
<td>Pre-algebra; elementary algebra; intermediate algebra; coordinate geometry; plane geometry; and trigonometry.</td>
</tr>
<tr>
<td>Reading</td>
<td>Measures reading comprehension as a product of skill in referring and reasoning.</td>
<td>Determine main ideas; locate and interpret significant details; understand sequences of events; make comparisons; comprehend cause-effect relationships; determine the meaning of context-dependent words, phrases, and statements; draw generalizations; and analyze the author’s or narrator’s voice or method.</td>
</tr>
<tr>
<td>Science</td>
<td>Measures the interpretation, analysis, evaluation, reasoning, and problem-solving skills required in the natural sciences.</td>
<td>Biology; chemistry; physics; and the Earth/space sciences.</td>
</tr>
</tbody>
</table>

Scores from this test are reported in two ways: component and composite. The component score on the test is the score attained on one of the particular parts of the exam, for example, the reading portion. A component score is given for each of the tested subjects. The composite score is the average of all the component scores. Typically, it is
the composite score that is of most interest to students, parents, educators and researchers, as this score gives an overall diagnosis of a student’s performance on the test.

The SAT test has been administered since 1926 and today examines three components, Critical Reading, Mathematics, and Writing (the writing portion was added in 2005). The purpose of the SAT, much like the ACT, is to assess a “student’s competence for college work” (Donlon, 1984, p. 37). Also like the ACT, the SAT claims to examine general knowledge instead of discipline-specific knowledge in order to obtain an independent measurement of problem-solving skills. As for specific testing of geographic knowledge, the SAT does not include a component that measures any type of geographic skill, although the verbal section does draw upon science for reading comprehension (Donlon, 1984, p. 47).

Both the ACT and SAT tests are offered to juniors and seniors in high school, and are typically administered in special testing places on specific dates in order to create a neutral testing environment for all students. The ACT and SAT tests are also known historically to accurately predict abilities and eventual college success (Donlon, 1984; ACT, 2006).

The other widely-used general skills tests are those used by individual states, typically as high school exit examinations or graduation tests (Haladyna, 2002). To date twenty-six states, including Ohio, require public high school students to pass an exit exam to be eligible for graduation. Ohio’s exit examination, the Ohio Graduation Test (OGT), claims to measure academic ability in areas of reading, writing, mathematics, science, and social studies. According to Ohio’s Department of Education, the OGT is
administered to make certain that students have the knowledge needed to be “successful in the workforce and higher education” (Ohio Academic Standards, 2005, p. 1). Studies have shown, however, that these types of tests do not predict college preparation or success as well as the ACT and SAT tests do (Davis, 2007).

Standardized achievement tests have been administered in the United States for almost a century. However, from their inception, these tests have come under constant scrutiny because of the “focus on testing declarative knowledge” instead of testing higher level thinking and problem solving skills, which most educators believe is the primary focus of mass education (Haladyna, 2002, p. 86). Despite the criticism, the results of these and all skill assessments indicate the level of scholastic achievement, encouraging some scholars to write that these assessments should be used to build public confidence in the educational system, not induce them to condemn it (Bednarz et al., 1999).

The other form of skills assessment typically utilized is a discipline specific test. These tests, while still standardized in most situations, give a better examination of explicit subject matter. Many school districts use these types of tests to identify certain deficiencies in a particular subject area in order to “prescribe remedial instruction” (Haladyna, 2002, p. 93). Historically, the most popular types of discipline specific tests have been reading or mathematics tests (Cangelosi, 1990).

In terms of geography-specific standardized tests, very few are in existence and even fewer are utilized. Only four matches were found on the Educational Testing Services’ (www.ets.org) test collection database. All four matches were from the same testing program employed by the U.S. Department of Defense (known as DANTES). Other standardized geography tests have been developed. The National Council for
Geographic Education (NCGE) published the “Competency-Based Geography Test” for secondary-level students in 1983.

More recently, a standardized geography test was developed for the AP Human Geography (APHG) class offered to high school students. Since its first run in 2000-2001, APHG has grown more than 10 percent annually until present, and over 10,000 students take the course’s standardized exam every year (Bailey, 2006). Bailey reports, however, despite the recent success of APHG within the AP subjects, it still has a relatively “low profile within the discipline of geography” (p. 70).

Geography-specific tests have also been created for conducting studies to discern certain predictors of geography skills in students. Eve et al. (1994) developed the first in a series of knowledge of geography (KOG) tests for college students. This test consisted of 50 multiple-choice questions that assessed geographic knowledge in four separate categories, including location of major geographic entities, cultural geography, location of political units, and names of constructed landmarks (i.e. Stonehenge). A questionnaire was also included in the study to collect basic demographic information, as well as other details considered to be important variables that would affect geographic knowledge. The study showed particularly high correlations between academic success and high scores on the KOG test. The authors also found that the best correlations came with race, age and gender, with the latter being the strongest predictor of geographic skills.

Subsequent studies further expanded and modified this original KOG test. Henrie et al. (1997) revisited the connection between gender and geographical knowledge. They took the original KOG test and revised it into a reliable instrument by constructing 60 intermediate level questions that accurately measured students’ knowledge in each of the
four subfields. They altered the subfields slightly from the Eve et al. (1994) test by sorting questions into the geographic fields of physical, human, regional, and map skills. This study included a similar background questionnaire to the first study; however, the authors included an additional question asking students for their ACT composite scores. From the results, the authors reported that after gender (again, the primary focus of their study), the single best predictor of geographic skills was ACT scores.

Nelson et al. (1999) followed up with an additional study, again focusing on the importance gender plays in predicting geographic skills. Although an exact replica of the KOG test developed by Henrie et al. was used in this study, students were not asked to report as many demographic details as previous students had. Only age, gender, major, class level (i.e. freshman, sophomore, etc.), and ACT composite scores. To keep confidentiality between the students and the researchers, ACT scores were acquired by a nongeographer through the university’s student information database, and combined with corresponding (although nameless) answer sheets. Again, results suggested that the ACT composite score had a positive correlation with the KOG test scores. This study also examined the ACT science component score, which was positively correlated with the overall score on the KOG test. The results suggested that the ACT composite score was still the best predictor of KOG test scores (besides gender), although the science score also had a positive correlation. From these results, the authors argued that “general knowledge was a better predictor of performance than background knowledge within a particular . . . domain” (p. 535).

Since the publication of these studies, there has not been an adequate supply of literature that further explains the ability to predict geographic knowledge/skills from
existing variables, especially standardized test scores. What is even more surprising is the total absence of any literature exploring correlations between the component scores of standardized achievement tests (i.e. English, mathematics, etc.) and the KOG test’s component scores (i.e. physical, cultural, etc.).

Although there has been an obvious lack in research and publication, there are scholars who are calling for these types of studies (Downs et al., 1988; Bailey, 2006). With the exodus of geographic curriculum from schools, Bailey argues for research that would establish what kinds of skills and content knowledge professional geographers find advantageous for college students, especially those in their first year. If component scores of standardized tests can be found to be a good predictor of different types of geographic skills, this would be a step toward answering this call.
CHAPTER III
METHODOLOGY

Methodology Summary

The KOG survey was administered to 215 students enrolled in seven sections of Introduction to Geography at the University of Akron, a publicly assisted urban university with an undergraduate full-time enrollment of about 24,000 students. These seven sections were selected randomly from ten sections total (except those sections that met after 5 p.m. or those sections that did not meet on the University of Akron’s main campus). To avoid treatment affect (gained geographic knowledge prior to the administration of the KOG survey), the administration took place during the first week of class during the spring semester of 2008. A whole class period was used to administer the KOG.

Specific instructions (Appendix A) were given to the students on how to complete the informed consent form (Appendix B), the questionnaire (Appendix C), and the KOG survey (Appendix D). The participants were asked to read through and then sign and date the consent form. After they had signed the consent form, they proceeded to fill out the questionnaire, using their student identification number as the only source of identification. After they completed the questionnaire, students could move on to the
KOG survey. They answered the survey using a bubble answer sheet, on which they also included their student identification number.

After the completion of the survey, the KOG answer sheets were scored using university testing services. The answers given on the questionnaire were coded by the researcher and the data collected were added to the KOG answers into a database. Other independent variables (including age, gender, ACT scores, and total credit hours) were collected from the university’s student information system and entered into the same database.

When the database was completed, an elimination process commenced to remove students from the pool of participants. Students were removed if they failed to meet any of the following qualifiers: (1) students needed to have taken the ACT college entrance exam, (2) students needed to be under the age of 21, and (3) students needed to have less than 64 credit hours completed. The second and third criteria were used to achieve portions of the KOG’s internal validity (discussed later). After this elimination process, there were 113 participants who met all of the criteria for inclusion in this study.

Once the database was narrowed to 113 observations, several multiple regression models were run in order to determine whether any of the independent variables (Table 3.1) were found to have statistically significant positive correlations with the dependent variables (the KOG component and composite scores). The independent variables included in these regression models were selected based upon their use in similar studies described in the literature review.
Table 3.1
Independent Variables to be Examined

<table>
<thead>
<tr>
<th>Independent Variable</th>
<th>Description</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>Current age of participant.</td>
<td>Student Info. System</td>
</tr>
<tr>
<td>Gender</td>
<td>Gender of participant.</td>
<td>Student Info. System</td>
</tr>
<tr>
<td>Credit Hours</td>
<td>The total number of credit hours accumulated.</td>
<td>Student Info. System</td>
</tr>
<tr>
<td>ACT Sub-scores</td>
<td>Component scores for the ACT.</td>
<td>Student Info. System</td>
</tr>
<tr>
<td>Mother’s Education</td>
<td>Highest level of education completed.</td>
<td>Reported by Student</td>
</tr>
<tr>
<td>Father’s Education</td>
<td>Highest level of education completed.</td>
<td>Reported by Student</td>
</tr>
<tr>
<td>Reading</td>
<td>Number of books read in the past year (not textbooks).</td>
<td>Reported by Student</td>
</tr>
<tr>
<td>Travel</td>
<td>Number of countries visited outside the U.S.</td>
<td>Reported by Student</td>
</tr>
<tr>
<td>Language</td>
<td>Number of languages spoken.</td>
<td>Reported by Student</td>
</tr>
</tbody>
</table>

Before the regression models were processed, the KOG was analyzed for validity and reliability. Some of the users of the KOG (Henrie et al., 1997; Nelson et al., 1999) previously tested for validity and reliability. Their tests of validity and reliability on the KOG ensured them that they had an instrument that used questions that “would be an accurate measure of students’ general knowledge within each subfield” (Henrie et al., 1997, p. 608). Although the KOG had already been processed with tests of validity and reliability, the study group used in this research was different from previous studies, and therefore the KOG needed to be reassessed within this new setting before running the regression models.
Instrument

The measuring instrument (Appendix D) selected for this research was the Knowledge of Geography (KOG) test as used by Nelson et al. (1999). The instrument was obtained through personal communication with one of the original authors (D. Poole, personal communication, September 12, 2007). The KOG test examines four areas of geographic knowledge: physical geography, cultural geography, regional geography, and map skills. Each section or component contains 15 multiple choice questions, examining both declarative and procedural knowledge. Declarative knowledge, or descriptive knowledge, is knowing “that” (e.g. that Columbus is the capital of Ohio), whereas procedural knowledge is knowing “how” (e.g. how to read a map).

