Predictors of proficiency in critical thinking for college freshmen
by Kenneth Dale Wilson

A thesis submitted in partial fulfillment of the requirements for the degree of Doctor of Education
Montana State University

Abstract:
The problem of this study was twofold: (1) to determine if selected variables of college aptitude and demographic characteristics can be used as predictors of proficiency in critical thinking for beginning college freshmen, and (2) to determine if differences in levels of selected variables of college aptitude and demographic characteristics operate as predictors of proficiency in critical thinking for beginning college freshmen.

The population of this study was composed of students entering Montana State University in the fall of 1987. The data were collected from 203 students by administering the Watson-Glaser Critical Thinking Appraisal and from the university's ACT College Reports for students.

Multiple linear regression and stepwise regression were used to analyze the data to determine if the independent variables of ACT standard scores, high school GPA, anticipated college major, size of high school, and gender could be used as predictors of critical thinking proficiency for incoming college freshmen. One-way analysis of variance was used to analyze the data to determine if significant relationships existed between mean WGCTA raw scores based on strata of the independent variables. All analyses were performed at the .05 level of significance.

The findings were that only ACT standard scores were significant predictors of critical thinking proficiency, accounting for 28.41% of the variance in WGCTA raw scores. It was also determined that significant relationships existed between mean WGCTA raw scores based on strata of the ACT national score intervals, high school GPA intervals, and gender.

Recommendations for further study include: a study that would investigate the relationship between critical thinking proficiency and the Enhanced ACT (begun in 1989) subtest scores; a follow-up study that would investigate the differences between entry level and exit level proficiency in critical thinking; a study that would investigate the relationship between critical thinking proficiency and students' postsecondary choices; a study that would investigate the relationship between development of critical thinking proficiency and such variables as student participation in student government, extracurricular academic activities, athletic activities, and working at jobs while in school; and a study that would investigate how various styles of classroom instruction influence the critical thinking profieciency of students.

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by

Kenneth Dale Wilson

A thesis submitted in partial fulfillment
of the requirements for the degree

of

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APPROVAL

of a thesis submitted by

Kenneth Dale Wilson

This thesis has been read by each member of the graduate committee and has been found to be satisfactory regarding content, English usage, format, citations, bibliographic style, and consistency, and is ready for submission to the College of Graduate Studies.

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Date November 6, 1989

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CHAPTER 1

INTRODUCTION

Futurists have asserted that education must change from a process of acquiring knowledge to a process of developing thinking skills. Recent national education reports have stressed the need for institutions of higher education to incorporate the development of critical thinking skills in their curricula. However, only limited research has been conducted investigating predictors of entry level critical thinking proficiency for college freshmen. The following study contributes to the understanding of predictors of critical thinking proficiency for college freshmen by investigating whether or not significant relationships exist between a selected measurement of critical thinking and selected characteristics of students.

In *Thinking in the Classroom: A Survey of Programs*, Chance (1986) stated that "there seems to be a growing realization among American educators that our society is in the midst of a profound cultural transformation, one that will provide a world in which high level thinking is a basic skill" (p. 2). Chance further stated, "[This transformation] has given rise to an unprecedented interest in the teaching of thinking" (p. 2). The cultural transformation Chance referred to was the transition in America from the industrial age to the information age. This transition is reflected in what society is expecting from education.

In *The Third Wave*, Toffler (1980) identified three great advances, or waves, in the history of civilization. The first was a shift from an itinerant society based on the hunting and gathering of food to an agricultural society with stable communities and working and leisure classes. According to Toffler, formal education was reserved for the rich. The majority of the people learned to work and little else.

The development of machines brought about the second wave, the industrial age (Toffler, 1980). During this period, education of the masses became important. Toffler asserted children were taught skills necessary to function in factories. They learned basic knowledge (the three R's), to be punctual, to follow directions, to be quiet, to recognize the authority of a supervisor, and how to work at monotonous tasks for long periods of time.

Today, as a result of the invention of the computer, American society is in the midst of the third wave, the transition from the industrial age to the informational age (Toffler, 1980). In *Megatrends: Ten New Directions Transforming Our Lives*, Naisbitt (1982) predicted that by 1990 three out of four Americans will earn their pay by manipulating information. Statistics from the U.S. Bureau of the Census (1986, p. 385) show that 55.2 percent of American workers in 1985 were employed in managerial, professional, technical, administrative support, or sales related jobs. Nonagricultural labor intensive jobs employed 15.7 percent of the work force and only 3.2 percent of the American workers held jobs relating to agriculture. Statistics such as these demonstrate the third wave is rapidly spreading across America.

Professional educators across the country are recognizing that American education must offer today's students more than minimal competencies and the development of basic cognitive thought. In 1966, the Northwest Regional Educational Laboratory adopted the "Taba Method" as one of its programs for regional dissemination. This method of instruction was developed as a result of research done by Dr. Hilda Taba, which revealed that the most marked single influence on the cognitive development of students resided in the impact of teaching strategies that encourage formal thought in planned classroom discussion (Taba, 1964). In *A Nation at Risk: The Imperative for Educational Reform*, the National Commission on Excellence in Education (1983) stated, "This promise (of education) means that all children . . . can hope to attain the mature and informed judgment needed to secure gainful employment and to manage their own lives" (p. 8). In 1984, the Association for Supervision and Curriculum Development (ASCD) surveyed a sample of members to determine the educational topics on which they wanted more information; 82 percent named instruction in thinking (Chance, 1986). Improvement of students' thinking was ranked as the most important of 25 educational goals in the 1985 Gallup Poll on teachers' attitudes toward the public schools (Gallup, 1985). However, 54.8 percent of the high school students surveyed in a national study reported they did not feel their school placed enough emphasis on developing students' ability to think (Clark, 1987).

It is generally accepted that one of the primary goals of colleges and universities is to stimulate critical thinking within students. The importance of including critical thinking in higher education curricula was emphasized in the reports, *Involvement in Learning* (National Institute

of Higher Education, 1984) and *Integrity in the College Curriculum* (Association of American Colleges, 1985). These reports strongly recommended the teaching of thinking skills in higher education.

If the development of proficiency in critical thinking is to be a part of the curricula in institutions of higher education, then predictors of students' entry level proficiency in critical thinking should be determined. This study was designed to determine what selected characteristics of college freshmen can be used as predictors of entry level critical thinking proficiency.

Statement of the Problem

This study investigated whether or not the selected characteristics of entry level college freshmen could be used as predictors of proficiency in critical thinking. The problem of the study was twofold:

(1) To determine if selected variables of college aptitude and demographic characteristics can be used as predictors of proficiency in critical thinking for beginning college freshmen.

(2) To determine if differences in levels of selected variables of college aptitude and demographic characteristics operated as predictors of proficiency in critical thinking for beginning college freshmen.

Need for the Study

Beyer (1984) summed up the current state of the teaching of thinking skills when he stated, "The teaching of thinking skills is a lot like the weather. Almost everybody talks about it, but few educators seem to be

able to do much to improve it" (p. 486). Current literature indicated a limited, and in many instances complete absence of, assessment of students' proficiency in critical thinking by public schools and institutions of higher education. Authorities in curriculum design (Doll, 1974; Guskey, 1985; McNeil, 1985) have stressed the importance of reliable and valid measures of students' performance in curriculum evaluation. This study gives public schools and institutions of higher education in Montana an indication of the current critical thinking proficiency of graduates choosing to enter institutions of higher education. It also provides institutions of higher education information as to whether or not variables investigated in this study can be used as predictors of critical thinking proficiency for incoming students.

As a result of this study, public schools and institutions of higher education have a better understanding of how the variables investigated operate as predictors of critical thinking. This allows institutions of higher learning and public schools a means to better meet the needs of students in regard to assessing students' proficiency in critical thinking.

General Questions to Be Answered

(1) Which of the selected variables of college aptitude and demographic characteristics can be used as predictors of entry level proficiency in critical thinking for college freshmen?

(2) Do differences in levels of the variables of college aptitude and demographic characteristics operate as predictors of entry level proficiency in critical thinking for college freshmen?

General Procedures

The procedures followed in this study began with a thorough survey of the literature and existing research with regard to the relationship between proficiency in critical thinking and college aptitude and demographic characteristics of students.

The population for this study was composed of students entering Montana State University in the fall of 1987. The sample consisted of students enrolled in Introduction to College Writing (ENG 121) who had complete *ACT College Reports* on file with the university and who had completed the Watson-Glaser Critical Thinking Appraisal.

The Watson-Glaser Critical Thinking Appraisal (WGCTA) was used as a measure of students' critical thinking proficiency. The WGCTA is a 40-minute test that measures students' critical thinking abilities using subtests of inference, recognition of assumptions, deduction, interpretation, and evaluation of arguments. The raw composite score on the WGCTA reflects students' abilities to perform correctly the universe of tasks represented by the five subtests. These tasks are generally accepted as the foundation of critical thinking (Berger, 1985).

Arrangements were made through the Vice President of Academic Affairs, the Registrar, the Supervisor of Admissions, and the Data Management Center at Montana State University to obtain data essential to this study from the ACT reports of students. All guidelines set forth by the university to maintain the confidentiality of information from students' files were observed by the researcher in procedures of this study.

