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THE RELATIONSHIP BETWEEN PROBLEM-SOLVING SKILL OF
11th- AND 12TH-GRADE VOCATIONAL AND NON-
VOCATIONAL EDUCATION STUDENTS
IN A PUBLIC SCHOOL

DISSERTATION

Presented in Partial Fulfillment of the Requirements
for the Degree of Doctor of Philosophy in the
Graduate School of The Ohio State University

by

Ernest Efetevbia, B.S., M.A.

* * * * *

The Ohio State University
1996

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Adviser

College of Education
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DEDICATION

This dissertation is dedicated in memory and honor of my late mother, Bisi, and my late brother, Abayomi. May the peace and mercy of God Almighty rest and abide with you forever, in Jesus name, Amen.
ACKNOWLEDGMENTS

This dissertation would not have been possible without the help and guidance of many individuals and organizations. To anyone I may leave out, please pardon me.

Special thanks must be given to Dr. Anthony A. Olinzock, my new advisor and chairperson of my dissertation committee, who gave guidance and counsel through the rest of this research project after a sudden and untimely death of my former advisor, Dr. Thomas White. Gratitude and appreciation are also expressed to the members of the committee, Dr. Jack Naglieri and Dr. Ray D. Ryan, for their able, understanding and willing assistance.

My special thanks also goes to Mrs. Lucretia Williams, assistant superintendent of Columbus Public Schools, and to its Research Proposal Review Committee for giving me permission to use their school in this study.

I also wish to use this opportunity to thank my typist and friend, Tracy Pence of Typing Express, for her words of encouragement, organizational support, proofreading, and excellent job quality in presenting this project to everyone. I say once more, thank you and God bless.
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Cognate Area: Technological/Vocational
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CHAPTER I
INTRODUCTION

A few years ago, basic skills meant reading, writing, and arithmetic (Wilcox, 1991). According to Wilcox (1991), it is much more than that today. It includes other skills among which are problem-solving skills, which are the focus of this study. According to the American Society for Training and Development, a professional organization of corporate trainers, problem solving was defined as new styles of work organization that required all workers to analyze problems and come up with a solution.

Many leaders have called for the integration of academics into the vocational education program. Education is being urged to change the way it is preparing our youth and adults to function in a global economy. In response to this call, educators are taking a hard look at vocational-academic integration, linking academic skills instruction to vocational applications to enhance student learning. Across the country, schools are implementing a number of strategies that teach basic skills through an integrated vocational-academic approach. These efforts have been bolstered by the Carl D. Perkins Vocational and Applied Technology Education...
Act, through which Congress mandated the integration of academics and vocational education nationwide (Printz and Davis, 1990).

No time is more important to address the issue than now, especially considering the fact that the world economy is rapidly changing. The necessity and the importance of educators and professionals alike to teach basic skills, especially problem-solving skills, has become more evident in our daily lives. Problem-solving skill is an important skill a potential worker should have in order to function adequately, efficiently, and effectively in the rapidly changing technological world.

Many believe that vocational education students lack these basic skills compared to non-vocational students (Stone, 1993). This view, however, has not been substantiated nor supported. While it is contestable and open to debate, one fact remains: problem-solving skill is a very important skill needed by all to survive today and tomorrow in a rapidly-changing, technological world. To compete in a global market demands a literate workforce, as well as one able to use problem-solving skills (Warnat, 1991).

In response to this call to meet the challenges of the global world market competition, the United States government embarked on new visions for vocational-technical education with the Perkins Act of 1990. The Act emphasized
integrating academic and vocational curricula. One purpose of the Carl D. Perkins Act of 1990 was to make the United States more competitive in the world economy by developing more fully the basic skills of reading, writing, arithmetic, interpersonal relationships, and problem solving for all segments of the population. The purpose will principally be achieved through concentrating resources on improving educational programs leading to basic skill competencies needed to work in a technologically advanced society (Warnat, 1991).