Data Sources

In addition to data collected from the KOG instrument itself, two additional data sources were used. The first was a supplemental questionnaire (Appendix C) that will obtain general information about student educational background, interests, and experiences. These data were used as control variables for the study. Although the variables were measured using a nominal scale (or categorically), the categories they measured were different from one another on in an interval scale. For example, when asking students about a parent’s educational background, the order in which the available options appeared was in a chronological or ordinal order (i.e. some high school, high
school, associates, bachelors, etc.). The variables therefore were coded in numerical order and included in the regression models. Refer to the appendix to view how each question was coded.

The second source of data is from the University of Akron student information system. This system provided basic demographic information, such as age and gender, as well as ACT composite and component scores. Data from the KOG and the supplemental questionnaire were combined with ACT scores from the student information system. All identifying information was removed before the scores and student information were returned to the researcher in order to ensure student confidentiality.

The ACT is one of two widely administered general aptitude tests. The other is the SAT. Only ACT component and composite scores were used in this study for several reasons. First, certain obstacles exist when attempting to convert one type of test score to another, especially as the two tests (ACT and SAT) are scored on different scales. Second, although both tests have similar component tests, they ultimately are dissimilar in their measurement and reporting. Most importantly, the ACT is the dominant standardized test taken in the state of Ohio (ACT, 2007). Over 95 percent of the university’s student body is from the state of Ohio. Therefore, it was expected that the majority of the undergraduate population had taken the ACT exam.

Testing for Sample Bias

Data sources were explored for sample bias to determine whether the sample group was representative of University of Akron undergraduates as a whole. Sample bias
refers to the systematic exclusion of a population within a specific study group or area. The one-sample difference of means test was used to test for sample bias. This test was used because it compares the mean of a single sample mean with the mean of an entire population (McGrew and Monroe, 2000).

\[ \text{Example} - H_0: \text{Sample}_{ACT} = \text{UA}_{ACT} \]

The results of this test aimed to answer the question: Is the mean ACT score of the sample group significantly different from the mean ACT score of the student body as a whole? The one-sample difference of means test was evaluated for the composite ACT score only because it was available data. Sample bias was not tested for other variables such as age or gender. The average age of the potential sample group will most likely represent students taking general education courses (typically those students in their first or second year), and the university does not specifically report an average age of students enrolled in general education courses. Gender, like age, would also be representative of general education courses, and not of the entire undergraduate student body.

Measuring the Predictive Validity of the KOG Instrument

To establish whether the KOG test could be used as a measure of prediction, this research assessed the predictive validity of the instrument. Predictive validity measures the accuracy with which an early test, in this case ACT scores, can be used to estimate criterion scores, in this research, KOG scores (APA, 1985; Ardovino et al., 2000). In order to conduct predictive validity, regression analysis was used. Regression analysis
examines the relationship of a dependent variable with multiple independent variables (Kahane, 2001).

Two regression models were analyzed (Figure 3.1). The first regression model explored the relationship of the independent variables (Table 3.1) to each of the four KOG test component scores. The second regression model explored the relationship of the independent variables to the KOG test composite score. In order to verify that the underlying assumptions of regression analysis had not been violated, the statistical distribution of dependent and independent variables were explored.

Several assumptions are made when using an ordinary least squares (OLS) multiple linear regression analysis. The first assumption is that the data are normally distributed. The second assumption is that independent variables are not highly correlated. As part of the analysis, violation of the normality and multicolinearity assumptions were tested. Multicolinearity was tested using the variance inflation factor or VIF (Chatterjee and Price, 1977).

Colinearity means that within a group of independent variables, some of the independent variables are to some degree predicted by other independent variables (for example, increased education in parents may influence the amount of reading their child does). If independent variables are collinear, their $\beta$ values will be calculated less accurately. The VIF is an index that measures how much the variance of a coefficient is increased because of colinearity.
Model 1: \( KOG = \beta_1 \text{Age} + \beta_2 \text{CreditHours} + \beta_3 \text{ACT(English)} + \beta_4 \text{ACT(Math)} + \beta_5 \text{ACT(Reading)} + \beta_6 \text{ACT(Science)} + \beta_7 \text{Mother’sEducation} + \beta_8 \text{Father’sEducation} + \beta_9 \text{ReadingHabits} + \beta_{10} \text{Traveling} + \beta_{11} \text{Languages} \)

Model 2: \( \text{Physical} = \beta_1 \text{Age} + \beta_2 \text{CreditHours} + \beta_3 \text{ACT(English)} + \beta_4 \text{ACT(Math)} + \beta_5 \text{ACT(Reading)} + \beta_6 \text{ACT(Science)} + \beta_7 \text{Mother’sEducation} + \beta_8 \text{Father’sEducation} + \beta_9 \text{ReadingHabits} + \beta_{10} \text{Traveling} + \beta_{11} \text{Languages} \)

Model 3: \( \text{Regional} = \beta_1 \text{Age} + \beta_2 \text{CreditHours} + \beta_3 \text{ACT(English)} + \beta_4 \text{ACT(Math)} + \beta_5 \text{ACT(Reading)} + \beta_6 \text{ACT(Science)} + \beta_7 \text{Mother’sEducation} + \beta_8 \text{Father’sEducation} + \beta_9 \text{ReadingHabits} + \beta_{10} \text{Traveling} + \beta_{11} \text{Languages} \)

Model 4: \( \text{Map Skills} = \beta_1 \text{Age} + \beta_2 \text{CreditHours} + \beta_3 \text{ACT(English)} + \beta_4 \text{ACT(Math)} + \beta_5 \text{ACT(Reading)} + \beta_6 \text{ACT(Science)} + \beta_7 \text{Mother’sEducation} + \beta_8 \text{Father’sEducation} + \beta_9 \text{ReadingHabits} + \beta_{10} \text{Traveling} + \beta_{11} \text{Languages} \)

Model 5: \( \text{Cultural} = \beta_1 \text{Age} + \beta_2 \text{CreditHours} + \beta_3 \text{ACT(English)} + \beta_4 \text{ACT(Math)} + \beta_5 \text{ACT(Reading)} + \beta_6 \text{ACT(Science)} + \beta_7 \text{Mother’sEducation} + \beta_8 \text{Father’sEducation} + \beta_9 \text{ReadingHabits} + \beta_{10} \text{Traveling} + \beta_{11} \text{Languages} \)

Figure 3.1 - Linear Regression Models for the KOG and Respective Sections
\[
VIF_k = \frac{1}{1 - R^2_k}
\]

In this equation, \( R^2_k \) is the multiple correlation coefficient. Variance inflation factors are often given as a reciprocal. If \( R^2_k \) equals zero (i.e. no correlation between \( R^2_k \) and the remaining independent variables), then \( VIF_k \) equals one, the minimum value of VIF. It is recommended looking at the largest VIF value produced (Neter et al., 1990). A value greater than 10 is a sign of possible multi-collinearity problems. If variables were found to be colinear, one of the like variables were excluded from the study (at the discretion of the researcher) to ensure that no basic assumptions of the regression model were violated.

It has been stated repeatedly in the literature that gender is by far the best predictor of geographic knowledge (Beatty and Troster, 1987; Eve et al., 1994; Henrie et al., 1997; Nelson et al., 1999). However, the focus of this study was not gender issues, and although it was initially going to be used in the regression models, gender was removed from the analysis in order to explore other predictors of geographic knowledge and skill.

This study also removed another variable that was initially going to be used in the regression models. The ACT composite score has previously been used in studies using the KOG as a predictive variable (Henrie et al., 1997; Nelson et al., 1999). The present research was strictly focused on ascertaining the relationship between the components of the ACT and the components of the KOG, and no additional study was necessary for the ACT composite score.
Determining Validity and Reliability of the KOG Instrument

Studies are only valid if they measure what they claim to measure, and avoid underlying bias or selectivity (Kubiszyn and Borich, 1996). Studies that use instruments which are proven to have validity, draw conclusions that are more accurate from the collected data. In previous studies, the KOG instrument was tested for validity and reliability. However, the previous studies using the KOG instrument were used in different research contexts. For example, previous studies were conducted in non-urban areas. The KOG instrument was re-evaluated for validity and reliability with a new study group.

In order to determine the reliability of the KOG, several tests of validity were administered. The usefulness of each validity estimate depended on both the strength of the validity coefficient and the type of validity being determined (Kubiszyn and Borich, 1996). There are four basic tests of validity that were utilized in this research: construct validity (both convergent and discriminant), content validity, and internal validity, and predictive validity (Figure 3.2).

Construct Validity

Construct validity is concerned with defining the constructs of the instrument, how they relate to other variables, and if the instrument correctly measures the constructs (or concepts) that are to be measured (APA, 1985). For example, loss of appetite is a sign
of depression. However, loss of appetite may also be a sign of fear or falling in love. Therefore, loss of appetite identifies depression only when it is found in association with other signs of depression. In the context of the KOG, each of the four domains of the test – physical, cultural, regional and map skills – was considered a construct. Two validity tests were conducted to determine construct validity.

**Figure 3.2 – Types of Validity and Respective Tests of Validity (Summarized from APA, 1985, 9-13)**

*Convergent Validity*

The first is convergent validity, which correlates items being measured to prove internal consistency and ensures that the items are measuring a single construct. Each of
the four constructs of the KOG are measured by 15 items. Performance across these 15 items should be similar if they are measuring the same construct (Figure 3.3). To establish internal consistency, Cronbach’s alpha (Figure 3.4) was calculated for each of the constructs in the KOG. According to the literature, to obtain an adequate convergent validity, Cronbach’s alpha should be 0.7 or higher. However, typical cutoff values found in the literature to determine construct validity can vary, for example, lower than 0.60 can still be considered acceptable (Nunnaly, 1978).