The data were analyzed using descriptive statistics, multiple linear regression, stepwise regression, and one-way analysis of variance. From the results, conclusions were drawn and recommendations for future research were suggested.

Limitations and Delimitations

Limitations

The study was limited to first quarter freshmen at Montana State University enrolled in Introduction to College Writing during the fall 1987 quarter who completed the Watson-Glaser Critical Thinking Appraisal and who had complete *ACT College Reports* on file at Montana State University.

Delimitations

(1) The strata for the students' WGCTA raw scores were limited to the four national raw score intervals reported in the *Watson-Glaser Critical Thinking Appraisal Manual*.

(2) The strata for the students' ACT standard scores were limited to the four national standard score intervals reported in *The ACT High School Profile Report, 1987*.

(3) The strata for the students' high school GPAs were limited to the five strata listed on the *ACT College Report*.

(4) The strata for the size of students' high school senior classes were limited to the seven strata listed in the *ACT College Report*.

(5) The strata for the students' anticipated college majors were limited to eight colleges/schools listed in the *Montana State University Undergraduate Catalog, 1986-88*.

Definition of Terms

(1) *ACT College Report*: A report to colleges by the American College Testing Program summarizing a student's raw and normed scores on subtests, raw and normed composite scores, and various demographic data.

(2) Anticipated college major: The major selected by first choice on a student's *ACT College Report*.

(3) Critical thinking: "The use of basic thinking processes to analyze arguments and generate insight into particular meanings and interpretations; develop cohesive, logical reasoning patterns and understand assumptions and biases underlying particular positions; attain a credible, concise, and convincing style of presentation" (Presseisen, 1985, p. 44).

(4) ENG 121: The course abbreviation for College Writing I which is a required introductory course in college writing offered by the Montana State University Department of English.

(5) High school GPA: The self-reported grade point average of a student on the *ACT College Report*.

(6) Proficiency in critical thinking: For the purpose of this study, critical thinking proficiency was measured by the composite score of students on the Watson-Glaser Critical Thinking Appraisal. The raw composite reflected the student's ability to perform correctly the tasks of inference, recognition of assumptions, deduction, interpretation, and evaluation of arguments.

(7) SAS: A statistical computer program developed by Statistical Analysis Systems Institute, Inc.

(8) WGCTA: The Watson-Glaser Critical Thinking Appraisal.

CHAPTER 2

REVIEW OF LITERATURE

"A questioning, critical attitude is one of the hallmarks of higher education" (Furedy & Furedy, 1985, p. 51). *The President's Commission for a National Agenda for the Eighties* (Cadette et al., 1981, p. 96) stated, "In the 1980's, students must be offered competent instruction--particularly in reading, writing, mathematics, and processes of logical thought. . . ." Education in this form should require both the students and the teachers to come together to examine and question various issues and assert new hypotheses to be tested. Critical thinking should be an integral part of higher education curricula and should be a fundamental component of public education. Yet, few teachers can readily explain precisely how they attempt to develop proficiency in critical thinking among students (Furedy & Furedy, 1985).

This does not mean that educators are unaware of the need to include the development of critical thinking in educational goals. Brandt (1984) recognized the high level of interest in critical thinking when he stated:

> Educators across the country are reviewing their curricula and looking for assistance in planning thinking skills programs. . . . The stress on intellectual development voiced in the recent national reports makes it prudent for schools to provide for the teaching of thinking throughout the curriculum. (p. 3)

Current research and theory on cognition suggest that knowledge of an academic area is fluid and generative (Glasser, 1987; McKeachie,

1987). In a report conducted by the Mid-Continent Regional Educational Laboratory, researchers stated:

> What is needed is a reconceptualization of our current curriculum and instructional practices. We need to integrate a systematic approach to introducing thinking skills into the school experience. . . . To do that will require the development of a new, unified approach to defining what we mean by thinking skills and the integration of those thinking skills into the daily interplay among teacher, student and curriculum. (Marzano & Hutchins, 1985, p. 2)

An inherent step in the introduction of thinking skills into the curriculum is the determination of students' entry level proficiency in thinking. This study assessed to what extent selected variables of college aptitude and demographic characteristics operate as predictors of proficiency in critical thinking for incoming college freshmen.

Therefore, for the purpose of this study, the review of literature was divided into three main categories: (1) literature defining critical thinking, (2) assessments of critical thinking, and (3) research related to predictors of proficiency in critical thinking.

Defining Critical Thinking

Furedy and Furedy (1985) stated, "Research into critical thinking is difficult, partly because there is no agreed-upon general definition of critical thinking" (p. 52). As noted by Costa et al. (1985), the core discipline for critical thinking is philosophy. They referred to the fact that the majority of ideas and writings pertaining to critical thinking come from philosophy. The researcher explored the literature to determine the current positions pertaining to defining critical thinking.

The term "critical thinking," as applied in modern education, had its origins in the works of John Dewey. In *How We Think*, Dewey (1910) discussed a phenomenon called reflective thought, which he defined as "active, persistent, and careful consideration of any belief or supposed form of knowledge in the light of the grounds that support it and the further conclusion which it tends" (p. 9).

Anderson (1942) stated that critical thinking was a process of systematic thought that included inductive and deductive reasoning to help understand data and generalizations. He also noted that critical thinking has three essential elements: (1) defining problems; (2) locating, selecting, and organizing information; and (3) evaluating information.

In *Critical Thinking*, Black (1946) suggested that the goal of critical thinking is to guard people against prolific, ungrounded truths or uncertainties, errors in judgments and blind beliefs in absurdities. The attainment of the new truths depends on conditions such as clarity of discourse, freedom from contradictions, and the use of analytic thought methods to achieve correct solutions to problems or right answers to questions.

Watson & Glaser (1942) carried out a number of studies of critical thinking abilities in high school students. The subjects in experimental groups were taught some of the essentials of logic and the psychology of thinking, with practice in recognition of errors and critical evaluation of newspaper articles. The experimental groups performed consistently better than the control groups on tests that included such items as (1) survey of opinions, (2) general logic, (3) inference test,

(4) generalization test, and (5) evaluation test. These studies demonstrated that critical thinking was a cognitive process that could be taught and measured. As a result of these studies, the definition of critical thinking was operationalized in the Watson-Glaser Test on Critical Thinking.

Watson and Glaser (1953) revised the test to include the five subtests of inference, recognition of assumptions, deduction, interpretation, and evaluation of arguments which are currently found in the Watson-Glaser Critical Thinking Appraisal. These subtests were developed out of the authors' belief that critical thinking represents the ability of an individual to: (1) recognize the existence of problems and the need for evidence to support what is asserted to be true, (2) make valid generalizations and inferences by logically determining the accuracy of different kinds of evidence, and (3) utilize skills necessary in employing and applying the above attitudes and knowledge.

Smith (1953) and Dressel and Mayhew (1954) also contributed to the development of the conceptual definition of critical thinking. Smith (1953) described critical thinking as a kind of problem solving in which the purpose is to decide whether what is stated is dependable and reliable. Dressel and Mayhew (1954) defined critical thinking to be related to abilities in problem solving, selection of pertinent information, recognition of stated and unstated assumptions, formulation of relevant hypotheses, and drawing valid conclusions and judging the validity of inferences.

Black (1962) defined critical thinking as a process involving the organization and unbiased examination of stimuli through comparison with

relevant, objective evidence, and with the norms of conduct and behavior and formulation and verification of hypotheses.

Ennis (1964) attempted to clarify and limit critical thinking by defining it as determining the meaning of a statement and deciding whether to accept it or reject it. Ennis (p. 600) also noted that critical thinkers had abilities to judge whether:

1. a statement follows from a premise;
2. a statement is an assumption;
3. an observation statement is reliable;
4. a simple generalization is warranted;
5. a hypothesis is warranted;
6. a theory is warranted;
7. an argument depends on ambiguity;
8. a statement is overly vague or overly specific;
9. an alleged authority is reliable.

Usery (1967) defined critical thinking as the act of searching for the clearest idea about a subject derived from facts, points of view, observations, and other elements. The final result is the ability to use logical and creative thinking to make judgments that would become the basis for action.

Ennis (1967, p. 11) attempted to further clarify and specify the various aspects of critical thinking by defining it as the assessing of statements and by enumerating 12 essential aspects of critical thinking as individual abilities in:

1. grasping the meaning of a statement;
2. judging whether there is an assumption in a line of reasoning;
3. judging whether certain statements contradict one another;
4. judging whether conclusions follow necessarily;
5. judging whether a statement is specific enough;
6. judging whether a statement is actually the application of certain principles;
7. judging whether an inductive conclusion is warranted;

8. judging whether a problem has been identified;
9. judging whether an observation statement is reliable;
10. judging whether something is an assumption;
11. judging whether a statement by an alleged authority is acceptable;
12. judging whether a definition is adequate.

Pascual-Leone (1970) described the development of the capacity for critical thinking when he found evidence of an individual's capacity to deal with independent ideas and to relate them in increasing combinations in two- or three-year spurts from about age 3 through 17.

D'Angelo (1971) stated that critical thinking was a process of evaluating statements, arguments, and experiences. The process requires open-mindedness, flexibility, objectivity, persistence, decisiveness, respect for interpretations, being systematic and intellectually curious, skepticism, and honesty.