The Purpose of the Study

Industries are becoming increasingly aware of the need for their workers to have problem-solving skills. Presently, schools think having more and more programs is better, and, as such, do not spend enough time on what is critical, such as solid technical skills, interpersonal relationships, team work, and problem solving. What vocational teachers should understand is that they are employed to prepare people for industry to meet all of the technical challenges, such as technicians who can analyze and diagnose components to determine what went wrong. Thus, vocational teachers can help ensure that students have this problem-solving skill by requiring them to document their work, record failure rates, and analyze problems (Dykman, 1994).
Similarly, the Carl D. Perkins Vocational and Applied Technology Education Act of 1990 (PL 101-392) prescribed significant changes in the way vocational education is funded and delivered. Among the requirements of the Act was that each state conduct an assessment of its vocational education programs. According to Section 116 of the Perkins Act, the first assessment criteria identified was the integration of vocational and academic education.

Concerns over the quality of workforce preparation have been gathering momentum. Parnell (1985) argued that adequate preparation of students with necessary skills such as the problem-solving skill is virtually ignored in American schools. Carnevale, Gainer, and Meltzer (1990) identified the need for preparation in workplace basics, including problem solving. Kolda (1991) also found deficiency of basic skills among over half of the students.

The Statement of the Problem

The major research question investigated was, is the skill of problem-solving related to the type of curriculum a student is following? Also investigated was the question, is the skill of problem solving related to age, gender, socioeconomic status, racial background or geographical location?
Different people have different opinions concerning the factors which seem to be related to problem-solving skills. This research investigated some of those factors.

In order to investigate the major problem of the study, the researcher developed the following research questions:

1. Is there a difference in the problem-solving skill of students based on type of program?
2. Is there a difference in the problem-solving skill of students based on grade level?
3. Is there a difference in the problem-solving skill of students based on gender?
4. Is there a difference in the problem-solving skill of students based on ethnicity of the student?
5. Is there a difference in the problem-solving skill of students based on socioeconomic status?

The following general hypotheses guided this study:

1. There will be no difference in the mean problem-solving skill of 11th-grade vocational and 11th-grade non-vocational students.
2. There will be no difference in the mean problem-solving skill of 12th-grade vocational and non-vocational education students.
3. There will be no difference in the mean problem-solving skill of 11th-grade vocational and 12th-grade vocational education students.
4. There will be no difference in the mean problem-solving skill of 11th-grade non-vocational education students and 12th-grade non-vocational students.
5. There will be no difference in the mean problem-solving skill of 11th-grade and 12th-grade students regardless of program area.
6. There will be no difference in the mean problem-solving skill of vocational education students and non-vocational education students regardless of grade level.
Hunter and Aiken (1987) have indicated that problem-solving skills have increasingly become a necessary skill required to function efficiently and effectively in the workplace. Therefore, they advised that it is of paramount importance to incorporate this in all aspects of vocational instructions.

Vocational education students are the potential backbone of our industries; more often than not, they are regarded as having inadequate problem-solving skills when compared to their non-vocational peers (Dykman, 1994). Wilcox (1991) said that just as secondary school students take more and more vocational courses, so are vocational students taking more and more academic courses.

The findings from this study should be useful in several ways. First, this study will add to the growing body of knowledge about vocational education students and their skills in problem solving. It will furnish information as to whether the vocational education students are prepared for the challenges of the 21st century by showing how good or how poorly they perform on the problem-solving skill test. One of the challenges of the 21st century is that workers must have problem-solving skills in order to function effectively and efficiently in the global market. Vocational education students are the bedrock and backbone of our industrialization, and it is important that they have problem-solving skills.
Second, since this study included students from different program areas (vocational versus non-vocational), it is possible to see if the problem-solving skill is related to the type of program. In addition, the researcher investigated the comparison of other factors to problem-solving ability: socioeconomic status, student ambitions, gender, age, and race.

Delimitations of the Study

The study was delimited in the following ways:

1. The researcher investigated the problem-solving ability of 11th- and 12th-grade vocational and non-vocational students in a public school. There were 236 participants: Sixty, 11th-grade vocational students; 59, 11th-grade non-vocational students; 57, 12th-grade vocational students; and 60, 12th-grade non-vocational students.

2. The instrument was administered to all participants on March 20, 1995, at 10:00 a.m.

3. A public school in Columbus, Ohio, was chosen for the investigation. It has both vocational and non-vocational students with a student population of 1,644.
4. The students are from different socioeconomic backgrounds: low, average, and high-income families.