![Diagram of Construct Validity](image)

**Figure 3.3 - Diagram of Construct Validity.** Performance on these items should correlate if they are measuring the same construct. (Summarized from APA, 1985)

\[
\frac{N}{N - 1} \left( \frac{\sigma_X^2 - \sum_{i=1}^{N} \sigma_{Y_i}^2}{\sigma_X^2} \right)
\]

**Figure 3.4 – Cronbach’s Alpha** (Bollen, 1989, 215)
After running the analysis, Cronbach’s Alpha suggested that three of the four constructs fell above the cutoff range of 0.6 (Table 3.2), making them acceptable for use. The regional geography portion of the KOG was the only construct that fell under the cutoff of 0.6. However, regional geography also measures knowledge from several fields of geography, so the result was not unexpected, as the relationship between regional geography and the other three constructs have a strong disciplinary connection.

<table>
<thead>
<tr>
<th>Construct</th>
<th>Cronbach’s Alpha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical</td>
<td>0.623</td>
</tr>
<tr>
<td>Regional</td>
<td>0.511</td>
</tr>
<tr>
<td>Map Skills</td>
<td>0.749</td>
</tr>
<tr>
<td>Cultural</td>
<td>0.690</td>
</tr>
</tbody>
</table>

Discriminant Validity

The second construct validity test measured discriminant validity. Discriminant validity indicates whether there was enough distinction between those constructs being measured (APA, 1985). A successful discriminant validation would show items from one construct not to be highly correlated with items in the other constructs. To establish discriminant validity, correlational methods were used. Correlational methods measure the likelihood of two constructs relating to one another. This research used the correlational method of Kendall’s tau to measure discriminant validity because it is a highly useful measure of association between variables and it has a very simple interpretation (Cliff and Charlin, 1991). It is most useful when “one is trying to be as informal as possible” and “where the investigator is interested in assessing the degree of
association” between ordinal data, in this case the list of items (or questions) in the KOG (Cliff and Charlin, 1991, p. 693). Kendall’s tau is also a rather robust measurement that is not extremely sensitive to a wide variety of values.

The results from Kendall’s Tau-b produced several interpretations (Tables 3.3 – 3.6). The first is the clear split between physical geography and all of the other constructs in the discipline. It is also should be noted that map skills show the least discrimination among constructs. This indicates that although maps themselves are a key instrument in geography, they are only representations of other constructs, whether it is the physical or cultural geography.

These results are not ideal. Ideal results would find all of the questions only relating to their respective constructs. However, these results do raise a point about the integrative nature of geography as a discipline. In most cases, one would want and expect Kendall’s Tau-b to show significant boundaries among the constructs of a test. However, geography has always crossed the boundaries within its own subfields, regardless of the topic or concept. Geography is a subject that draws its identity from the numerous subfields that build the discipline. It should not be surprising that the results indicated that there were numerous questions that related to more than one of the different constructs being measured.
Table 3.3
Physical Geography Questions - Discriminant Validity using Kendall's Tau-b

<table>
<thead>
<tr>
<th>Question #</th>
<th>Physical</th>
<th>Regional</th>
<th>Map Skills</th>
<th>Cultural</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.223**</td>
<td>-0.004</td>
<td>0.067</td>
<td>-0.004</td>
</tr>
<tr>
<td>2</td>
<td>0.280**</td>
<td>0.084</td>
<td>0.170*</td>
<td>0.191*</td>
</tr>
<tr>
<td>3</td>
<td>0.334**</td>
<td>0.067</td>
<td>0.156</td>
<td>0.099</td>
</tr>
<tr>
<td>4</td>
<td>0.203*</td>
<td>0.132</td>
<td>0.084</td>
<td>0.024</td>
</tr>
<tr>
<td>5</td>
<td>0.367**</td>
<td>0.170*</td>
<td>0.215**</td>
<td>0.179*</td>
</tr>
<tr>
<td>6</td>
<td>0.251**</td>
<td>0.043</td>
<td>0.012</td>
<td>0.124</td>
</tr>
<tr>
<td>7</td>
<td>0.205*</td>
<td>0.105</td>
<td>0.154</td>
<td>0.095</td>
</tr>
<tr>
<td>8</td>
<td>0.166*</td>
<td>-0.015</td>
<td>-0.025</td>
<td>-0.020</td>
</tr>
<tr>
<td>9</td>
<td>0.461**</td>
<td>0.308**</td>
<td>0.351**</td>
<td>0.290**</td>
</tr>
<tr>
<td>10</td>
<td>0.498**</td>
<td>0.386**</td>
<td>0.342**</td>
<td>0.377**</td>
</tr>
<tr>
<td>11</td>
<td>0.455**</td>
<td>0.125</td>
<td>0.134</td>
<td>0.229**</td>
</tr>
<tr>
<td>12</td>
<td>0.483**</td>
<td>0.362**</td>
<td>0.414**</td>
<td>0.325**</td>
</tr>
<tr>
<td>13</td>
<td>0.433**</td>
<td>0.358**</td>
<td>0.310**</td>
<td>0.341**</td>
</tr>
<tr>
<td>14</td>
<td>0.313**</td>
<td>0.205*</td>
<td>0.210**</td>
<td>0.153</td>
</tr>
<tr>
<td>15</td>
<td>0.370**</td>
<td>0.360**</td>
<td>0.302**</td>
<td>0.294**</td>
</tr>
</tbody>
</table>

*. Correlation is significant at the 0.05 level (2-tailed).
**. Correlation is significant at the 0.01 level (2-tailed).

Table 3.4
Regional Geography Questions - Discriminant Validity using Kendall's Tau-b

<table>
<thead>
<tr>
<th>Question #</th>
<th>Physical</th>
<th>Regional</th>
<th>Map Skills</th>
<th>Cultural</th>
</tr>
</thead>
<tbody>
<tr>
<td>16</td>
<td>0.264**</td>
<td>0.236**</td>
<td>0.221**</td>
<td>0.162*</td>
</tr>
<tr>
<td>17</td>
<td>0.098</td>
<td>0.314**</td>
<td>0.200*</td>
<td>0.211**</td>
</tr>
<tr>
<td>18</td>
<td>-0.044</td>
<td>0.264**</td>
<td>0.192*</td>
<td>0.184*</td>
</tr>
<tr>
<td>19</td>
<td>0.241**</td>
<td>0.403**</td>
<td>0.292**</td>
<td>0.356**</td>
</tr>
<tr>
<td>20</td>
<td>0.126</td>
<td>0.203*</td>
<td>0.058</td>
<td>0.079</td>
</tr>
<tr>
<td>21</td>
<td>0.059</td>
<td>0.363**</td>
<td>0.129</td>
<td>0.047</td>
</tr>
<tr>
<td>22</td>
<td>0.331**</td>
<td>0.329**</td>
<td>0.367**</td>
<td>0.312**</td>
</tr>
<tr>
<td>23</td>
<td>0.148</td>
<td>0.335**</td>
<td>0.269**</td>
<td>0.260**</td>
</tr>
<tr>
<td>24</td>
<td>0.173*</td>
<td>0.275**</td>
<td>0.203*</td>
<td>0.189*</td>
</tr>
<tr>
<td>25</td>
<td>0.089</td>
<td>0.266**</td>
<td>0.093</td>
<td>0.082</td>
</tr>
<tr>
<td>26</td>
<td>0.352**</td>
<td>0.262**</td>
<td>0.306**</td>
<td>0.329**</td>
</tr>
<tr>
<td>27</td>
<td>0.165*</td>
<td>0.362**</td>
<td>0.273**</td>
<td>0.369**</td>
</tr>
<tr>
<td>28</td>
<td>0.278**</td>
<td>0.442**</td>
<td>0.426**</td>
<td>0.429**</td>
</tr>
<tr>
<td>29</td>
<td>0.292**</td>
<td>0.246**</td>
<td>0.138</td>
<td>0.120</td>
</tr>
<tr>
<td>30</td>
<td>-0.033</td>
<td>0.240**</td>
<td>0.104</td>
<td>-0.026</td>
</tr>
</tbody>
</table>

*. Correlation is significant at the 0.05 level (2-tailed).
**. Correlation is significant at the 0.01 level (2-tailed).
Table 3.5
Map Skills Questions - Discriminant Validity using Kendall's Tau-b

<table>
<thead>
<tr>
<th>Question #</th>
<th>Physical</th>
<th>Regional</th>
<th>Map Skills</th>
<th>Cultural</th>
</tr>
</thead>
<tbody>
<tr>
<td>31</td>
<td>0.165*</td>
<td>0.182*</td>
<td>0.315**</td>
<td>0.201*</td>
</tr>
<tr>
<td>32</td>
<td>0.214**</td>
<td>0.245**</td>
<td>0.380**</td>
<td>0.173*</td>
</tr>
<tr>
<td>33</td>
<td>0.375**</td>
<td>0.373**</td>
<td>0.402**</td>
<td>0.334**</td>
</tr>
<tr>
<td>34</td>
<td>0.161*</td>
<td>0.301**</td>
<td>0.320**</td>
<td>0.168*</td>
</tr>
<tr>
<td>35</td>
<td>0.257**</td>
<td>0.293**</td>
<td>0.347**</td>
<td>0.179*</td>
</tr>
<tr>
<td>36</td>
<td>0.086</td>
<td>0.176*</td>
<td>0.327**</td>
<td>0.219**</td>
</tr>
<tr>
<td>37</td>
<td>0.250**</td>
<td>0.338**</td>
<td>0.411**</td>
<td>0.254**</td>
</tr>
<tr>
<td>38</td>
<td>0.129</td>
<td>0.307**</td>
<td>0.352**</td>
<td>0.256**</td>
</tr>
<tr>
<td>39</td>
<td>0.327**</td>
<td>0.264**</td>
<td>0.418**</td>
<td>0.249**</td>
</tr>
<tr>
<td>40</td>
<td>0.141</td>
<td>0.376**</td>
<td>0.461**</td>
<td>0.328**</td>
</tr>
<tr>
<td>41</td>
<td>0.267**</td>
<td>0.367**</td>
<td>0.450**</td>
<td>0.349**</td>
</tr>
<tr>
<td>42</td>
<td>0.134</td>
<td>0.171*</td>
<td>0.270**</td>
<td>0.032</td>
</tr>
<tr>
<td>43</td>
<td>0.306**</td>
<td>0.332**</td>
<td>0.547**</td>
<td>0.325**</td>
</tr>
<tr>
<td>44</td>
<td>0.338**</td>
<td>0.260**</td>
<td>0.458**</td>
<td>0.281**</td>
</tr>
<tr>
<td>45</td>
<td>0.226**</td>
<td>0.198*</td>
<td>0.397**</td>
<td>0.182*</td>
</tr>
</tbody>
</table>

*. Correlation is significant at the 0.05 level (2-tailed).
**. Correlation is significant at the 0.01 level (2-tailed).