Ennis and Millman (1971) defined critical thinking as reasonable assessing of statements. They noted that a critical thinker should possess some specific characteristics as defined by Ennis (1967) in *A Concept of Critical Thinking*. By operationalizing these characteristics, Ennis and Millman (1985) created the Cornell Critical Thinking Test in 1971.

Henderson (1972) stated that to engage in critical thinking is to engage in criticism or the application of criteria or standards in the act of making judgments. He pointed out that such a concept of critical thinking is consistent with the views of both Ennis (1964, 1967, 1972) and Smith (1953).

The College Board (1981) described critical thinking as the ability to: (1) identify and formulate problems; (2) propose and evaluate

solutions to problems; (3) recognize and use inductive and deductive reasoning; (4) draw reasonable conclusions from various sources of information; (5) comprehend, develop, and use concepts and generalizations; and (6) distinguish between fact and opinion.

Presseisen's (1985) definition of critical thinking was chosen by the Association for Supervision and Curriculum Development as one of the operational definitions in the resource book, *Developing Minds*. She stated that critical thinking was:

> The use of basic thinking processes to analyze arguments and generate insight into particular meanings and interpretations; develop cohesive, logical reasoning patterns and understand assumptions and biases underlying particular positions; attain a credible, concise, and convincing style of presentation. (Presseisen, 1985, p. 45)

Bitner (1986) defined critical thinking as an eclectic style of thinking involving logical, creative, and reflective thinking to analyze, synthesize, verify and evaluate information.

Sternberg (1986) defined critical thinking as the mental processes, strategies, and representations people use to solve problems, make decisions, and learn new concepts.

In *A Taxonomy of Critical Thinking Skills*, Ennis (1987) further suggested that critical thinking results from the interaction of a set of dispositions toward critical thinking with a set of abilities for critical thinking. The dispositions include: (1) seeking a clear statement of the thesis or question, (2) seeking reason, (3) trying to be well-informed, and (4) trying to remain relevant to the main point. The set of abilities are classified under five categories: (1) elementary

clarification, (2) basic support, (3) inference, (4) advance clarification, and (5) strategy and tactics.

According to Paul (1987), an essential element of critical thinking is the ability to see things from other people's point of view. Paul referred to such thinking as dialogical.

As can be seen, there are as many definitions of critical thinking as there are theorists. Critical thinking has been practiced since at least the days of Plato. However, there is still much that remains unknown about the process of cognition, which leads to the ambiguity found in definitions of critical thinking. Of the definitions presented above, the researcher considered Presseisen's to be the one that best summarized current thoughts on critical thinking. Therefore, the operational definition for critical thinking used in this study was:

> The use of basic thinking processes to analyze arguments and generate insight into particular meanings and interpretations; develop cohesive, logical reasoning patterns and understand assumptions and biases underlying particular positions; attain a credible, concise, and convincing style of presentation. (Presseisen, 1985, p. 45)

Assessments of Critical Thinking

The literature has revealed that three tests are generally used in studies to assess critical thinking abilities (Arter & Salmon, 1987; Ennis, 1985; Morante & Ulesky, 1984; Sternberg, 1986). These tests are the Cornell Critical Thinking Test, the New Jersey Test of Reasoning, and the Watson-Glaser Critical Thinking Assessment. The review of literature for this section focused on the content, validity and reliability of the above referenced tests.

The Cornell Critical Thinking Test (CCTT), Level Z (Ennis & Millman, 1985) is a test designed to evaluate the critical thinking abilities of advanced high school students, college students and adults, as defined by Ennis (1964, 1967, 1972) and Ennis and Millman (1971). It contains 52 items divided into seven sections on induction, credibility, prediction and experimental planning, fallacies, deduction, definition, and assumption identification.

The validity of the test was established through the theoretical work of Ennis (1964, 1967) and Ennis and Millman (1971). The test manual (Ennis & Millman, 1971) reported that the CCTT correlates moderately with tests of vocabulary (.37 to .53) and mathematical abilities (.37 to .62), and negatively or very low with tests of attitudes. These correlations are in line with the construct assertions of Ennis (1964, 1976) that critical thinking is a skill associated with language and logic.

The test manual (Ennis & Millman, 1971) reported reliability for Level Z as ranging from .55 to .77. Follman and Miller (1971) reported the split half and total test reliability as .548 and .632, respectively.

The New Jersey Test of Reasoning Skills was developed by Virginia Shipman (1983) of the Educational Testing Service and used in conjunction with the Philosophy for Children program of Lipman et al. (1977). The New Jersey Test of Reasoning Skills is a 50-item inventory purporting to measure 22 different skill areas. The test is highly verbal. Its reliability was reported to be in the mid-to-high .80s and it is reported to correlate at the .6 to .8 level with subtests of the New Jersey College Basic Skills Placement Test.

The Watson-Glaser Critical Thinking Appraisal (WGCTA) was designed to determine the levels of various aspects of an individual's critical thinking ability. The WGCTA is a 40-minute test, consisting of 80 items, that measures students' critical thinking abilities using subtests of 16 items each. The subtests are inference, recognition of assumption, deduction, interpretation, and evaluation of arguments. The raw composite score reflects students' abilities to perform correctly the universe of tasks represented by the five subtests.

Validity of the WGCTA has been established through construct and content analysis since 1953 by judgments of qualified persons (Berger, 1985) and correlations with other tests (Watson & Glaser, 1980). The WGCTA has been shown to correlate at the .01 level of significance with various measures of academic achievement, including the Stanford Achievement Test (r=.53), Otis-Lennon Mental Ability Test (r=.81), Scholastic Aptitude Test (r=.69), and American College Testing Program (r=.65).

According to Berger (1985, p. 1692), the reliability of the test has been determined through estimates of the test's internal consistency (split-half reliability coefficients ranged from .69 to .85), stability of test scores (test-retest at a three-month interval was .73 with means and standard deviations "virtually identical" across time), and scores on alternate forms (r=.75).

For this study the researcher chose the Watson-Glaser Critical Thinking Appraisal as the measurement of students' critical thinking ability. The factors on which the researcher based this decision were: (1) the WGCTA has been shown to be a valid and reliable test; (2) subtest areas measure the components of the operational definition of critical

thinking for this study; and (3) when the WGCTA and the CCTT were evaluated by a panel of 12 psychologists using the 10 essential validity standards and the five essential reliability and measurement error standards from the 1974 *Standards for Educational and Psychological Tests*, the WGCTA was judged to be equal to or superior to the CCTT in all categories (Modjeski & Michael, 1983).

Predictors of Proficiency in Critical Thinking

This study was limited to the investigation of ACT standard scores, high school GPA, anticipated college major, size of high school senior class and gender as potential predictors of critical thinking proficiency as measured by the WGCTA. ACT standard scores and high school GPAs were viewed as measures of college aptitude, while anticipated college majors, size of high schools, and gender were selected as the demographic characteristics to be investigated. In this section, literature and research studies that relate these variables to WGCTA scores were reviewed.

College Aptitude

The literature revealed that limited studies have been conducted concerning the relationship between proficiency in critical thinking and measures of college aptitude. Table 1 presents a summary of studies cited by Watson and Glaser (1980) in *The Critical Thinking Assessment Manual*.

The data in Table 1 show that formal tests of college aptitude were generally consistent in correlation with the WGCTA and that various averages of grades were inconsistent in correlation.

Table 1. Correlations between WGCTA and various predictors of college aptitude.

Student Group	N	Variable	R
Public School, Grade 12	55	Otis-Lennon Mental Ability, Int.	.70**
Freshmen at SE College	26	Course Grades in Eng. Composition	.16
	20	Scholastic Aptitude, Verbal	.69**
Freshmen at U. in South	61	ACT, Composite	.65**
	61	California Achievement, Reading	.64**
	61	1st Semester GPA	.30*
Freshmen in Liberal Arts at NE U.	60	Scholastic Aptitude, Verbal	.60**
	60	Scholastic Aptitude, Math	.41**
Freshmen in Small NE College	50	Scholastic Aptitude, Verbal	.57**
	50	Scholastic Aptitude, Math	.29*
	116	1st Semester GPA	.19
College Nursing Students	32	Scholastic Aptitude, Verbal	.45**
	32	Scholastic Aptitude, Math	.48**
	24	ACT, English	.21
	24	ACT, Math	.30
	86	High School GPA	.19

*Denotes significant at .05 level.
**Denotes significant at .01 level.

Demographic Characteristics

Literature and studies pertaining to the relationship between proficiency of critical thinking and demographic characteristics were limited. For the purpose of this study, findings relating to the relationship between proficiency in critical thinking and the demographic characteristics of anticipated college major, high school size, and gender are presented in this section.

Norms for WGCTA raw scores corresponding to many different groups have been developed. These include: state highway patrol officers; police officers; sales representatives; preprofessional groups of teachers, nurses, MBA students, and medical students; high school students by grade level; and college students in general (Watson & Glaser, 1980). In many instances these norms were used in the process of determining employment eligibility and admission standards. However, to date no studies exist that address the relationship between WGCTA raw scores and anticipated majors for college students.

No studies were found by the researcher that investigated school size as a predictor of critical thinking proficiency. However, Clarke (1985) cited numerous studies investigating the relationship between school size and success in college. Twenty-six of these studies found no significant relationship between success in college and size of high school while 29 studies showed a significant relationship. Clarke's study supported the position that the size of students' high schools was not related to academic success in college.