5. The students were from different racial backgrounds: Hispanic, Whites, and Blacks.

6. The students' ages ranged from 16 years to 19 years.

7. The instrument (MAT-SF) was made up of 35 questions. Each student's score was equal to the total number of correct answers. The correct answers to the 34 scorable items were keyed on the bottom page of the answer sheet and were summed to obtain the student's total score.

Other variables which might be included in a study of this type were specifically excluded.

Limitations of the Study

The reader of this dissertation should be aware of the following limitations to the study:

1. The findings of this study were only generalized to students in a public school.

2. The investigator had no control over the physical presence of the students to take the test on the test day. Although the students were selected at random by name, the individual students selected had the choice or the right to take or not take
the test. It was envisaged that because of this freedom or flexibility that some students would not show up to take the test. In view of this, the investigator selected 360 student names instead of the targeted 200 samples in order to make room for those who would not be present. By allowing for this extra number, the investigator was able to get the required 200 samples for this study.

3. A maximum time limit of 25 minutes was allowed for completing the instrument.

4. Although the sample for this study was chosen at random, the actual participation was purely voluntary (See Appendix D). This was in accordance with the condition and terms of agreement to conduct the research study as instructed by The Ohio State University Research Center.

A major limitation of this study was the lack of an adequate number of student representatives participating in the different career programs. Although the career center has many vocational programs, some of the programs have low representation. For example, Data Processing had six students, Fashion Design had five students, Child Care had four students, and so on. All students, enrolled in any one of the vocational programs, were identified as vocational,
rather than a specific vocational area such as Data Processing, Carpentry, Fashion Design, Automotive, and Metal Work.

**Definition of Terms**

Following are definitions of selected terms used for this study:

**Problem-Solving Skills**

These are the necessary skills required to overcome an obstacle that intervenes between the present state of affairs and the desired state of affairs (Taylor, 1990).

**Basic Skills**

These are fundamental skills necessary to function in the workplace. They include writing, reading, arithmetic, and problem-solving skills (Wilcox, 1991).

**Literate Workforce**

This is a worker who has the fundamental skills of writing, reading, arithmetic, and problem solving (Wilcox, 1991).

**Vocational Education**

Vocational Education is a part of the school curriculum designed to make the student employable in at least one occupation. Federal legislation defines vocational education as including all occupations except those requiring at least a baccalaureate degree or the professions. Vocational education include the fields of
agricultural education, business and office education, 
distributive education, health occupations education, wage 
earning, home economics education, trade and industrial 
education, and technical education (Dejnozka and Kapel, 

Non-Vocational Education (Liberal Education)

It is defined as a form of education that is broad and 
general as opposed to being specialized or preparing one for 

Undecided

Not having one's mind made up (Barnhart, 1993)

Global Economy

Refers to worldwide management of resources (natural 
and human resources (Barnhart, 1993).
CHAPTER II
REVIEW OF THE LITERATURE

The purpose of this chapter is to review the literature relating to the comparison between problem-solving skills of vocational education students and non-vocational students in a comprehensive high school. The review of literature has been organized in sections, each of which had direct bearing on this study. This chapter includes an overview of problem solving, steps in problem solving, and characteristics of good and bad problem solvers.

Adams (1986) advocates the development of problem-solving skills as a fundamental aim of all teachers, regardless of the age of the pupils or the subject being taught. Barbs (1990) presents the techniques of teaching problem-solving skills. Menrzano and Ewy (1989) present the need to ready students with problem-solving skills. Beyer and Backes (1990) advocate integrating problem-solving skills into the student's curriculum. Claus (1989) suggests that vocational educators and policy makers must make a commitment to provide a more academically integrated curriculum that will enhance problem-solving skills of the students.
The dynamic nature of the workplace has added increased emphasis on a prospective employee’s ability to learn. Changing jobs frequently has become increasingly evident among workers today. When workers change jobs, they must acquire new skills. Reasoning and problem-solving are fundamental skills one must have to continue to learn. Curriculum developers should, therefore, be aware of the need to prepare vocational students adequately for occupational mobility and advancement by incorporating in their curriculum problem-solving strategies.