Table 3.6
Cultural Geography Questions - Discriminant Validity using Kendall's Tau-b

<table>
<thead>
<tr>
<th>Question #</th>
<th>Physical</th>
<th>Regional</th>
<th>Map Skills</th>
<th>Cultural</th>
</tr>
</thead>
<tbody>
<tr>
<td>46</td>
<td>0.188*</td>
<td>0.133</td>
<td>0.209**</td>
<td>0.196*</td>
</tr>
<tr>
<td>47</td>
<td>0.207*</td>
<td>0.240**</td>
<td>0.239**</td>
<td>0.388**</td>
</tr>
<tr>
<td>48</td>
<td>0.285**</td>
<td>0.347**</td>
<td>0.251**</td>
<td>0.427**</td>
</tr>
<tr>
<td>49</td>
<td>0.084</td>
<td>0.200*</td>
<td>0.170*</td>
<td>0.384**</td>
</tr>
<tr>
<td>50</td>
<td>0.226**</td>
<td>0.211**</td>
<td>0.216**</td>
<td>0.372**</td>
</tr>
<tr>
<td>51</td>
<td>0.364**</td>
<td>0.432**</td>
<td>0.363**</td>
<td>0.430**</td>
</tr>
<tr>
<td>52</td>
<td>-0.006</td>
<td>0.092</td>
<td>0.090</td>
<td>0.202*</td>
</tr>
<tr>
<td>53</td>
<td>0.116</td>
<td>0.206*</td>
<td>0.074</td>
<td>0.280**</td>
</tr>
<tr>
<td>54</td>
<td>0.258**</td>
<td>0.335**</td>
<td>0.327**</td>
<td>0.510**</td>
</tr>
<tr>
<td>55</td>
<td>0.188*</td>
<td>0.146</td>
<td>0.150</td>
<td>0.264**</td>
</tr>
<tr>
<td>56</td>
<td>0.309**</td>
<td>0.409**</td>
<td>0.371**</td>
<td>0.557**</td>
</tr>
<tr>
<td>57</td>
<td>0.193*</td>
<td>0.328**</td>
<td>0.220**</td>
<td>0.491**</td>
</tr>
<tr>
<td>58</td>
<td>0.057</td>
<td>0.243**</td>
<td>0.240**</td>
<td>0.235**</td>
</tr>
<tr>
<td>59</td>
<td>0.254**</td>
<td>0.151</td>
<td>0.086</td>
<td>0.366**</td>
</tr>
<tr>
<td>60</td>
<td>0.464**</td>
<td>0.269**</td>
<td>0.364**</td>
<td>0.368**</td>
</tr>
</tbody>
</table>

*. Correlation is significant at the 0.05 level (2-tailed).
**. Correlation is significant at the 0.01 level (2-tailed).
Content Validity

Content validity, also referred to as face validity, demonstrates how well items being measured are within a “defined universe or domain of content” (APA, 1985, 10). Simply put, do measured items (questions) within each construct relate to accepted concepts? To support content validity, I assessed each section of the KOG to specific geographic standards set by two organizations: the National Assessment of Educational Progress’ geography framework (NAEP, 2001) and the National Geography Standards (1994). Specifically, the analysis determined that the concepts measured on the KOG instrument, such as the physical or cultural sections, did relate to the accepted concepts established by these recognized organizations.

Internal Validity

Internal validity indicates whether certain biases were included within the study (APA, 1985). If there was bias in the study, variables other than those cited as independent or predictor variables may be responsible for some, or even all, of the observed results of the dependent variable, the KOG test scores. Types of internal validity that were explored are indicated in Table 3.7. Although there were small and unavoidable biases included in the research, the impact these biases on the overall study are minimal.

To evade the Hawthorne effect, or researcher bias, sections used in this study were selected randomly from all of the offered sections of Introduction to Geography. In
addition, students completed the test in a neutral environment that did not contain any windows or other distracting features. The researcher did not make any comments concerning the expectations of the participants, apart from expecting them to complete the test to the best of their knowledge and ability. Therefore, the risk of the Hawthorne effect was quite low.

In order to avoid evaluation apprehension, several steps were taken to alleviate the natural anxiety people have with assessment of their knowledge. Students were introduced to the research process in a non-threatening way. They were reminded several times that their participation was strictly voluntary and that the test would in no way influence their grade in the course. In addition, participants were told their professor would not be made aware of the results and that their identity would be kept confidential.

The effect of recent instrument change was also taken into consideration for internal validity. Unlike the SAT examination, which recently was altered in the way it is scored (Dorans, 2002), the ACT examination has not recently been normalized for its scoring or its content (ACT, 2007). In addition, the KOG has not altered since it was used by Henrie et al. (1997), and was not altered for its use in this research. This consistency in testing from the ACT and the KOG allowed this research to confidently use these tests as reliable sources of information.

Originally there were two steps that were going to be taken to mitigate maturation or intervening events: the age of ACT scores and the number of credit hours. Unfortunately, the age of the ACT scores was not supplied by the university’s student information database. Instead, the student’s age was utilized. Only those students who
were under the age of 21 were applicable to the study. Also, only those students with less than 64 credit hours completed were used.

### Table 3.7

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
<th>Steps to Assess/Mitigate Inhibitors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hawthorne Effect</td>
<td>Do expectations or actions of the researcher contaminate the outcome?</td>
<td>A low risk of Hawthorne effect exists as sections were chosen randomly and testing will be conducted in a neutral environment.</td>
</tr>
<tr>
<td>Evaluation Apprehension</td>
<td>Does the phrasing of questions or other steps taken by the researcher suffice to alleviate the natural apprehension people have about evaluations of their knowledge?</td>
<td>Alleviated through several factors: test is not for a grade; researcher is not the students’ teacher; introductory language before test is non-threatening.</td>
</tr>
<tr>
<td>Instrumentation Change</td>
<td>Are variables measured in the same way in previous testing and present testing?</td>
<td>Unlike the recent SAT normalization, the ACT has not been altered in test content or scoring scale in the last five years.</td>
</tr>
<tr>
<td>Intervening Events or Maturation</td>
<td>Are invalid inferences made about the maturation or experience of the study group between the previous testing and present testing which would affect results?</td>
<td>If age of ACT scores is greater than three years, they were deleted as an outlier. In addition, if the number of credit hours exceeds 64, these samples were deleted as well.</td>
</tr>
</tbody>
</table>
CHAPTER IV
RESULTS AND DISCUSSION

Sample Bias

To test whether sample bias had occurred, the average ACT composite scores obtained from participants in the study was compared to the entire university’s average ACT composite score. A one-sample difference of means test revealed that the average ACT composite score for the participants in the study (M = 21.28, SD = 4.431) was not significantly different (T[112] = 1.639, p = 0.104) from the university’s average ACT composite score of 20.6. These results suggest that the study group used in this research was representative of the university and that the mean ACT composite score did not differ significantly between the study group and the broader university population.

Distribution of Results

To determine whether the continuous variables’ data were normally distributed, they were analyzed twofold, once statistically measuring the coefficients of skewness and
kurtosis (Table 4.1) and once graphically against a normal curve (Figures 4.1 and 4.2).

The skewness coefficient (SC) was calculated by dividing the skewness (the measure of asymmetry) by the standard error of skewness (Rogerson, 2006). Likewise, the kurtosis coefficient (KC) was calculated by dividing the kurtosis (the measure of “peakedness”) by the standard error of kurtosis (Rogerson, 2006). The normality limit for both the SC and KC is found between -2 and +2.

### Table 4.1

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Skewness Coefficient</th>
<th>Kurtosis Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Credit Hours</td>
<td>18.05</td>
<td>13.950</td>
<td>6.069</td>
<td>2.825</td>
</tr>
<tr>
<td>ACT – English Score</td>
<td>20.49</td>
<td>5.244</td>
<td>0.917</td>
<td>-0.506</td>
</tr>
<tr>
<td>ACT – Math Score</td>
<td>21.26</td>
<td>5.261</td>
<td>2.655</td>
<td>-1.416</td>
</tr>
<tr>
<td>ACT – Reading Score</td>
<td>21.88</td>
<td>4.975</td>
<td>1.074</td>
<td>-0.881</td>
</tr>
<tr>
<td>ACT – Science Score</td>
<td>21.99</td>
<td>4.546</td>
<td>1.123</td>
<td>-0.611</td>
</tr>
<tr>
<td>Age (Years)</td>
<td>19.19</td>
<td>0.589</td>
<td>-2.969</td>
<td>6.956</td>
</tr>
<tr>
<td>KOG Score (out of 60)</td>
<td>37.69</td>
<td>9.527</td>
<td>-0.408</td>
<td>-1.795</td>
</tr>
<tr>
<td>KOG – Physical Score</td>
<td>9.87</td>
<td>2.644</td>
<td>-1.757</td>
<td>1.543</td>
</tr>
<tr>
<td>KOG – Regional Score</td>
<td>8.82</td>
<td>2.504</td>
<td>0.426</td>
<td>-0.814</td>
</tr>
<tr>
<td>KOG – Map Skills Score</td>
<td>10.25</td>
<td>3.192</td>
<td>-2.802</td>
<td>0.715</td>
</tr>
<tr>
<td>KOG – Cultural Score</td>
<td>8.75</td>
<td>3.063</td>
<td>0.916</td>
<td>-1.374</td>
</tr>
</tbody>
</table>

N = 113

All of the ACT composite and component scores were found to be normally distributed (except for the ACT Math), and all of the KOG composite and component scores were also found to be normally distributed (except for map skills). In both instances, with the ACT Math scores and the scores of the map skills component of the KOG, the skewness was reported as outside the normality limit of -2 to +2 (Table 4.1). Although they fell outside the normality limit, neither was extremely skewed. More than likely, there was minimal effect on the regression models due to these irregularities in the distribution of these variables.
The average scores for the KOG varied among the four components. The map skills portion of the KOG had the highest average score and the cultural had the lowest average score (Table 4.1). The results for the component tests were high, although the overall average for the entire KOG was only 37.69 correct out of 60, only a 62.9 percent accuracy rate.