Studies which have investigated the relationship between proficiency in critical thinking and gender have shown inconsistent findings. Simon and Ward (1974) reported that college men performed at a significantly higher level than college women on the WGCTA. Mattheis (1988) found significant differences in logical thinking abilities favoring high school male students in both North Carolina and Japan.

Bushner (1986) found that gender was not a significant predictor of critical thinking. Bitner (1986) found no significant differences in logical thinking ability of high school students in a north Arkansas high

school. Baxter-Magolda (1987) found that proficiency in the development of critical thinking is not significant to either gender. Riley (1988) found similar results in high school students in the Philippines.

Sadker and Sadker (1985, 1986) found that the classroom interaction and organization tend to favor behavior patterns that would encourage male students to develop proficiency in critical thinking, while at the same time discouraging its development among female students. Baxter-Magolda (1987) supported this position when she asserted that the learning environment found in college classrooms tended to use learning styles favored by males. This "favoritism" encouraged the development of methods of reasoning predominately used by males.

Summary

In this chapter the researcher reviewed the literature in three sections: (1) literature defining critical thinking, (2) assessments of critical thinking, and (3) research related to predictors of proficiency in critical thinking.

The first section showed the chronological development of critical thinking definitions. The definition by Presseisen (1985) was selected as the operational definition of critical thinking for this study:

> The use of basic thinking processes to analyze arguments and generate insight into particular meanings and interpretations; develop cohesive, logical reasoning patterns and understand assumptions and biases underlying particular positions; attain a credible, concise, and convincing style of presentation. (p. 45)

In the second section, the researcher reviewed three of the most widely used measures of critical thinking proficiency. Based upon the

needs of this study and the data pertaining to content validity, construct validity, and reliability, the researcher chose the Watson-Glaser Critical Thinking Assessment as the instrument to be used in measuring students' proficiency in critical thinking.

In the third section, the literature revealed that correlations of formal tests of college aptitude with the WGCTA were generally consistent, while correlations with grade point averages were inconsistent. The *ACT User Handbook* (ACT, 1989, p. iv) stated that each year over one million high school students take the ACT. The results of these tests are used by high schools across the country as a basis for counseling and curriculum evaluation. More than 3,300 two-year and four-year colleges and state educational systems depend on the ACT results for admission and placement functions. Because of the wide use of the ACT program on a national scale and the availability of ACT scores at Montana State University, a portion of this study was designed to investigate whether or not ACT scores could be used as predictors of critical thinking proficiency for college freshmen. Also, the study design allowed for high school grade point averages of college freshmen to be investigated as predictors of critical thinking proficiency.

The review demonstrated the need for investigating the relationship between critical thinking proficiency and the variable of anticipated college major. It was shown that WGCTA raw scores have been normed for many different groups. However, no studies have investigated the relationship between critical thinking proficiency and college freshmen by anticipated major.

It was also shown that no studies have investigated the relationship between critical thinking proficiency and size of students' high schools, even though many studies have been done investigating the relationship between academic success of college students and size of students' high schools. If critical thinking is an important component of the curricula of institutions of higher education (as Chapter 1 of this study suggests), then the researcher believes it is only logical to investigate this variable as part of this study.

The review of literature relating to the relationship between critical thinking proficiency and gender indicates that males seem to perform better than females on assessments of critical thinking. The researcher chose to investigate this relationship to determine whether this tendency was true for this study.

CHAPTER 3

PROCEDURES

The problem of this study was to determine if selected variables of students entering college could be used as predictors of proficiency in critical thinking. The researcher examined selected measures of college aptitude and demographic characteristics of entering 1987 freshmen at Montana State University (MSU) to determine the significance of these variables as predictors of critical thinking proficiency.

This chapter describes the population, sampling procedure, data collection process, hypotheses, and statistical procedures that were employed in this study.

Population Description and Sampling Procedure

The population for this study was composed of the freshmen entering Montana State University in the fall of 1987. Montana State University is a four-year, coeducational, state university located in southwestern Montana. The school is one of two universities in the Montana University System which is composed of six institutions of higher learning. It was established as a land-grant, agricultural college in 1893. Degrees offered include the baccalaureate, master's, and doctorate. The university is accredited by the Northwest Association of Schools and Colleges. Enrollment is approximately 10,000 students and is composed of 95 percent

white, 1 percent Asian, 1 percent black, 1 percent Hispanic, and 2 percent Native American students, with 15 percent of the students being from out-of-state. Fifty-three percent of enrolling freshmen ranked in the top one-fifth of their high school class.

The sample consisted of students from the population who were enrolled in ENG 121 in the fall of 1987. The Registrar (Joseph Frazier) and the Director of Writing (Dr. John Ramage) stated that students traditionally enroll in ENG 121 on a random basis. The sample was limited to only those students who had completed the Watson-Glaser Critical Thinking Assessment and had complete *ACT College Reports* on file with the university. Of the 373 students enrolled in ENG 121, 312 completed the WGCTA. Of this number, 203 had complete *ACT College Report* forms on file and were included in the sample of this study.

A minimum ratio of sample size to independent variable of 30:1 is recommended by Kerlinger (1965) when multiple regression is used. In this study, five of the independent variables were analyzed by application of multiple regression. Therefore, a minimum sample size of 150 was needed for a valid study. The sample of 203 was sufficiently large to permit valid analysis by application of multiple regression.

Data Collection

Data collected for this study included the WGCTA raw score, ACT standard score, high school GPA, anticipated college major, size of high school senior class, and gender of each student in the sample of this study.

Permission was obtained from the MSU Director of Writing to seek the cooperation of instructors in the administration of the Watson-Glaser Critical Thinking Assessment to students in ENG 121 during the first week of the 1987 fall quarter. The WGCTA is a 40-minute, paper-pencil test designed to measure proficiency in critical thinking ability. The split-half reliability ranged from .69 to .85 and test-retest reliability was reported to be .73 for a three-month interval. Alternate form reliability was established to be .75. Validity has been established through construct and content analysis and from various studies (Berger, 1985). The publisher notes that reliability estimates and validity reports from numerous studies since 1964 warrant use of the WGCTA in group administration and research (Watson & Glaser, 1980). The WGCTA was administered to nine of the ten sections of ENG 121. The tests were then hand-scored by the researcher using the hand-scoring key supplied with the test.

Students' ACT standard scores, high school GPA, size of high school senior class, anticipated college major, and gender were obtained from the university's file of *ACT College Reports*. The researcher requested a list of students enrolled in ENG 121 for the 1987 fall quarter from the registrar to be sent to a data management specialist for the purpose of compiling data for this study. The researcher also obtained permission from the supervisor of the Office of Admissions for the data management specialist to have access to the university's ACT magnetic tapes for the purpose of compiling data for this study. Once the necessary permission was obtained, information relevant to this study was retrieved from the magnetic tapes of students' *ACT College Reports* and forwarded to the researcher.

Memoranda of understanding regarding the administration of the Watson-Glaser Critical Thinking Assessment and the retrieval of data from the *ACT College Reports* are contained in Appendix A.

Method of Organizing Data

Frequency distribution tables were used to illustrate the number and percentage of students in each stratum of WGCTA national raw score intervals, ACT national standard score intervals, high school grade point average intervals, colleges of anticipated major, high school senior class size intervals, and gender. The strata and coding (codes shown below in parentheses) for each variable of this study were established by the researcher as follows:

(1) The strata for the students' WGCTA raw scores corresponded to the WGCTA national raw score intervals reported in the *Watson-Glaser Critical Thinking Appraisal Manual*. These strata were: (1) 62-80, (2) 55-61, (3) 48-54, and (4) 0-47.

(2) The strata for the students' ACT standard scores corresponded to the 1987 ACT national standard score intervals reported in *The ACT High School Profile Report, 1987*. The strata were: (1) 26-36, (2) 21-25, (3) 16-20, and (4) 1-15.

(3) The strata for the students' high school GPAs corresponded to the seven intervals listed on the *ACT College Report*. These strata were: (1) 0.5-0.9, (2) 1.0-1.4, (3) 1.5-1.9, (4) 2.0-2.4, (5) 2.5-2.9, (6) 3.0-3.4, and (7) 3.5-4.0.

(4) The strata for the size of students' high school senior classes corresponded to the seven intervals listed in the *ACT College Report*.

These strata were: (1) 1-24, (2) 25-99, (3) 100-199, (4) 200-399, (5) 400-599, (6) 600-899, and (7) 900 and up.

(5) The strata for the students' anticipated college majors corresponded to the colleges/schools listed in the *Montana State University 1986-88 Undergraduate Catalog*. These strata were the Colleges of: (1) Agriculture, (2) Arts and Architecture, (3) Business, (4) Education, (5) Engineering, (6) Letters and Science, (7) Nursing, and (8) General Studies/non-degree programs.

(6) The strata for the gender of students were: (1) female, and (2) male.

For the purpose of analysis, each student was assigned a random three-digit identification number and the research data were entered into a database as shown in Table 22 of Appendix B.

Hypotheses to Be Tested

Ferguson (1982) stated that it is conventional to adopt levels of significance at either .05 or .01. "For most practical purposes it is sufficient to designate the probability as $P < .05$ or $P < .01$" (p. 162). He further stated that the investigator may adopt, perhaps arbitrarily, a particular level of significance. For the purpose of this study, the .05 level of significance has been adopted by the researcher.