Vocational education is faced with the problem of preparing students for the uncertain demands of a new and complex era. New technology, global economic competition, interdependence, demographic and social changes are constantly transforming the workplace (National Academy of Sciences, 1984).

Studies of American education (Adler, 1982; Education Commission of States, 1983, 1984; Gisi and Forbes, 1982; and Sizer, 1984), focused on developing an educated person. Central to developing an educated person are the abilities to reason and to solve problems.

Problem-solving skills are viewed as perhaps the most important of all educational components. The ability to think, reason, create, and seek solutions to problems has traditionally been viewed as evidence of a student’s educational experience. "While problem-solving skill is a
widely touted goal of education, it is also an elusive and hard-to-defined entity or product of schooling" (Barba, 1990, p. 32). Bransford, Sherwood, and Sturdevant (1984) said there are no simple solutions to problems; only intelligent choices.

Problem-solving skill is an essential skill necessary for effective human functioning. An ability to resolve problems insures survival and increases the possibility of growth and development. Problem solving has relevance for individuals, as well as groups and institutions. If individual problems can be conquered, then group problems can be conquered (Carkhuff, 1973).

Adams (1986) revealed that it is beyond question that children will be faced with a world which is rapidly and continuously changing, and will have to tackle new knowledge, learn new skills, and solve new problems. Robert Gagne (1977) sees the teaching of problem solving as the ultimate important task of any educational program.

Human life is full of problems ranging from domestic problems or personal problems to more complex individualized or collective problems. According to Adams (1986), every individual spends a large amount of time each day tackling problems concerning family, friends, neighbors, workmates, strangers, house, school, job, career, transportation, hobbies and leisure time, social life, hopes and
aspirations, finances, career development, time management, and a host of other areas.

The work environment is constantly and rapidly changing. To survive this rapidly changing world, one will need problem-solving skills (Mikulecky, 1988; Sticht, 1980; Mikulecky and Drew, 1988; and McLune, 1986). The problem solving process is not complete until the individual involved is equipped with the skills needed to solve his or her own problems (Carkhuff, 1973).

Ann Taylor (1990) suggests a problem may be said to arise whenever a desired goal is not immediately accessible. Barba (1990) defined problem solving as a situation in which a goal is to be attained and a direct route to the goal is temporarily blocked. More generally, people may be said to have problems when they cannot see the way to reach some goal state. One example is when a government has a political problem, and it cannot see how to persuade its followers that a certain policy is necessary. Another example is the person with a financial problem who has made a prior commitment which cannot be met.

A universal feature of these problems is that an objective is perceived, but an obstacle prevents the desired state from being reached by means of customary or habitual thoughts and actions. Jackson (1975) states this in terms of an equation: \( P \) (Problem) = \( O \) (Objective) + \( O \) (Obstacle). This means an obstacle intervenes between the present state
of affairs and the desired state of affairs. The mental and physical actions undertaken in such circumstances, which are aimed at removing or overcoming the obstacle, are termed problem solving.

Whatever is the definition, problem solving is a multifaceted construct that involves questions about the way people think and learn. Problem-solving skills are skills everyone needs in daily life. The initial exposure to problem solving must begin as soon as the child enters school, and the process should continue throughout the entire schooling. The elementary school teacher has the responsibility to begin this instruction and thereby lay the foundations for the child's future problem-solving skills.

Problem solving requires bold initiative and attempts to teach general thinking skills within a disciplinary context for consequent transference of those skills to all phases of life. This is an important aspect of vocational literacy programs. Educators are, therefore, advised to incorporate this into all aspects of educational instruction.

The importance of problem solving in vocational education is receiving more national attention now than ever before. Daniels and Karmos (1982) found that problem-solving skill was one of the most frequently mentioned skills in literature that employers regard as the essential skill of the future. Michael Timpane (1982), in his report
of corporations and public education, emphasized the need for teaching young people problem-solving skills so they will be ready for further education and training.

Roy Forbes, Director of The Assessment and Evaluation Division of the Education Commission of the States, predicted that a large percentage of high school graduates will not possess the problem-solving skills required for employment in a rapidly changing, technological society (Whimbey and Lockhead, 1984). Pratzer (1984) stated that the priority is for vocational education to offer good education in problem solving. Problem solving is either lacking or there is not enough of it in the classrooms. Goodlad (1983) remarked that "teacher talk" was by far the most common classroom activity. He went further to say that rarely do teachers encourage student-to-student dialogue, or provide opportunities for students to work collaboratively in small groups, or for students to play, set goals, determine alternative ways of achieving their goals, and the like.