Some of the dependent variables were not measured on a continuous scale, but rather a categorical scale. According to McGrew and Monroe (2000), to measure the central tendency of categorical data, one would measure the modal class, or the category with the largest number of observations (p. 38). The categorical variables were analyzed by graphing the distributions (Figures 4.3 and 4.4) and recognizing the modal class as the measurement of central tendency. The results from this analysis revealed that there was typically a dominant category in each question, and none of the other categories had a large number of observations. This would suggest that most of the students who participated in this research had similar backgrounds in terms of parental education, reading habits, traveling experience, and languages spoken.
Figure 4.1 - Distribution of Observations and Scores: (A) Total Credit Hours Completed, (B) ACT English, (C) ACT Math, (D) ACT Reading, (E) ACT Science, and (F) Age (years). N = 113
Figure 4.2 - Distribution of KOG Scores: (A) Physical Geography, (B) Regional Geography, (C) Map Skills, (D) Cultural Geography, and (E) the KOG. N = 113
Figure 4.3 - Distribution of Categorical Variables: (A) Father’s Education, (B) Mother’s Education, and (C) Reading Habits (books read in the past year). The modal class is highlighted in each graph. N = 113
Figure 4.4 - Distribution of Categorical Variables: (A) Travel in U.S. and Canada (states and provinces), (B) International Travel, and (C) Languages Spoken. The modal class is highlighted in each graph. N = 113
Regression: Physical Geography

The regression analysis determined the impact of the independent variables on the physical geography score. This model indicated that the independent variables as a group reliably predicted the dependent variable total points, yielding an $F$ value of 6.006 with a probability of an $F$ value greater than 6.006 being less than 0.0001. Overall, the model accounted for 34.9 percent (adjusted $R^2$) of the variation in total points (Table 4.2). Only the Math score from the ACT was statistically significant when all other variables were included in the model (Table 4.2), suggesting that the best predictor of physical geography scores came from this component of the ACT.

Although the relationship between math and the physical world is apparent, the mechanism for the relationship between math and physical geography is unclear. However, as described by Handley et al. (2006), a key component for both of these disciplines is the process of developing real-world application of problem-solving skills.

In the past, some scholars concluded that there were several important things that geography and mathematics had in common (Cole, 1969). These relationships ranged between the use of certain language and symbols, to graphs and diagrams. In the past fifteen years though, the combination of geographic and mathematic concepts, and its impact on student learning, has received extensive study (Enedy, 1993; Makoski and Strong, 1996; Abel and Abel, 1996; Shaw, 1998; Drier and Lee, 1999; Feeman, 2000; Dorn et al., 2005; Hinde and Ekiss, 2005; Handley et al., 2006). Whether it is using addition to measure distances between locations or calculating the cost of fuel for a trip, math has a place within geography (Kirman, 1988).
Table 4.2
Impact of Independent Variables on the Multiple Variable Regression Models

<table>
<thead>
<tr>
<th>Independent Variable</th>
<th>Physical</th>
<th>Regional</th>
<th>Map Skills</th>
<th>Cultural</th>
<th>Entire KOG</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACT – Math</td>
<td>0.417**</td>
<td>0.387*</td>
<td>0.112</td>
<td>0.196</td>
<td>0.318*</td>
</tr>
<tr>
<td>ACT – Science</td>
<td>0.209</td>
<td>0.228</td>
<td>0.499**</td>
<td>0.135</td>
<td>0.329*</td>
</tr>
<tr>
<td>ACT – Reading</td>
<td>0.215</td>
<td>0.033</td>
<td>0.166</td>
<td>0.372*</td>
<td>0.244</td>
</tr>
<tr>
<td>ACT – English</td>
<td>-0.124</td>
<td>-0.114</td>
<td>-0.102</td>
<td>-0.165</td>
<td>-0.152</td>
</tr>
<tr>
<td>Age</td>
<td>0.061</td>
<td>0.081</td>
<td>0.075</td>
<td>0.056</td>
<td>0.081</td>
</tr>
<tr>
<td>Total Credit Hours</td>
<td>-0.184</td>
<td>-0.149</td>
<td>0.032</td>
<td>-0.062</td>
<td>-0.099</td>
</tr>
<tr>
<td>Father’s Education</td>
<td>0.028</td>
<td>0.222*</td>
<td>0.106</td>
<td>0.080</td>
<td>0.127</td>
</tr>
<tr>
<td>Mother’s Education</td>
<td>-0.026</td>
<td>0.069</td>
<td>-0.013</td>
<td>0.157</td>
<td>0.057</td>
</tr>
<tr>
<td>Reading Habits</td>
<td>0.083</td>
<td>0.181*</td>
<td>0.029</td>
<td>0.125</td>
<td>0.121</td>
</tr>
<tr>
<td>Travel in U.S. &amp; Canada</td>
<td>-0.022</td>
<td>0.068</td>
<td>0.028</td>
<td>-0.041</td>
<td>0.008</td>
</tr>
<tr>
<td>International Travel</td>
<td>0.074</td>
<td>0.030</td>
<td>0.131</td>
<td>0.088</td>
<td>0.100</td>
</tr>
<tr>
<td># of Languages Spoken</td>
<td>-0.036</td>
<td>0.029</td>
<td>-0.019</td>
<td>0.070</td>
<td>0.014</td>
</tr>
</tbody>
</table>

**Adjusted R²**: 0.349  0.306  0.429  0.293  0.480

*. Correlation is significant at the 0.05 level.
**. Correlation is significant at the 0.01 level.

Some studies have further explored the relationship between student’s understanding of geographical concepts and their overall mathematical knowledge (Kaplan, 1990; Kaplan, 1991). These studies suggest that the discipline of mathematics links closely with geographical concepts. Kaplan (1991) suggests geographical facts, such as climate, economic data, and population, all relate to the understanding of math. More importantly though, Kaplan’s (1990, 1991) research acknowledges the fact that the way students understand and interpret geographic content is directly linked “to their own levels of understanding of mathematical concepts and procedures” (p. 3). She also suggested that certain types of mathematical competencies were more strongly associated with geographic knowledge. Overall, the study concluded that students who are not competent in mathematics may be at a disadvantage for learning geographical content.
Essentially, math ties in well with any type of physical science, as both are concerned with the building of hypotheses or questions and the method of collecting and processing data. Drier and Lee (1999), in an investigation of climate (a field within physical geography), contend that “by focusing on data collection, calculation, interpretation, and analysis, students learn important skills that can be directly applied to real-world decision making situations” (p. 10). However, the link here between math and physical geography may suggest that a student’s understanding of the world around them in the physical form, at least in part, is produced through the problem solving nature of subjects such as algebra, geometry, and trigonometry. As suggested by Dorn et al. (2005), teaching geographic concepts improves student performance in mathematics, but similarly, “practicing math skills in a geography lesson also helps [students] learn geography . . . objectives” (p. 157).

Regression: Regional Geography

The regression analysis yielded an $F$ value of 5.116 with a probability of an $F$ value greater than 5.116 being less than 0.0001. This indicated that the independent variables as a group reliably predicted the dependent variable total points. The overall model accounted for 30.6 percent of the variation in total points (Table 4.2). In examining the parameter estimates for each of the variables, like the Physical section of the KOG, the Math component score from the ACT, as well as father’s education level and reading habits were statistically significant when all other variables were included in the model (Table 4.2).
Regional geography was the only portion of the KOG that had more than one independent variable that was significantly correlated. The highest correlation was found with the score once again on the math section of the ACT. Here again we are reminded that math is part of geographic knowledge. As mentioned previously, these results suggest that those students with higher abilities in math seem to have a better understanding of the function and form of different geographic areas, whether it is physical or cultural characteristics.

Regional geography is simply the combination of all aspects of geographic study in a specific area or region. This includes the study of both physical geography and human geography. It is especially important to realize that for regional geography, the wide range of interests within this study forces an expansive knowledge base within a number of different disciplines. The importance of mathematics in regional geography is highlighted by Wilson and Kirkby (1975), who suggest, “the geographer not only needs the mathematical equipment necessary to the study of his own subject, but also that which is necessary for the study of ‘adjacent’ disciplines” (p. 5). They go on to state that it is almost impossible to go into any depth within the study of geography “without having the appropriate mathematical tools available” (p. 10). This would therefore imply that students most certainly need some types of mathematical skills to understand geographical concepts and build a geographic knowledge base.

The other two independent variables found to be significant were the father’s educational background and the reading habits of the student. If a student’s father has a higher level of education, it is assumed that the household may be more prone to supporting healthy reading habits. These reading habits may in turn help students
understand the world around them, and even more so, explain to them the differences between regions, whether it be physical or cultural. Eve et al. (1994) and Henrie et al. (1997) both reported that increased reading habits associated with higher scores on the KOG. However, the connection made here is quite weak and without much support from available literature. It could be that these two variables are simply peculiarities of this sample.

Regression: Map Skills

The regression analysis yielded an $F$ value of 8.005 with a probability of an $F$ value greater than 8.005 being less than 0.0001, which indicated that the independent variables as a group reliably predicted the dependent variable total points. The overall model accounted for 42.9 percent of the variation in total points (Table 4.2). In examining the parameter estimates for each of the variables, only the science component score from the ACT was statistically significant when all other variables were included in the model (Table 4.2).

Put simply, scores on the science section of the ACT were found to have the highest predictive utility for students’ ability to read and interpret maps. While there is an extensive amount of literature available on the methods of teaching map reading skills, very little of this literature points directly to a direct link between map reading skills and the discipline of science. In fact, most of the literature on map reading repeatedly states that a student’s ability to analyze and understand maps goes hand in hand with their abilities in mathematics (Makowski and Strong, 1996; Feeman, 2000; Dorn et al., 2005).
The lack of support from literature makes it difficult to discuss the results found here, especially with such a strong difference found between the results of the regression model (Table 4.2) and the evidence of math playing a significant role in comprehending maps.

However, the ability to locate places on the earth’s surface and understand the spatial arrangement of things fits nicely with the idea of science. The science section of the ACT measures the interpretation, analysis, evaluation, reasoning, and problem-solving skills required in the natural sciences (ACT, 2006). We use science to give order and understanding to the world around us. Maps give us one method of doing just that. By using maps as organizers of space and place, the function of science is achieved. Maps are merely the science of describing the spatial distribution of the physical and cultural phenomena of the world.