The null hypotheses tested at the .05 level of significance were as follows:

(1) The R^2 between the dependent variable, WGCTA raw scores, and the independent variables of strata based on ACT national standard

scores, high school GPA, college of anticipated major, high school senior class size, and gender is zero.

(2) The independent variable of ACT national standard score strata does not make a significant contribution to the R^2 of the multiple regression model developed in hypothesis 1.

(3) The independent variable of high school GPA strata does not make a significant contribution to the R^2 of the multiple regression model developed in hypothesis 1.

(4) The independent variable of college of anticipated major strata does not make a significant contribution to the R^2 of the multiple regression model developed in hypothesis 1.

(5) The independent variable of high school senior class size strata does not make a significant contribution to the R^2 of the multiple regression model developed in hypothesis 1.

(6) The independent variable of gender does not make a significant contribution to the R^2 of the multiple regression model developed in hypothesis 1.

(7) There are no significant differences between mean WGCTA raw scores based on strata of ACT national standard scores.

(8) There are no significant differences between mean WGCTA raw scores based on strata of students' high school GPA.

(9) There are no significant differences between mean WGCTA raw scores based on strata of students' anticipated college major.

(10) There are no significant differences between mean WGCTA raw scores based on strata of students' high school senior class size.

(11) There are no significant differences between mean WGCTA raw scores based on students' gender.

Analysis of Data

Descriptive statistics were used to summarize various factors of this study. The data were expressed in terms of frequency tables illustrating numbers and percentages. Engelhart (1972) stated, "[I]n the realm of descriptive statistics are counts and percentages classified in various ways, distribution of test scores, tables, and graphs. All of these are useful in summarizing data so as to facilitate their interpretation" (p. 194).

Multiple linear regression was used to test hypothesis 1. Cohen and Cohen (1975) stated:

> Multiple regression/correlation analysis is a highly general and therefore very flexible data-analytic system that may be used whenever a quantitative variable (the dependent variable) is to be studied as a function of, or in relationship to, any factors of interest (expressed as independent variables). (p. 3)

Stepwise regression was used to analyze hypotheses 2 through 6 in order to determine if any of the partial regression coefficients were significant at the .05 level and the order of contribution to the total variance for each of the significant independent variables.

A one-way analysis of variance was utilized to test hypotheses 7 through 11 at the .05 level of significance. According to Ferguson (1981), a one-way analysis of variance is the appropriate test when the data have been organized such that the researcher is testing for differences in a dependent variable among groups which represent categories of a single independent variable.

The researcher rejected the null hypothesis if an ANOVA produced an F-ratio that was statistically significant at the .05 level. The Tukey post hoc analysis for multiple comparisons was used as the method of identifying the exact location of mean differences. Borg and Gall (1983) indicated that when it is determined significance exists between categories, a test for multiple comparisons should be used as a post hoc test to determine which differences among means of the independent variable strata were significant. The Tukey post hoc analysis was chosen by the researcher because it is a more stringent test than other post hoc methods. It has been called the "honestly significant difference method" leading to fewer significant differences than either the Newman-Keuls or the Dunkan (Ferguson, 1981).

Precautions Taken for Accuracy

The retrieval of relevant *ACT College Report* data and statistical computations was done using the computer facilities at Montana State University. WGCTA tests were hand-scored with the scoring, computation of raw scores, and recording of scores double checked by the researcher and verified by an independent agent. The various data analyses were completed by computer utilizing the SAS software program.

CHAPTER 4

RESULTS

This study investigated the relationship between selected variables of college freshmen and proficiency in critical thinking. Emphasis was placed on which variables could be used as predictors of proficiency in critical thinking. The study also determined which stratum of the variables related significantly to proficiency in critical thinking.

The results of this study are presented in two sections. First, the characteristics of the sample are shown by frequency tables illustrating the number and percentage of students in each strata of the selected variables. Second, the results of testing the statistical hypotheses by various statistical methods are presented. These include: the results from testing hypothesis 1 utilizing multiple linear regression, the results from the stepwise regression analysis of hypotheses 2 through 6, and the results from the testing of hypotheses 7 through 11 utilizing one-way analysis of variance.

Characteristics of the Sample

The following frequency distribution tables summarize the number and percentage of students in each stratum of: WGCTA national raw score intervals (Table 2), ACT national standard score intervals (Table 3), high school grade point average intervals (Table 4), colleges of anticipated major (Table 5), high school senior class size intervals (Table 6), and gender (Table 7).

Table 2. Number and percentage of students by WGCTA national raw score intervals.

Stratum	Raw Score Interval	Number	Percentage
1	62 - 80	31	15
2	55 - 61	62	31
3	48 - 54	61	30
4	0 - 47	49	24
Totals		203	100

Table 3. Number and percentage of students by ACT national standard score intervals.

Stratum	Standard Score Interval	Number	Percentage
1	26 - 36	42	20
2	21 - 25	99	49
3	16 - 20	38	19
4	1 - 15	24	12
Totals		203	100

Table 4. Number and percentage of students by high school GPA intervals.

Stratum	H.S. GPA Interval	Number	Percentage
1	0.5 - 0.9	0	0
2	1.0 - 1.4	1	0
3	1.5 - 1.9	7	3
4	2.0 - 2.4	20	10
5	2.5 - 2.9	31	15
6	3.0 - 3.4	84	42
7	3.5 - 4.0	60	30
Totals		203	100

Table 5. Number and percentage of students by college of anticipated major.

Stratum	College of Anticipated Major	Number	Percentage
1	Agriculture	12	6
2	Arts and Architecture	17	8
3	Business	41	20
4	Education	15	7
5	Engineering	54	27
6	Letters and Science	18	9
7	Nursing	9	4
8	Undecided	37	19
Totals		203	100

Table 6. Number and percentage of students by high school senior class size.

Stratum	High School Senior Class Size	Number	Percentage
1	1 - 24	33	16
2	25 - 99	69	34
3	100 - 199	35	17
4	200 - 399	25	12
5	400 - 599	24	12
6	600 - 899	14	7
7	900 and up	3	1
Totals		203	100

Table 7. Number and percentage of students by gender.

Stratum	Gender of Students	Number	Percentage
1	Female	87	43
2	Male	116	57
Totals		203	100

Statistical Hypotheses

The statistical hypotheses in this study were tested using multiple linear regression, stepwise regression, and one-way analysis of variance. The level of significance used for all tests was $\alpha = .05$.

Hypothesis 1

Hypothesis 1 stated, "The R^2 between the dependent variable, WGCTA raw scores, and the independent variables of strata based on ACT national standard scores, high school GPA, college of anticipated major, high school senior class size, and gender is zero." Hypothesis 1 was tested utilizing multiple linear regression. The data for this test are summarized in Table 8.

Table 8. Summary of multiple linear regression of WGCTA raw scores by ACT national standard score strata, high school GPA strata, college of anticipated major strata, high school senior class size strata, and gender.

Source	DF	Sum of Squares	Mean Square	R^2	F
Model	5	3804.27960	760.85592	0.2878	15.841
Error	197	9413.76495	48.02941		
C Total	202	13218.04455			
		Prob. > F 0.0001			

The R^2 of 0.2878 in Table 8 indicates that 28.78 percent of variance of WGCTA raw scores is predictable from the variance of the independent variables. The F-ratio of 15.841 indicates that this relationship between the dependent and independent variables is significant at a level of less than .05; therefore, hypothesis 1 was rejected. The results of the tested hypothesis showed that there was a significant relationship ($P < .05$) between WGCTA raw scores and the independent variables of ACT national standard score strata, high school GPA strata, college of anticipated major strata, high school senior class size strata, and gender.

Hypotheses 2 through 6

Hypotheses 2 through 6 stated that the independent variables of ACT national standard score strata, high school GPA strata, college of anticipated major strata, high school senior class size strata, and gender made no significant contributions to the R^2 of the multiple regression model developed in hypothesis 1.

These hypotheses were tested utilizing stepwise regression. Stepwise regression selects independent variables for an equation one at a time. The most valid predictor variable is selected first, followed by the variable which adds the most to the multiple correlation. Subsequent variables are selected in like manner until a variable, when added, produces no appreciable increase in correlation (Kerlinger, 1965).

Table 9 shows that the independent variable of ACT national standard score strata contributed 28.41 percent of the total variance of 28.78 percent that was found in the multiple regression model. This contribution was significant at a level of less than .05. The other independent variables did not enter into the stepwise regression equation because of their small contribution to the total variance. Therefore, hypothesis 2 was rejected and hypotheses 3 through 6 were retained.

Table 9. Summary of stepwise regression of WGCTA raw scores by ACT national standard score strata.

Source	DF	Sum of Squares	Mean Square	R^2	F
Regression	1	3755.32180	3755.32180	0.2841	79.37
Error	201	9462.72275	47.31361		
C Total	202	13218.04455			
		Prob. > F 0.0001			

Hypothesis 7

Hypothesis 7 stated, "There are no significant differences between WGCTA raw scores based on strata of ACT national standard scores." This hypothesis was tested utilizing one-way analysis of variance. The data are contained in Tables 10 and 11.