Ann Brown, from the University of Illinois, conducted an interview with Edward Binet (Brown, 1984) on the teaching of problem-solving skills. Binet said:

What I object to in traditional classes is that it is the teacher who produces, and the students who passively listens. Such a lesson has two faults: It does not impress the student other than by its verbal function, it gives him words instead of making him deal with actual objects, and it appeals only to his
memory, reducing him to a passive state. He doesn’t judge, doesn’t think, doesn’t invent, and doesn’t produce. He needs only to retain. His aim is to repeat without mistake, make his memory work, know what is in the lecture, in the textbook and reproduce it. The results of such practices are deplorable: A lack of curiosity for what is not in the book or lecture; a tendency to look for the truth only in the book, the belief that one is doing some original research by going through a book, too much respect for the writer’s opinion, a lack of interest in the world and the lesson it gives, a naive belief in the power of simple formulas, a difficulty to adapt oneself to contemporary life, and above all, a static regimentation unwelcome at a period when social evolution is so fast. (p. 14-15)

Steps in Problem Solving

Karmos and Karmos (1986) stated that for students to succeed and hold jobs in this rapidly changing, technological world, they will need skills on how to attack and solve problems. Possession of at least one general model for solving problems is one essential strategy (p. 9).

Karmos and Karmos (1986) provide a five-step model for solving problems which is as follows:

1. Understanding the Problem.

   If people are involved, then there should be explicit agreement among the people on what the problem is. If appropriate, analyze the problem for possible causes.

2. Brainstorm for possible solution strategies.

   No evaluation or judgment should occur here. This should be a free-wheeling act of generating ideas.
3. Choose a Tentative Solution Strategy.

For every problem, consequences of behaviors and solutions must be carefully considered. If people are working out an interpersonal problems, then the tentative strategy will likely be a compromise.


In implementing most strategies involving people, it is important to decide, "who, does what, when."

5. Learn.

Immediately and over time, think about what can be learned from the experience. What are the implications of what has been done? If appropriate, evaluate the effectiveness of the solutions (Karmos and Karmos, 1986, p. 9-10).

According to the Resource Manual for Business Educators (1991), approaches to problem solving vary according to the nature of the problem. For example, the approaches to solving our everyday problems of a personal nature may vary from approaches used to solve business problems or those used in creative problem solving on tests or during problem-solving competitions. Depending upon the circumstances, any one of the following five problem-solving techniques could be useful to students seeking to improve their ability to solve problems.

Visualization: The ability to close the eyes and visualize the process of solving the problem is a very good technique. It helps to "see" what to do about the problem.

Self-talk: Thinking aloud and talking to oneself about the problem helps to clarify thoughts and to identify what
may be missing about the problem. Self-talk also creates the room for concentration and focussing on the problem.

Perseverance: If the first applied solution on a problem does not work, then back up and reassess, reevaluate, and readjust for alternative solutions. Ability to try and try again and not give up is a realistic and practical way of solving problems.

Trial and Error: This technique helps in "getting a feel" for a problem. This method works best when there are limited or few alternatives available, and if the alternatives are not going to be time consuming.

Working Backwards: This method involves a change in perspective. Instead of stating the problem first, the goal is stated first and then worked back to the present. This method is good only if it was found that the problem cannot be solved by stating the problem first. Backward working is a method of temporary distancing from the problem when a "dead-end" is met and all ideas have been exhausted. For the purpose of good management, allow the problem to "set" while the mind is being cleared. Having rested and thinking the problem over again you could then return with fresh insights (A Resource Manual for Business Educators, 1991, p. 19).

Characteristics of a Good Problem Solver

Good problem solvers share many of the same characteristics. They tend to use prediction during their
problem-solving. They tend to have fewer gaps in their content structure than poor problem solvers; they rely on information learned from the lesson; they make fewer mistakes reading and interpreting graphs, diagrams, and data; and they rely less on memory than poor solvers. Good problem solvers or master problem solvers express less doubt, confusion, and misconceptions (Barba, 1990).