Although there is no evidence in the existing literature connecting map reading and science, increasing interest examining the usefulness of map making and map reading activities within science classrooms is noticeable (Price, 2005; Lee, 2005; Mannikko and Sterling, 2005; McDuffie and Cifelli, 2006). These activities range from using state highway and topographic maps, to understanding the use of contour lines and developing ways to show landscapes three-dimensionally. In addition, there should be no reason to believe that a student’s ability in the natural sciences does not have a significant relationship with their ability in map reading skills. In all likelihood, the natural sciences could be shown to be just as important as mathematical skills have been shown in previous research.
As explained by Kirman (1988), links between geography and science are not only possible but also appropriate. A wide range of topics, such as climate, geology, hydrology, and plant and animal life, connect these two disciplines. Especially important though, as Kirman (1988) suggests, is “the use of maps, globes, and compass directions” to show students where these different topics are found on Earth (p. 104). The process of mapping the distribution of different types of scientific data (i.e. animal habitats) also encourages students to develop map-reading skills.

Learning how to read and analyze maps, however, does not necessarily start in geography or social studies coursework. As described by Blaut and Stea (1971), “map learning begins long before the child encounters formal geography” (p. 387). Whether this learning takes place in other classes such as math or science, the research clearly shows that the ability to create maps and read them is an essential part of human development. They also suggest maps are a form of communication, a “mapping language” that, when in its simplest of forms, despite language barriers or slow reading abilities. This may indicate why the ACT Reading score did not contribute significantly to the map reading score (Table 4.2). These results also reiterate the suggestion from Douglass (1998) that reading a map requires much more complex thought processes than “a consistent, and relatively limited, group of symbols” (p. 100) in print reading.

Regression: Cultural Geography

The regression analysis for cultural geography indicated that the independent variables as a group reliably predicted the dependent variable total points, yielding an $F$
value of 4.860 with a probability of an $F$ value greater than 4.860 being less than 0.0001. Overall, the model accounted for 29.3 percent of the variation in total points (Table 4.2).

In examining the parameter estimates for each of the variables, only the Reading component score from the ACT was statistically significant when all other variables were included in the model (Table 4.2).

Only one variable that was statistically significant contributed to the cultural geography section (ACT Reading score), but unlike the other portions of the KOG, this connection seems quite clear. A student’s ability to read and process written material indicates an advantage to better understanding the many cultural phenomena found in the world (religion, politics, race, etc.). As indicated by Friend and Thompson (1987), and again by Atkinson (1989), the reading of both fictional and nonfictional literature expands basic geographic concepts, including those concepts contained within cultural geography (i.e., economic situations, cultural patterns, and historical backgrounds).

While fictional books contain stories laced with descriptive narratives, informational books contain maps and facts about various geographic regions and their corresponding cultures (Johnson and Giorgis, 2001). Even the use of other literary types, such as poetry (Donaldson, 2001) or simple picture books (Dowd, 1990; Macken, 2003; Landt, 2007) can stimulate interest in geographic concepts and facilitate basic knowledge about cultural traditions and human interaction.

Both types of literature (although especially fictional for school-aged children) allow readers to travel well beyond their understood environments and enlighten them to the differences found between physical and cultural landscapes, and familiarizing themselves with necessary skills and knowledge for living in a ever growing global
community (Cone, 1990; Bolding, 1994; Lickteig and Danielson, 1995). Literature opens a door for understanding cultural geography, as Lickteig and Danielson (1995) explain, reading experiences “give students opportunities to compare and contrast cultures, identify similarities and differences among cultures, and learn about the interaction between the cultures and their environments” (69).

Research has started to assess the utility of geography coursework to improve students’ reading comprehension scores on high-stakes testing (Hinde and Ekiss, 2002; Dorn et al., 2005; Hinde et al., 2007). Preliminary results from this research suggest that there are statistically significant improvements in reading comprehension with the teaching of geographic concepts. Almost all the students who were exposed to geographic concepts showed growth in reading achievement, as opposed to students who did not. In addition, those students who had only moderate reading skills prior to the study showed tremendous gains in reading comprehension after the implementation of geographic themes into the classroom.

Although a student’s reading skill was shown to be significantly correlated to knowledge of cultural geography, a student’s reading habits, or the amount of reading a student does, was not shown to be statistically significant (Table 4.2). According to the National Geographic Society (1988), exposure to books, magazines, and maps improves geographic knowledge. However, as shown in this study, the amount of reading a student did had no effect on their awareness of cultural geography or their overall geographic knowledge as suggested by the results of the regression models.

It is interesting that when Eve et al. (1994) and Henrie et al. (1997) administered the KOG, their results suggested that the amount of reading a student did strongly
predicted their geographic knowledge and performance on the KOG. Granted, both of these previous studies only correlated reading habits to the entire KOG score and not to this particular section of the KOG, it would seem logical that the amount of reading a student does would affect their overall geographic knowledge. Even though these previous studies found that those students who read beyond assigned literature had greater knowledge, it did not explain how students acquired their general background knowledge about geography. The result from this study also could simply be a peculiarity of this sample.

Regression: The Overall KOG

This regression analysis yielded an $F$ value of 9.619 with a probability of an $F$ value greater than 9.619 being less than 0.0001, indicating that the independent variables as a group reliably predicted the dependent variable total points. The overall model accounted for 48.0 percent of the variation in total points (Table 4.2). In examining the parameter estimates for each of the variables, only the Science component score and Math component score from the ACT were statistically significant when all other variables were included in the model (Table 4.2). It is also worth noting that the Reading component score was just outside of the significance threshold.

As a whole, the variables with the highest positive correlation to the entire KOG instrument were the science, math, and reading scores from the ACT. In comparison to the literature, some of the results match up quite well. For instance, Nelson et al. (1999)
found that ACT science scores had a significant, positive correlation with the entire KOG score.

These results also give testimony to programs such as the National Science Foundation Graduate Teaching Fellows in K-12 Education (GK–12) Program. Specifically, the GK-12 Program “is an innovative program for enriching the value of graduate and advanced undergraduate students’ education while simultaneously enriching science and mathematics teaching at the K – 12 level” (Mitchell et al., 2003, p. 1). These funds support the creation and implementation of improved school curricula nationwide, especially within four major areas: science, technology, engineering, and mathematics (STEM). Some of the universities with GK-12 grants specifically address the lack of geographic curricula and look to improve geographic education (typically found within science) in schools across the country. The strong relationships found here between science, math, and reading and overall geographic knowledge encourage the idea that a geographic knowledge base can be fostered through other areas of learning.
CHAPTER V
CONCLUSION

The research problem asked whether or not standardized test scores were a good predictor of geographic knowledge and skill in undergraduates. The study emphasized an examination of the relationship between component scores on the ACT and component scores on the KOG. This study found that there are distinct relationships found between the general areas of knowledge measured through the ACT and the specific areas of knowledge measured through the KOG (Figure 5.1).

According to the results and the subsequent analysis, three components of the ACT have significant positive correlations with the KOG instrument as a whole. These are the math, science, and reading sections. While these results reiterated some of the findings of Nelson et al. (1999), specifically their suggestion that the ACT science score correlated with the entire KOG score, these results also give new information about how the other sections of the ACT relate to this survey of geography knowledge.
The fact that in addition to science, both the math and reading sections of the ACT as strong predictors of geographic knowledge supports the idea that geography is a practical subject, a way of thinking rather than a particular body of subject matter (Douglass, 1998). According to Nolan (2002), geography is not some “abstract, nice-to-know type of knowledge, but truly a type of knowledge impinging on our ability to solve problems and make decisions” (p. 143). This knowledge or way of thinking that both Douglass and Nolan write about incorporates many aspects of other fields of study, including science, mathematics, and reading.
Within the KOG, other relationships were found between the different sections of the KOG and the ACT component scores. Specifically, three distinct relationships were brought to light. The first was the relationship between the physical geography and the regional geography scores and the ACT math score. The second was the relationship between the map reading score and the ACT science score. Finally, the third was the relationship between the cultural geography score and the ACT reading score. Respectively, each of these relationships are the strongest found in each regression model. The various component scores from the ACT are the strongest predictor of specific geographic knowledge and skill among any of the independent variables used in the models.

Most importantly, the relationships found between the components of the ACT and the components of the KOG help to address the issues of how to assist students or improve geography curricula. By finding that there were significant relationships between these two tests, we can now make use of ACT component scores as a predictor of different types of geographic knowledge and skill. This can be accomplished in several ways.

The first use is through the advisement of students. Although many students enter higher education prepared for all that this arena demands, “others arrive ill-suited to meet the expectations of post-secondary education” (Kidwell, 2005, p. 253). For students who enter college looking to succeed, there are two key stumbling blocks they must overcome: the lack of intellectual maturity and the lack of understanding of the purpose and opportunities of college (Conley, 2005). Many colleges and universities nationwide have designed freshman or first-year experiences to combat these stumbling blocks.
Academic advising is a very important part of students’ educational experiences in these situations, especially during their first and second years, and according to Addus et al. (2007), “in order to enhance teaching and learning effectiveness, higher education institutions must listen to their students’ unique needs and priorities” (p. 325). These unique needs may represent themselves through standardized test scores like those of the ACT exam.

Students who show specific weakness in a particular area on the ACT may be recommended by their academic advisor to strengthen those problem areas by taking related courses (i.e. a basic math course to improve a weak ACT math score). After the student shows improvement in this subject, the student may then be advised to enroll into an introductory geography course. By directing students to strengthen their weak academic areas, it increases their potential for performing well in an introductory geography course that demands a certain extent of knowledge for success.

The second use is through the modification of current introductory curriculum. If a certain pattern typifies a university’s student body, in the form of an overall low average score on the components of the ACT, then specific modifications or alterations could be made to curriculum. As the results of this study show, certain components of the ACT can predict knowledge in several areas of geographic knowledge. For example, if a student population typically scores low on the reading portion of the ACT, it could be inferred that their general knowledge about cultural geography could be somewhat limited. In such a case, the curriculum could be adapted to the unique population needs of that university. Similarly, a university could use the same predicting scheme to enhance curriculum by challenging a student body that has high average scores in particular ACT
components. For example, the curriculum could stress the reading of more complicated maps if the student population has high average science scores.

Future Research

The areas of geographic literacy and geographic proficiency are topics that have distinct places within future research. With repeatedly poor performances on examinations of geographic knowledge, interest in this subject will only increase until U.S. students finally can perform competitively with other nations in the world. Geography has been put on the ‘back burner’ during the restructuring of the educational system through the No Child Left Behind Act, and it remains one of the largely untouched areas of education in this nation. As long as geographic education remains largely ignored in the educational system, it will continue to produce poor testing scores.