Table 10. Means of WGCTA raw scores based on strata of ACT national standard scores.

Stratum	ACT National Standard Score Interval	N (203)	Mean of WGCTA Raw Scores
1	26 - 36	42	59.12
2	21 - 25	99	54.39
3	16 - 20	38	49.82
4	1 - 15	24	45.42

Table 11. ANOVA table of mean WGCTA raw scores based on strata of ACT national standard scores.

Source	DF	Sum of Squares	Mean Squares	F-Ratio	Prob > F
Between groups	3	3758.90205	1252.96735	26.23	0.0001
Within groups	199	9459.14250	47.77345		
Total	202	13218.04455			

Results of the one-way analysis indicated there were significant differences ($P < .05$) between mean WGCTA raw scores based on strata of ACT national standard scores; therefore, hypothesis 7 was rejected.

A Tukey post hoc analysis for multiple comparisons was used in order to determine differences between groups at the .05 level. The data of the post hoc analysis are shown in Table 12. An examination of the data revealed that there were significant differences in all paired comparisons of mean WGCTA raw scores based on strata of ACT national standard scores except the comparison of groups 3 and 4.

Table 12. Tukey's post hoc analysis for paired comparisons of mean WGCTA raw scores based on strata of ACT national standard scores.

Strata Comparison	Lower Confidence Limit	Difference Between Means	Upper Confidence Limit	
1 - 2	1.6904	4.9932	8.2960	*
1 - 3	5.7700	9.7794	13.7889	*
1 - 4	9.5961	14.1786	18.7910	*
2 - 3	1.3639	4.7863	8.2086	*
2 - 4	5.1067	9.1854	13.2641	*
3 - 4	-0.2702	4.3991	9.0685	

*Significant at the .05 level.

Hypothesis 8

Hypothesis 8 stated, "There are no significant differences between WGCTA raw scores based on strata of students' high school GPA." This hypothesis was tested utilizing one-way analysis of variance. The data are contained in Tables 13 and 14.

Results of the one-way analysis indicated there were significant differences ($P < .05$) between mean WGCTA raw scores based on strata of students' high school GPA; therefore, hypothesis 8 was rejected.

Table 13. Means of WGCTA raw scores based on strata of students' high school GPA.

Stratum	High School GPA Interval	N (203)	Mean of WGCTA Raw Scores
1	0.5 - 0.9	(0)	o
2	1.0 - 1.4	(1)	o
3	1.5 - 1.9	(7)	53.71
4	2.0 - 2.4	(20)	50.75
5	2.5 - 2.9	(31)	52.39
6	3.0 - 3.4	(84)	53.32
7	3.5 - 4.0	(60)	56.15

Table 14. ANOVA table of mean WGCTA raw scores based on strata of students' high school GPA.

Source	DF	Sum of Squares	Mean Squares	F-Ratio	Prob > F
Between groups	5	912.94343	181.76571	2.91	0.0148
Within groups	197	12305.10112	62.46244		
Total	202	13218.04455			

A Tukey post hoc analysis for multiple comparisons was used in order to determine differences between groups at the .05 level. The analysis of data revealed that there were no significant differences in any of the paired comparisons of mean WGCTA raw scores based on strata of high school GPA.

Hypothesis 9

Hypothesis 9 stated, "There are no significant differences between WGCTA raw scores based on the strata of students' anticipated college

major." This hypothesis was tested utilizing one-way analysis of variance. The data are contained in Tables 15 and 16.

Table 15. Means of WGCTA raw scores based on students' anticipated college major.

Stratum	College of Anticipated Major	N (203)	Mean of WGCTA Raw Scores
1	Agriculture	12	55.58
2	Arts and Architecture	17	53.12
3	Business	41	52.37
4	Education	15	53.73
5	Engineering	54	55.43
6	Letters and Science	18	53.83
7	Nursing	9	49.89
8	Undecided	37	53.11

Table 16. ANOVA table of WGCTA raw scores based on students' anticipated college major.

Source	DF	Sum of Squares	Mean Squares	F-Ratio	Prob > F
Between groups	7	426.16127	60.35145	0.92	0.4897
Within groups	195	12791.88328	65.59940		
Total	202	13218.04455			

The one-way analysis of variance indicated there were no significant differences in WGCTA raw scores based on strata of students' anticipated college major. Therefore, hypothesis 9 was retained.

Hypothesis 10

Hypothesis 10 stated, "There are no significant differences between WGCTA raw scores based on strata of students' high school senior class

size." This hypothesis was tested utilizing one-way analysis of variance. The data are contained in Tables 17 and 18.

Table 17. Means of WGCTA raw scores based on strata of students' high school senior class size.

Stratum	High School Senior Class Size Interval	N (203)	Mean of WGCTA Raw Scores
1	1 - 24	33	53.03
2	25 - 99	69	53.96
3	100 - 199	35	55.46
4	200 - 399	25	52.04
5	400 - 599	24	52.08
6	600 - 899	14	55.14
7	900 and up	3	54.00

Table 18. ANOVA table of WGCTA raw scores based on strata of students' high school senior class size.

Source	DF	Sum of Squares	Mean Squares	F-Ratio	Prob > F
Between groups	6	288.41567	47.49659	0.72	0.6301
Within groups	196	12929.62888	65.96749		
Total	202	13218.04455			

The one-way analysis of variance indicated there were significant differences in WGCTA raw scores based on strata of students' high school senior class size. Therefore, hypothesis 10 was retained.

Hypothesis 11

Hypothesis 11 stated, "There are no significant differences between WGCTA raw scores based on students' gender." This hypothesis was tested

utilizing one-way analysis of variance. The data are contained in Tables 19 and 20.

Table 19. Means of WGCTA raw scores based on students' gender.

Stratum	Gender of Students	N (203)	Mean of WGCTA Raw Scores
1	Female	87	52.13
2	Male	116	54.86

Table 20. ANOVA table of WGCTA raw scores based on students' gender.

Source	DF	Sum of Squares	Mean Squares	F-Ratio	Prob > F
Between groups	1	372.04567	372.04567	5.79	0.0170
Within groups	201	12845.99858	63.91044		
Total	202	13218.04455			

The one-way analysis indicated there were significant differences ($P < .05$) between mean WGCTA raw scores based on students' gender. Therefore, hypothesis 11 was rejected. Tuckey's post hoc analysis for multiple comparisons was not used in this instance because there is only one pair of groups.

Summary

Table 21 presents a summary of the results of the statistical analyses of the 11 hypotheses of this study.

Table 21. Summary of statistical analyses.

Hypoth. No.	Statement	Retained	Rejected
1.	The R^2 between the dependent variable, WGCTA raw scores, and the independent variables of strata based on ACT national standard scores, high school GPA, college of anticipated major, size of high school senior class, and gender is zero.		X
2.	The independent variable of ACT national standard score strata does not make a significant contribution to the R^2 of the multiple linear regression model developed in hypothesis 1.		X
3.	The independent variable of high school GPA strata does not make a significant contribution to the R^2 of the multiple regression model developed in hypothesis 1.	X	
4.	The independent variable of college of anticipated major strata does not make a significant contribution to the R^2 of the multiple regression model developed in hypothesis 1.	X	
5.	The independent variable of high school senior class size strata does not make a significant contribution to the R^2 of the multiple regression model developed in hypothesis 1.	X	
6.	The independent variable of gender does not make a significant contribution to the R^2 of the multiple regression model developed in hypothesis 1.	X	
7.	There are no significant differences between WGCTA raw scores based on strata of ACT national standard scores.		X
8.	There are no significant differences between WGCTA raw scores based on strata of students' high school GPA.		X

Table 21--Continued.

Hypoth. No.	Statement	Retained	Rejected
9.	There are no significant differences between WGCTA raw scores based on strata of students' anticipated college major.	X	
10.	There are no significant differences between WGCTA raw scores based on students' high school senior class size.	X	
11.	There are no significant differences between WGCTA raw scores based on students' gender.		X

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

This chapter presents conclusions drawn from the analysis of data and offers recommendations for further study. This study answered two general questions:

(1) Which of the selected variables of college aptitude and demographic characteristics can be used as predictors of entry level proficiency in critical thinking for college freshmen?

(2) Do differences in levels of the variables of college aptitude and demographic characteristics operate as predictors of entry level proficiency in critical thinking for college freshmen?

Conclusions

The researcher reached the following conclusions based on analysis of the data and information collected in this study:

(1) The means of WGCTA raw scores for the students of this study and the national mean for freshmen in four-year colleges are nearly identical at 53.45 and 53.8 (range 80), respectively. This finding indicates that students in Montana's public schools developed critical thinking skills at a level comparable with the national average.

(2) The multiple regression equation developed in this study, $Y = X_{act} + X_{hsgpa} + X_{major} + X_{class\ size} + X_{gender}$, produced a correlation coefficient of

0.5365. Thus, the predictors account for 28.78 percent ($R^2 * 100$) of variance in WGCTA scores. Stepwise regression showed that of the 28.78 percent of the variance accounted for in the regression equation, the ACT predictor accounted for 28.41 percent. Therefore, of the predictors investigated in the multiple regression equation, only ACT scores were shown to be significant predictors of critical thinking proficiency. This finding was consistent with the findings of other studies shown in Table 1. However, because of the relatively low predictability (28.41 percent), ACT scores are of only limited value in predicting critical thinking proficiency of individuals.