There is no one "right" way to solve problems. Many strategies can be employed by students engaged in problem-solving activities. According to Adams (1986), the most recent models of the problem-solving process and teacher "talking through" are below:

<table>
<thead>
<tr>
<th>Formulation</th>
<th>What is the problem?</th>
<th>What do we want to do?</th>
<th>What is stopping us?</th>
<th>Do we understand what is required?</th>
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<tr>
<td>Interpretation</td>
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<td>Which idea is best?</td>
<td>What does &quot;best&quot; mean?</td>
<td>How can we judge?</td>
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<tr>
<td>Implementation</td>
<td>Do it.</td>
<td>Have we finished?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Evaluation</td>
<td>Is the problem solved?</td>
<td>Did it work?</td>
<td>Is there a better solution?</td>
<td>Can we make it work better?</td>
</tr>
</tbody>
</table>
Communication  
Tell others what we did and how we did it.

It is becoming unmistakably clear that all students leaving high school will need problem-solving skills whether they are going to college or not. Employers of workers at all levels stress that employees are expected to reason and develop logical steps for solving problems, regardless of job category (Marzano and Ewy, 1989).

deBono (1982) advised that a conscious effort should be made to think of everything that might be relevant for solving problems. For example, think about buying a new house. Consider all factors, and be sure you ask all relevant and right questions. Issues as size, cost, and layout are bound to come to mind. Is the television reception working? Is there a fire exit? Is the house properly insulated? Can the pipes be drained quickly in case of power failure in freezing weather?

Ability to perceive the consequence of an action in advance is a trait of a good problem solver, and can be greatly improved by using it in a systematic way. Outcome of an action could be characterized into four categories: Immediate, short term (1 to 5 years), medium term (5 to 25 years), and long term (over 25 years). By comparing the consequences of thoughts and actions, people can be less impulsive and make better decisions for themselves, based upon careful thought and not on quick emotions.
More often than not, people assume they know what their goals are, but often there are hidden or unconsidered goals that get in their way. Sometimes people just act without considering whether their actions will get them what they want. Setting priorities and goals can help people be more efficient. Sometimes there is so much to do that it is overwhelming. To sit down and list the first priority, then the second, the third, and so on, can help the talk become more manageable.

Sometimes problems involve a conflict with a friend, boyfriend, girlfriend, or parent. It is the goal of a good problem solver to be able to find a solution to the problem being confronted. This is particularly difficult to achieve when one is upset and angry. However, if one can take another person's point of view at such times, then one possess one of the major skills of good problem solvers.

Good problem solvers take great care to understand fully and accurately the facts and the relationships in a problem. In contrast, poor problem solvers generally lack an intense concern about understanding. Good problem solvers tend to read several times until they are sure they understand it. On the other hand, poor problem solvers frequently miss a problem because they do not know what it exactly states.

Good problem solvers have learned that analyzing complex problems and ideas often consists of breaking the
ideas into smaller steps. They have learned to attack problems by starting at a point where they can make some sense of it, and then they proceed from there. In contrast, poor problem solvers have not learned the approach of breaking a complex problem into smaller problems and then dealing with them step by step.

The final characteristic of good problem solvers is the tendency to be more active than poor problem solvers when dealing with problem solving. For example, if a written description is hard to follow, good problem solvers may try to create a mental picture of the ideas in order to see the situation better. If a presentation is lengthy, confusing, or vague, try to pin or narrow it down in terms of past experiences. Furthermore, they ask questions about the problem, they answer the questions, and they talk to themselves to clarify thoughts. They also use charts, diagrams, and brainstorming for possibilities, or they use other physical aids to thinking. Good problem solvers are active in many ways which help achieve clearer understanding and boost progress on a problem (Karmos and Karmos, 1986).
CHAPTER III
METHODOLOGY

Selection of the Sample

A public school in Columbus, Ohio was chosen for the study because of its large diversified student population and because it has both vocational and non-vocational students. The school has a student population of 1,644 students: 926 vocational and 718 non-vocational. There are approximately 50 programs ranging from automotive, food science, carpentry, and child care to metal works.