The analysis and study of standardized test scores as a predictor of geographic knowledge remains a compelling subject for future research. The first research possibility is whether other standardized tests show similar results, especially that of the SAT examination, which is the other major college entrance examination used in the United States.

A second research possibility could be the difference between the geographic knowledge of students in large, urban-based universities versus those in smaller, perhaps even private institutions. Research could assess if similar results could be matched between different sized colleges and universities. Specifically, it is interesting to think whether or not the same results could be produced in the many different types of
educational environments found throughout the U.S. There is much more investigation to be done to prove that the different components of the ACT do in fact predict geographic knowledge and ability.

The use of other predictive variables linked to geographic knowledge is also of interest. These could range from simple demographic variables such as socio-economic background or ethnicity, to much more specific variables such as computer literacy or psychological evaluations. Although in this study ACT component scores were shown to be the best predictor of geographic knowledge, and in the past gender has been shown to be the best predictor (Beatty and Troster, 1987; Eve et al., 1994; Henrie et al., 1997; Nelson et al., 1999; Nolan, 2002), perhaps there are other variables that would also reasonably predict the geographic abilities of students.

Finally, due to the predictive nature of the ACT scores, the effectiveness of using either academic advisement or curriculum modification could be assessed. Research could report the success or failure of students who were advised to wait to take an introductory geography course, or discuss the pros and cons to adjusting introductory curriculum to match the student body’s characteristics. These types of studies could enhance the knowledge about whether or not the ACT scores truly predict different types of geographic knowledge.


APPENDICIES
APPENDIX A.

SCRIPT

Instructions given for completing the KOG and the questionnaire:

“The following test is part of a project researching geographic knowledge and skills of undergraduates. This survey will not influence your final grade in this course, nor will your teacher be made aware of how well you did on this survey. You are not obligated to take this survey. If you do, any identifying information that you provide will be hidden from the researcher to insure your privacy. Please place all your belongings on the floor except for a writing tool. You will have until the end of this scheduled meeting time to complete the survey. Before starting, please read over the informed consent form and sign and date the back if you agree to the research obligations. After signing the consent form, complete the short questionnaire attached in front of the answer sheet. After completing the questionnaire, proceed to the survey and read each question carefully. Select the best possible answer and indicate your selection on the provided answer sheets. Please do not write on the survey booklet. During the test, please avoid temptation to speak with another student or look at other students’ answers. Those doing so will be asked to leave. Once you have completed the survey, please turn in all materials, including the test booklet, the questionnaire, and the answer sheet, to the administrator. You are free to leave after you have completed and turned in the survey materials. You may now begin the questionnaire portion and then move onto the test.”
APPENDIX B.

INFORMED CONSENT FORM

January 14, 2008

INFORMED CONSENT FORM

The Utility of Standardized Achievement Test Scores as a Predictor of Geography Skills in Undergraduates
Mr. Thomas R. Craig, Graduate Student

Introduction:
You have been asked to take part in a research project described below. The researcher will explain the project to you in detail. You should feel free to ask questions. If you have more questions later, Mr. Craig, the person mainly responsible for this study, will discuss them with you.

Description of the project:
You have been asked to take part in a study that will examine the usefulness of standardized test scores as a predictor of geography knowledge and skill. This study is voluntary and will not affect course grades or be shared with course instructors. You are being asked to partake in this study because you have registered for an introductory geography course offered by the Department of Geography and Planning. The purpose of this research is to determine whether ACT scores can be used as a predictor of student ability in geographic skills and concepts. If ACT scores are shown to be useful as a predictor of geography skills, improvements can be made on existing geography curriculum and student advising.

Procedures:
If you decide to take part in this study here is what will happen:

- You will be asked to complete a short questionnaire and a 60-question test, using your student identification number.
- You will be expected to complete the questionnaire and test to the best of your ability within the time allotted.
- Your participation in this study will end once you have completed both the questionnaire and the test.
Your questionnaire and answer sheet will be given to a third party who will attach academic records, and then return them to the researcher after removing your identification number.

The data collected will be analyzed and discussed in a Master’s thesis that will be completed sometime during the summer of 2008.

**Risks or discomfort:**
No risks are involved in this study as all identifiable information (your student ID) will be removed from the questionnaires and answer sheets before being returned to the researcher.

**Benefits of this study:**
There is no direct benefit to you as a participant in this study. Although there will be no direct benefit to you taking part in this study, the researcher may learn more about the use of standardized test scores relationship to geographic skills in undergraduates, which may result in improved courses and student advising.

**Confidentiality:**
Your part in this study is confidential. None of the information will identify you by name. All records will be handled by someone the university has given the authority to do so. Identification numbers provided to help combine your records with your test scores will be removed prior to being returned to the researcher. The researcher will then assign random case numbers to each student’s records and test scores.

**Voluntary participation and withdrawal:**
Participation in research is voluntary. You have the right to refuse to be in this study. If you decide to be in the study and change your mind, you have the right to drop out at any time. You may skip questions.

**Questions, Rights and Complaints:**
If you have any questions about this research project, please call Thomas Craig at (330) 972-8032 or email at trc23@uakron.edu

If you have any questions or concerns about your rights as a research participant in this study, please direct them to Sharon McWhorter, the IRB Administrator at The University of Akron, Office of Research Services and Sponsored Programs at (330) 972-8311.

**Consent statement**
By signing this document you consent to participating in The Utility of Standardized Achievement Test Scores as a Predictor of Geography Skills in Undergraduates being given by Mr. Thomas R. Craig, graduate student at The University of Akron. This statement certifies the following: that you are 18 years of age or older and you have read the consent and all your questions have been answered. You understand that you may withdraw from the study at any time.

All of the answers you provide to Mr. Craig will be kept private. You should know that you have the right to see the results prior to their being published.
APPENDIX C.

QUESTIONNAIRE

Circle the appropriate answer.

What is your father’s highest level of education completed?

<table>
<thead>
<tr>
<th>Some High School</th>
<th>High School</th>
<th>Associates</th>
<th>Bachelors</th>
<th>Masters</th>
<th>Doctorate</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td>(4)</td>
<td>(5)</td>
<td>(6)</td>
</tr>
</tbody>
</table>

What is your mother’s highest level of education completed?

<table>
<thead>
<tr>
<th>Some High School</th>
<th>High School</th>
<th>Associates</th>
<th>Bachelors</th>
<th>Masters</th>
<th>Doctorate</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td>(4)</td>
<td>(5)</td>
<td>(6)</td>
</tr>
</tbody>
</table>

About how many books have you read in the past year, not including textbooks?

<table>
<thead>
<tr>
<th>Less than 3</th>
<th>3 – 5</th>
<th>6 – 10</th>
<th>More than 10</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td>(4)</td>
</tr>
</tbody>
</table>

How many U.S. states or Canadian provinces, other than the state of Ohio, have you traveled to?

<table>
<thead>
<tr>
<th>None</th>
<th>1 – 3</th>
<th>4 – 6</th>
<th>More than 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td>(4)</td>
</tr>
</tbody>
</table>

How many countries, besides the U.S. and Canada, have you traveled to?

<table>
<thead>
<tr>
<th>None</th>
<th>1 – 3</th>
<th>4 – 6</th>
<th>More than 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td>(4)</td>
</tr>
</tbody>
</table>

How many languages can you speak functionally, including your native language?

<table>
<thead>
<tr>
<th>One</th>
<th>Two</th>
<th>Three</th>
<th>More than Three</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td>(4)</td>
</tr>
</tbody>
</table>
APPENDIX D.

KOG INSTRUMENT AND RESPONSES

NOTE: Student responses are in percentages; **bold** percentage is the correct answer

1. The different seasons that occur on the earth are largely due to
   a. the tilt of the earth with respect to the sun. (**88.5**)
   b. the size of the earth. (0.0)
   c. the distance from the sun. (9.7)
   d. the presence of large oceans. (1.8)

2. During the summer season in the United States, longer periods of daylight are encountered if one moves to the
   a. south (36.3)
   b. east (12.4)
   c. north (**36.3**)
   d. west (15.0)

3. As temperatures become cooler, the amount of water vapor air can hold
   a. does not change (2.7)
   b. increases (23.0)
   c. decreases (**69.0**)
   d. first increases then decreases (4.4)

4. Tornadoes occur most often on which continent?
   a. North America (**85.8**)
   b. Africa (8.8)
   c. Asia (1.8)
   d. South America (3.5)

5. Increased CO₂ (carbon dioxide) in the air would result in the earth’s atmospheric temperature being:
   a. warmer. (**72.6**)
   b. colder. (12.4)
   c. unchanged. (15.0)
6. The earth’s atmosphere consists primarily of
   a. carbon dioxide and water vapor (11.5)
   b. oxygen and nitrogen (71.7)
   c. oxygen and methane (3.5)
   d. nitrogen and water vapor (13.3)

7. The expression, the “Ring of Fire” refers to
   a. the Hawaiian Islands. (4.4)
   b. volcanoes around the Pacific Ocean. (88.5)
   c. a halo around the moon. (2.7)
   d. a type of coral located around certain tropical islands. (4.4)

8. Coral and the shells of most marine animals result in the formation of which type of rock?
   a. lava (9.7)
   b. granite (17.7)
   c. slate (17.7)
   d. limestone (54.0)

9. Ocean tides are caused primarily by
   a. sunspots (1.8)
   b. wind (13.3)
   c. earthquakes (7.1)
   d. the moon’s gravity (77.9)

10. In Michigan, lakes are common because the surface has been modified by
    a. volcanoes. (0.0)
    b. rivers. (14.2)
    c. glaciers. (68.1)
    d. changes in sea level. (17.7)

11. Other than the oceans, most moisture is found
    a. in glaciers and ice sheets (30.1)
    b. in rivers and lakes (19.5)
    c. underground (26.5)
    d. in the atmosphere (23.9)

12. At the South Pole, which of the following dates has the longest period of sunlight?
    a. June 17 (34.5)
    b. March 23 (16.8)
    c. December 25 (38.1)
    d. April 15 (9.7)
13. The highest mountains in the world are the
   a. Appalachian Mountains. (17.7)
   b. Rocky Mountains. (4.4)
   c. Ozark Mountains. (4.4)
   d. Himalayan Mountains. (73.5)

14. In the United States, on what day of the year is the sun highest in the sky?
   a. March 21 (7.1)
   b. June 21 (67.3)
   c. September 21 (11.5)
   d. December 21 (13.3)