(3) Significant differences did exist in mean WGCTA scores when students were grouped into strata based on ACT national score intervals or high school grade point average intervals. Therefore, this study does support schools/colleges using strata of these variables as predictors of critical thinking proficiency for purposes such as curriculum evaluation.

(4) Significant differences did not exist in mean WGCTA scores when students were grouped into strata based on anticipated college major. This finding would not support the use of WGCTA scores for placement purposes. However, it should be noted that this study dealt with freshmen that were entering college. Therefore, this finding can best be viewed as indicating that, in general, students entering the various colleges at Montana State University have the same proficiency in critical thinking.

(5) Significant differences did not exist in mean WGCTA scores when students were grouped into strata based on size of high school senior class. Therefore, this study supports findings that high school size is not related to academic success.

(6) Significant differences did exist in mean WGCTA scores when students were grouped according to gender. This difference was found to favor males. This finding supports studies that have found males to perform better than females on assessments of critical thinking.

Recommendations for Further Study

The researcher recommends the following additional research:

(1) In 1989, the American College Testing Program changed the format of ACT assessment to include subtests on English, mathematics, reading, and science reasoning. A study should be conducted to determine the relationship between WGCTA scores and scores on these subtests.

(2) A study should be conducted to determine if significant differences exist when graduating students are grouped according to strata based on college of major.

(3) A follow-up study should be conducted to determine if there is a significant difference between students' entry and exit WGCTA scores.

(4) This study did not address differences in WGCTA scores for all students graduating from high school. A study should be conducted to determine if there is a significant difference between mean WGCTA scores based on strata of post-secondary choices.

(5) This study did not address non-academic factors that might contribute to students' development of critical thinking proficiency. A study

should be conducted to determine if there is a significant difference between mean WGCTA scores and strata based on non-academic variables such as participation in athletics, student government, extracurricular academic activities, community activities, and working while a student.

(6) Various styles of instruction have been found to favor cognitive learning in either males or females. A study should be conducted to determine if these various styles of classroom instruction produce significant differences in the critical thinking proficiency of students.

Recommendations for Action

(1) This study did not determine any reliable predictors of proficiency in critical thinking for individual students. Therefore, institutions of higher education should administer assessments specifically designed to measure critical thinking if they wish to obtain the entry level proficiency of students in this area.

(2) Instructors of introductory courses should be aware that males tend to perform better than females in the area of critical thinking. Instructors should employ teaching strategies that have been shown to be helpful for students in the development of critical thinking proficiency. Examples of the strategies may be found in many resources, including *Perspectives on Individual Differences: Learning Strategies and Learning Styles* (Schmeck, 1988).

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APPENDICES

APPENDIX A:

MEMORANDUMS OF UNDERSTANDING

MEMORANDUM OF UNDERSTANDING REGARDING THE FORWARDING OF A LIST OF 1987 ENTERING FRESHMEN ENROLLED IN FALL SECTIONS OF ENG 121

The following memorandum of understanding is entered into this twenty-seventh day of July, 1987, between Kenneth Wilson (hereinafter referred to as "student"), Joe Frazier, Montana State University Registrar (hereinafter referred to as "Registrar"), and Montana State University (hereinafter referred to as the "University").

One of the primary goals of the University system is that the educational programs should stimulate critical analysis within students (Board of Regents, 1987, p. 251; MSU Faculty Handbook, 1987, 201.01-4). However, at the present time no assessment of students' proficiency in critical thinking has been undertaken. In light of the present emphasis being placed on the development of critical thinking, it seems only logical that a major University would address the contributions of its educational programs toward the development of critical thinking skills among students.

The student has proposed to conduct a doctoral study that will assess the proficiency in critical thinking of students entering the University in relationship to selected predictors of college success and demographic characteristics. The sample for the study has been defined as 1987 entering freshmen enrolled in fall sections of ENG 121. In order for the student to compile data relevant to this study, it is necessary that the Registrar forward a list of first semester freshmen enrolled in 1987 fall sections of ENG 121 to Don Nisewanger, data management specialist. The list should contain only the names and social security numbers of first semester freshmen enrolled in 1987 fall quarter sections of ENG 121. This information will be used by the data management specialists to compile relevant data and will not be used to identify freshmen to the student. Data will be taken from the ACT College Reports and will include ACT scores, high school GPA, size of senior class, educational major, ethnic background, and gender of freshmen in the sample.

The study will provide the University the base line data necessary to begin an assessment of the contributions of its educational program toward the development of proficiency in critical thinking among students. The student anticipates the University will advance further studies related to the development of critical thinking skills among its students. In doing so, the University will enhance its credibility in documenting the strengths that exist within the system and in identifying means for improvement.

In light of the foregoing, the Registrar recognizes the need for the student to have access to the information indicated and will forward to Don Nisewanger a list of first semester freshmen enrolled in 1987 fall sections of ENG 121.

AGREED TO: Kenneth D. Wilson Date: 8-7-87
Student

Registrar Date: 8/7/87

MEMORANDUM OF UNDERSTANDING REGARDING THE COMPILING OF INFORMATION FOR KENNETH D. WILSON

The following memorandum of understanding is entered into this eleventh day of August, 1987, between Kenneth Wilson (hereinafter referred to as "student"), and Don Nisewanger, Montana State University Data Management Specialist (hereinafter referred to as "data management specialist").

One of the primary goals of the University system is that the educational programs should stimulate critical analysis within students (Board of Regents, 1987, p. 251; MSU Faculty Handbook, 1987, 201.01-4). However, at the present time no assessment of students' proficiency in critical thinking has been undertaken. In light of the present emphasis being placed on the development of critical thinking, it seems only logical that a major University would address the contributions of its educational programs toward the development of critical thinking skills among students.

The student has proposed to conduct a doctoral study that will assess the proficiency in critical thinking of students entering the University in relationship to selected predictors of college success and demographic characteristics. The sample for the study has been defined as 1987 entering freshmen enrolled in fall sections of ENG 121. The independent variables of the study are ACT composite scores, anticipated educational major, size of senior class, ethnic background, and gender of students. The registrar, Joe Frazier, has agreed to forward a list of names and social security numbers of first semester freshmen enrolled in ENG 121 to the data management specialist on approximately October 22, 1987. The supervisor of admissions, Leota Pilon, has authorized the data management specialist access to the University's ACT magnetic tapes for the purpose of compiling the information indicated for the study. The vice president for academic affairs, Dr. Stuart Knapp, has authorized that the University will provide the requested information at no charge to the student.

In light of the foregoing, the data management specialist agrees to compile the requested information for the student within the guidelines of the University.

AGREED TO: Kenneth D. Wilson Date: 8-11-87
Student

Donald A. Nisewanger Date: 8-11-87
Data Management Specialist

MEMORANDUM OF UNDERSTANDING REGARDING THE ADMINISTRATION OF THE WATSON-GLASER CRITICAL THINKING APPRAISAL TO STUDENTS ENROLLED IN FALL SECTIONS OF ENG 121

The following memorandum of understanding is entered into this eleventh day of August, 1987, between Kenneth Wilson (hereinafter referred to as "student"), and John Ramage, Director of Writing (hereinafter referred to as "director").

One of the primary goals of the Montana State University system is that the educational programs should stimulate critical analysis within students (Board of Regents, 1987, p. 251; MSU Faculty Handbook, 1987, 201.01-4). However, at the present time no assessment of students' proficiency in critical thinking has been undertaken. In light of the present emphasis being placed on the development of critical thinking, it seems only logical that a major University would address the contributions of its educational programs toward the development of critical thinking skills among students.

The student has proposed to conduct a doctoral study that will assess the proficiency in critical thinking of students entering the University in relationship to selected predictors of college success and demographic characteristics. Numerous studies have identified proficiency in critical thinking as a key component in effective writing. Therefore, the student proposed to the director the administration of the Watson-Glaser Critical Thinking Assessment to students enrolled in 1987 fall sections of ENG 121. The WGCTA is a 40-minute test that measures students' critical thinking abilities using subtests of inference, recognition of assumptions, deductions, interpretations, and evaluation of arguments. The director agreed that the administration of the WGCTA could be beneficial to both the writing department and the student. As a result of this agreement, the student is seeking the cooperation of instructors of ENG 121 in the administration of the WGCTA during a class period within the first week of the quarter.

The study will provide the writing department and the University, in general, base line data necessary to begin an assessment of the contributions of programs toward the development of proficiency in critical thinking among students. The student anticipates future studies will be advanced related to the development of critical thinking skills among students. Through such studies, the credibility of the University will be enhanced by the documentation of strengths that exist within the system and in identifying means for improvement.

In light of the foregoing, the director will seek the cooperation of instructors in the administration of the Watson-Glaser Critical Thinking Assessment to ENG 121 students during the first week of the 1987 fall quarter. The student will provide individual scores to the freshmen who took the WGCTA and the department of writing, as well as the University, summary data from the study.

AGREED TO: Kenneth D. Wilson Date: 8-11-87
Student

John Ramage Date: 8/11/87
Director of Writing

MEMORANDUM OF UNDERSTANDING REGARDING THE AUTHORIZATION OF USE OF INFORMATION ON ACT MAGNETIC TAPES

The following memorandum of understanding is entered into this eleventh day of August, 1987, between Kenneth Wilson (hereinafter referred to as "student"), and Leota Pilon, Supervisor of the Office of Admissions, Montana State University (hereinafter referred to as "supervisor").

One of the primary goals of the University system is that the educational programs should stimulate critical analysis within students (Board of Regents, 1987, p. 251; MSU Faculty Handbook, 1987, 201.01-4). However, at the present time no assessment of students' proficiency in critical thinking has been undertaken. In light of the present emphasis being placed on the development of critical thinking, it seems only logical that a major University would address the contributions of its educational programs toward the development of critical thinking skills among students.

The student has proposed to conduct a doctoral study that will assess the proficiency in critical thinking of students entering the University in relationship to selected predictors of college success and demographic characteristics. The sample for the study has been defined as 1987 entering freshmen enrolled in fall sections of ENG 121. The independent variables of the study are ACT composite scores, anticipated educational major, size of senior class, ethnic background, and gender of students. The registrar, Joe Frazier, has agreed to forward a list of names and social security numbers of first semester freshmen enrolled in ENG 121 to Don Nisewanger, MSU Data Management Specialist. The student is requesting that the supervisor give authorization for the data management specialist to have access to the University's ACT magnetic tapes for the purpose of compiling data relevant to the study. The confidentiality of students will be maintained -- no student will be individually identified through the study.

In light of the foregoing, the supervisor gives permission for the data management specialist to have access to the University's ACT magnetic tapes for the purpose of compiling data for the student's study.

AGREED TO: Kenneth D. Wilson Date: 8-12-87
Student

Leota Pilon Date: 8/12/87
Supervisor of Admissions

APPENDIX B:

SUMMARY OF RESEARCH DATA

Table 22. Summary of research data.

ID No.	WGCTA	ACT	H.S. GPA	Class Size	Major	Gender
001	45	22	6	3	8	2
002	56	22	6	1	3	1
003	53	24	6	7	5	2
004	43	24	7	1	3	1
005	35	21	7	2	5	2
006	58	23	5	4	5	2
007	41	21	4	1	6	1
008	43	15	4	2	2	2
009	63	24	5	2	5	2
010	55	11	7	4	6	2
011	45	24	6	1	3	2
012	52	22	6	1	2	2
013	36	17	4	5	8	2
014	58	24	7	3	4	1
015	52	24	6	5	8	1
016	60	23	6	3	8	1
017	67	26	6	3	6	1
018	53	22	6	3	5	2
019	52	16	6	2	8	1
020	62	26	7	3	2	2
021	45	23	6	2	8	1
022	44	11	4	2	4	1
023	44	16	6	5	7	2
024	54	20	3	3	8	2
025	58	25	5	1	2	1
026	51	21	6	1	6	2
027	53	27	7	2	5	1
028	49	22	6	2	4	1
029	54	11	3	1	8	2
030	51	19	5	1	4	1
031	55	20	5	2	1	2
032	53	24	6	5	3	1
033	33	11	4	4	8	1
034	51	22	6	5	7	1
035	43	21	7	1	3	1
036	65	26	7	3	4	1
037	47	19	5	2	5	2
038	61	22	5	1	6	2
039	62	23	6	2	1	2
040	61	24	7	1	5	1
041	60	26	6	2	8	2
042	44	23	6	4	4	2
043	50	21	6	2	6	1
044	58	24	6	2	4	2

Table 22--Continued.

ID No.	WGCTA	ACT	H.S. GPA	Class Size	Major	Gender
045	54	16	6	3	3	1
046	53	27	7	3	4	2
047	50	18	5	2	2	1
048	47	23	6	5	3	1
049	44	14	6	2	2	1
050	50	21	7	5	2	1
051	63	27	7	3	5	2
052	55	22	6	6	8	1
053	65	28	7	2	1	2
054	56	19	3	4	4	1
055	46	22	7	3	5	2
056	43	17	7	2	3	1
057	72	29	7	3	3	2
058	54	23	6	2	4	1
059	58	24	7	6	5	1
060	53	23	7	3	4	1
061	61	20	6	6	5	2
062	51	24	6	3	5	1
063	51	22	7	3	1	2
064	52	27	7	1	6	1
065	41	18	6	2	8	2
066	40	23	5	7	3	1
067	51	21	7	5	6	1
068	60	21	6	2	4	1
069	52	18	3	5	3	2
070	51	24	6	5	1	2
071	60	25	6	3	5	2
072	66	25	6	2	3	1
073	47	21	5	4	1	2
074	52	24	6	5	8	1
075	52	23	7	5	7	1
076	53	21	7	2	3	1
077	56	23	7	1	7	1
078	59	25	6	5	5	2
079	46	17	5	3	3	1
080	50	15	6	3	3	1
081	69	23	4	7	5	2
082	68	26	6	6	3	2
083	48	22	7	4	3	1
084	64	21	6	5	8	1
085	56	26	7	2	6	2
086	64	24	6	1	8	2
087	63	23	6	1	9	1
088	44	18	6	2	3	1

Table 22--Continued.

ID No.	WGCTA	ACT	H.S. GPA	Class Size	Major	Gender
089	38	13	6	6	7	1
090	59	21	6	2	7	1
091	47	21	6	2	8	1
092	61	26	5	5	6	2
093	56	21	6	2	3	1
094	51	22	6	4	3	1
095	52	25	6	2	8	1
096	54	21	4	4	1	2
097	61	21	6	3	3	1
098	51	16	5	4	3	1
099	58	26	7	3	3	2
100	61	27	6	2	3	1
101	51	26	6	1	5	2
102	57	23	6	2	3	1
103	51	21	7	2	7	1
104	63	28	7	4	5	2
105	65	25	5	4	8	1
106	47	15	7	2	3	1
107	51	15	6	2	3	1
108	71	30	7	2	5	2
109	54	17	5	6	4	2
110	45	23	5	4	2	2
111	59	26	3	3	2	2
112	68	25	6	2	3	2
113	53	19	5	2	5	2
114	55	30	7	2	6	1
115	55	28	5	2	5	2
116	50	11	5	2	8	2
117	55	18	4	5	3	2
118	54	23	6	2	7	1
119	53	14	4	2	3	1
120	72	24	7	1	8	1
121	56	23	4	2	1	2
122	67	27	7	6	5	2
123	57	16	5	4	5	1
124	50	24	6	4	5	2
125	60	21	7	1	1	2
126	57	29	7	2	5	2
127	42	11	6	3	5	1
128	36	29	6	1	5	2
129	58	20	6	4	1	2
130	51	23	4	3	5	2
131	43	15	3	1	8	1
132	66	27	5	2	5	2

Table 22--Continued.

ID No.	WGCTA	ACT	H.S. GPA	Class Size	Major	Gender
133	46	23	7	1	5	2
134	53	26	5	1	5	2
135	57	27	7	1	2	1
136	46	9	4	2	4	1
137	61	27	7	2	5	2
138	47	20	6	5	3	1
139	60	19	7	4	2	2
140	44	11	5	2	7	1
141	55	23	7	5	3	2
142	57	26	7	2	5	2
143	53	21	7	2	5	2
144	63	24	6	4	5	2
145	61	24	7	6	4	1
146	54	19	6	1	8	1
147	61	27	5	1	5	2
148	55	21	5	4	3	2
149	67	25	7	3	6	2
150	56	22	6	4	8	1
151	65	29	4	3	6	2
152	59	32	7	2	2	2
153	55	20	6	2	6	2
154	57	29	7	6	5	2
155	44	22	6	4	8	2
156	50	17	5	5	5	2
157	62	21	6	2	2	2
158	59	25	4	2	5	2
159	54	22	5	2	8	1
160	67	25	4	4	8	2
161	52	17	6	1	6	1
162	64	27	6	3	8	2
163	62	21	6	1	8	2
164	59	22	7	1	5	2
165	56	22	4	2	3	2
166	51	24	6	3	3	2
167	36	11	2	4	6	2
168	71	31	7	2	5	2
169	46	11	5	3	3	2
170	40	16	4	2	3	2
171	65	27	6	2	2	2
172	39	20	6	4	6	2
173	45	14	5	3	3	1
174	40	14	5	2	3	1
175	54	23	7	2	5	1
176	63	25	7	2	1	2

Table 22--Continued.

ID No.	WGCTA	ACT	H.S. GPA	Class Size	Major	Gender
177	49	24	6	6	5	2
178	46	19	4	1	8	2
179	40	20	6	2	2	2
180	48	15	4	2	8	2
181	45	14	7	2	1	1
182	53	19	4	5	8	2
183	58	29	7	2	8	1
184	48	24	6	6	5	2
185	60	25	7	2	5	2
186	49	21	6	6	5	2
187	49	17	6	2	8	2
188	47	14	6	5	2	2
189	58	23	6	3	5	2
190	55	20	6	5	6	2
191	57	29	7	3	5	2
192	46	24	6	1	8	2
193	46	20	6	4	5	2
194	58	25	3	1	5	2
195	50	29	7	6	2	1
196	57	30	7	5	5	2
197	56	25	7	5	3	1
198	46	14	6	3	3	1
199	58	26	7	3	5	2
200	50	20	7	2	8	1
201	43	19	5	1	5	2
202	55	22	6	2	8	2
203	57	29	6	6	6	2