15. Fossil fuels were derived from:
   a. the remains of ancient plants and animals (65.5)
   b. volcanic rock (11.5)
   c. ocean water (1.8)
   d. fossilized rock (21.2)

16. Baja California is part of which country?
   a. Belize (7.1)
   b. Canada (4.4)
   c. Mexico (85.0)
   d. Spain (3.5)

17. The only predominantly Christian nation in southeast Asia is:
   a. Thailand (11.5)
   b. Laos (18.6)
   c. the Philippines (56.6)
   d. Vietnam (13.3)

18. In ancient times, within which part of the world did cities first develop?
   a. Europe (36.3)
   b. Middle East (45.1)
   c. Africa (14.2)
   d. South America (4.4)

19. Which mountain range separates France and Spain?
   a. Pyrenees (30.1)
   b. Alps (38.9)
   c. Andes (15.9)
   d. Himalayas (14.2)
20. The Andes Mountains are located in which continent?
   a. Australia (12.4)
   b. Eurasia (31.9)
   c. Africa (8.8)
   d. South America (45.1)

21. Which of the following produces the most timber?
   a. the Pacific Northwest (54.9)
   b. the Hawaiian Islands (4.4)
   c. interior Alaska (35.4)
   d. Texas (5.3)

22. Of the pairs of states listed below, which pair is most completely occupied by mountainous terrain?
   a. Pennsylvania and West Virginia (79.6)
   b. Texas and Oklahoma (1.8)
   c. Kansas and Nebraska (14.2)
   d. Arkansas and Louisiana (4.4)

23. Traditionally, which port city has been considered the “Gateway to Alaska”?
   a. San Diego (5.3)
   b. Seattle (62.8)
   c. Montreal (28.3)
   d. Los Angeles (3.5)

24. Which of the following states borders Mexico?
   a. Nevada (15.9)
   b. Colorado (1.8)
   c. Louisiana (8.0)
   d. Arizona (74.3)

25. The United Kingdom of Great Britain includes all of the following except:
   a. England (5.3)
   b. southern Ireland (48.7)
   c. Scotland (27.4)
   d. Wales (17.7)

26. Which animals are especially sacred to Hindus in India?
   a. Cows (78.8)
   b. Horses (11.5)
   c. Cats (8.0)
   d. Dogs (1.8)
27. Mongolia is:
   a. part of India (26.5)
   b. part of Japan (7.1)
   c. part of Russia (20.4)
   d. an independent country (46.0)

28. The holiest city to Muslims is
   a. Cairo (8.8)
   b. Baghdad (15.9)
   c. Mecca (70.8)
   d. Rome (3.5)

29. Which of these countries in South America does not border an ocean?
   a. Columbia (21.2)
   b. Bolivia (54.9)
   c. Brazil (9.7)
   d. Peru (13.3)

30. In North America, which of the following regions is located immediately to the west of the Corn Belt?
   a. Cotton Belt (18.6)
   b. Dairy Belt (23.9)
   c. Wheat Belt (49.6)
   d. Citrus Belt (8.0)

31. If one travels straight east from Florida, the first major landmass encountered is
   a. Europe. (8.8)
   b. Asia. (5.3)
   c. South America. (8.0)
   d. Africa. (77.9)

32. Which of the world’s oceans has the largest area?
   a. Atlantic (19.5)
   b. Indian (2.7)
   c. Arctic (1.8)
   d. Pacific (76.1)

33. Which of the following countries is located in the Western Hemisphere?
   a. Japan (17.7)
   b. the Philippines (17.7)
   c. Chile (56.6)
   d. Vietnam (7.1)
34. Which of the following most accurately states the correct ratio of land to ocean area on the earth’s surface?
   a. 29% land, 71% ocean (80.5)
   b. 50% land, 50% ocean (3.5)
   c. 11% land, 89% ocean (8.0)
   d. 66% land, 34% ocean (7.1)

35. The country of Chile has which type of shape?
   a. large square (4.4)
   b. long and narrow (84.1)
   c. round (3.5)
   d. a boot (8.0)

36. Which of the following countries has the largest area?
   a. Guatemala (0.9)
   b. Canada (19.5)
   c. Mexico (5.3)
   d. Russia (74.3)

37. Which continent is located both north and south of the Equator and east and west of the Prime Meridian?
   a. Africa (57.5)
   b. North America (14.2)
   c. Eurasia (13.3)
   d. South America (15.0)

38. Which of the following state does not border an ocean or a foreign country?
   a. Idaho (15.0)
   b. Kansas (77.0)
   c. Oregon (6.2)
   d. North Carolina (1.8)

For Questions 39-41 use the accompanying World Map

39. Nation number 15 is?
   a. Bolivia (19.5)
   b. Borneo (20.4)
   c. Iraq (5.3)
   d. Somalia (54.0)

40. Nation number 5 is?
   a. Argentina (6.2)
   b. China (8.8)
   c. India (78.8)
   d. Zaire 6.2)
41. Nation number 10 is?
   a. Iraq (76.1)
   b. India (2.7)
   c. Israel (20.4)
   d. Italy (0.9)
42. The elevation of point B could be:
   a. 127 ft (4.4)
   b. 149 ft (9.7)
   c. 162 ft (69.9)
   d. 219 ft (14.2)

43. The steepest slope is between points:
   a. A and E (14.2)
   b. A and B (58.4)
   c. B and C (19.5)
   d. C and D (8.0)

44. Which of the following two points are most nearly alike in elevation?
   a. A and B (14.2)
   b. J and H (54.0)
   c. C and D (21.2)
   d. B and H (9.7)

45. The difference in elevation between points G and I could be:
   a. 90 ft (49.6)
   b. 40 ft (11.5)
   c. 160 ft (32.7)
   d. 210 ft (6.2)
46. The predominate religion of Iran is best described as:
   a. Muslim (88.5)
   b. Hindu (2.7)
   c. Christian (3.5)
   d. Buddhist (4.4)

47. The two most common religions in Africa are Christianity and
   a. Hinduism. (23.0)
   b. Islam (Muslim). (46.0)
   c. Buddhism. (21.2)
   d. Judaism. (9.7)

48. In which of the following would you expect to find the most Polynesians?
   a. India (31.9)
   b. Hawaii (35.4)
   c. Kenya (27.4)
   d. Alaska (9.7)

49. Of the countries listed below, which one has the highest percentage of its workers
    involved in farming?
   a. Canada (8.0)
   b. France (7.1)
   c. China (70.8)
   d. Japan (12.4)

50. Marco Polo’s famous voyage was to
   a. Scandinavia. (30.1)
   b. Mexico. (24.8)
   c. China. (27.4)
   d. Turkey. (16.8)

51. In the 1840s and 1850s, large numbers of persons migrated to the United States
    when their homeland suffered a severe potato famine. What is the name of their
    homeland?
   a. Italy (4.4)
   b. China (1.8)
   c. Germany (20.4)
   d. Ireland (73.5)

52. Which statement is not correct about China?
   a. It has the largest population of any country in the world. (15.9)
   b. In ancient times, a highly advanced civilization emerged in China. (15.9)
   c. In areas where people can live, it is very crowded. (4.4)
   d. Today, starvation is common and life expectancies are short. (62.8)
53. Which group of Europeans were the first white settlers on Manhattan Island?
   a. the Dutch (62.8)
   b. Portuguese (15.0)
   c. Russians (3.5)
   d. the Germans (18.6)

54. Which state has the largest percentage of Mormons?
   a. Iowa (15.9)
   b. Utah (56.6)
   c. Michigan (13.3)
   d. Missouri (14.2)

55. Which continent has the lowest percentage of its population living in cities?
   a. Europe (4.4)
   b. North America (6.2)
   c. South America (23.0)
   d. Africa (66.4)

56. European patterns of culture have been diffused throughout the world primarily through?
   a. Industrialization (27.4)
   b. Exploration (19.5)
   c. Colonialism (37.2)
   d. Tourism (13.3)

57. Followers of which of these religions believe in more than one God?
   a. Christianity (8.0)
   b. Islam (Muslim) (5.3)
   c. Judaism (18.6)
   d. Hinduism (68.1)

58. Of the following crops, which is least likely to be found in tropical areas?
   a. Wheat (64.6)
   b. Rice (9.7)
   c. sugar cane (9.7)
   d. bananas (15.0)

59. The wealth of nomads is mostly found in?
   a. Banks (1.8)
   b. Land (28.3)
   c. Livestock (60.2)
   d. Gold (9.7)
60. When compared to other cultural systems in the world, social behavior in the Western World tends to be more:
   a. individualistic. (54.9)
   b. clan oriented. (11.5)
   c. simple. (17.7)
   d. rural. (13.3)
APPENDIX E.

HUMAN SUBJECTS APPROVAL LETTER

December 10, 2007

Thomas R. Craig
715 W. Market Street, Apt. 305
Akron, Ohio 44303

Mr. Craig:

Your protocol entitled "The Utility of Standardized Achievement Test Scores as a Predictor of Geography Skills in Undergraduates" was determined to be exempt from IRB review on December 10, 2007. The IRB application number assigned to this project is 20071208. The protocol represents minimal risk to subjects and meets the following federal category for exemption:

☐ Exemption 1 - Research conducted in established or commonly accepted educational settings, involving normal educational practices.

☐ Exemption 2 - Research involving the use of educational tests, survey procedures, interview procedures, or observation of public behavior.

☐ Exemption 3 - Research involving the use of educational tests, survey procedures, interview procedures, or observation of public behavior not exempt under category 2, but subjects are elected or appointed public officials or candidates for public office.

☐ Exemption 4 - Research involving the collection or study of existing data, documents, records, pathological specimens, or diagnostic specimens.

☐ Exemption 5 - Research and demonstration projects conducted by or subject to the approval of department or agency heads, and which are designed to study, evaluate, or otherwise examine public programs or benefits.

☐ Exemption 6 - Taste and food quality evaluation and consumer acceptance studies.

Annual continuation applications are not required for exempt projects. If you make changes to the study's design or procedures that increase the risk to subjects or include activities that do not fall within the approved exemption category, please contact the IRB to discuss whether or not a new application must be submitted. Any such changes or modifications must be reviewed and approved by the IRB prior to implementation.

Please retain this letter for your files. If the research is being conducted for a master's thesis or doctoral dissertation, the student must file a copy of this letter with the thesis or dissertation.

Sincerely,

Sharon McWhorter
Associate Director

Cc: Linda Barrett, Advisor
Rosalie Hall, IRB Chair

Office of Research Services and Sponsored Programs
Akron, OH 44325-2102
330-972-7666 • 330-972-8281 Fax

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