The population for this study was made up of vocational and non-vocational students in the 11th and 12th grade at the high school. For purpose of this study, a total of 320 students was initially selected by names at random from a total of 1,644, 11th- and 12th-grade vocational and non-vocational students. The names were separated into four categories as follows: 412, 12th-grade vocational students; 327, 12th-grade non-vocational students; 514, 11th-grade vocational students; and 391, 11th-grade non-vocational students.

A Table of Random numbers was used to select 80 students from each of the four groups making a total of 320
students. A letter requesting students to participate in the study was given to the 320 students. The letter indicated the time and the day of the Matrix Analogies Test-Short Form and described the purpose and nature of the test (see Appendix D). A total of 236 students took the MAT-SF: 57, 12th-grade vocational; 60, 12th-grade non-vocational; 60, 11th-grade vocational; and 59, 11th-grade non-vocational. Of the total 236 students who completed the test, the investigator randomly selected 50 from each group, thereby making a total of 200 students for the study.

**Instrument**

The measuring instrument employed in this study was the Matrix Analogies Test-Short Form (MAT-SF). The MAT-SF contains 34 items and uses abstract designs of the standard progressive matrix type, printed two per page (in black, white, yellow, and blue). Four types of items, described later, were included in the test (Naglieri, 1984). Before arriving at this choice, the researcher examined various verbal and non-verbal problem-solving tests used in educational dissertations to evaluate their appropriateness for the present study. The tests considered included:

1. Problem Situations Test - Besculides, George
2. Problem-Solving Approach Test - Vos, Kenneth
3. Problem-Solving Ability Test - Bartos, John
4. Problem-Solving Checklist - Roberts, John
5. Problem-Solving Competence Measure - Wilkinson, Larry
6. Problem-Solving Essay Test - Fodor, John
7. Problem-Solving Skills Test - Gengler, Charles
8. Problem-Solving Test - Schulert, David

(Mental Measurement Yearbook, 1989)

The Matrix Analogies Test was chosen based on its validity and reliability over the other tests. Its content, presentation, and format are good, and the test covers a wide range of problem-solving situations (See Appendix E).

The MAT test is a nonverbal measure of reasoning designed to be administered to elementary and high school students. It is Raven’s-like in format and presents problems with a visual stimulus having a missing element or sequence. The testee selects the best option, completing the stimulus. Variables include: size, shape, color, and direction (See Appendix E).

The items are divided into four groups. In Group 1, pattern completions, the testee "completes the pattern." For Group 2, reasoning by analogy, the testee "determines how changes in two or more variables converge to result in a new figure." In Group 3, social reasoning, the testee "discovers the order in which items appear throughout the matrix." With Group 4, spatial visualization, the testee "imagines how a figure would look when two or more components are combined." The item groups were not derived
empirically but by "logical organizations" (Mental Measurement Yearbook, 1989, p. 479).

The testees were given 25 minutes to complete the test. An additional fifteen minutes were allowed for distribution and collection of test materials, reading the guidelines/instructions and for completing the demographic sheet, making a total of 40 minutes.

The demographic sheet was used to collect information on the participant's age, gender, race/ethnicity, grade level, program area, average salary of parent/guardian, and post-high school plans (See Appendix E).

Validity of the Instrument

The instrument provides a culture-reduced measure of general reasoning ability and has great value for screening people with diversified backgrounds. Scattler (1982) states that tests like the MAT-SF are also useful for "screening children with severe language, auditory, or physical disabilities...[and] children who do not speak English or who have limited command of English" (p. 247). Additionally, the test was evaluated by the staff at the high school as appropriate and relevant with regard to its degree/level of difficulty in achieving its goals.

The validity of the MAT was supported in several ways. First, score progression corresponds to age. Second, median correlations of the MAT, based on both normal and special
samples, are .52 with the Multilevel Academic Survey Test, .32 with the Stanford Achievement Test, .43 with the Klechesler Intelligence scale for Children—Revised (WISC-R), and .68 with RPM. Third, gender and racial differences are minimal for groups matched on testing site, age, and father’s socioeconomic status.

Factor analysis did not fully substantiate the item groups. Even using oblique notation (correlated factors), there were only three distinguishable factors. Only half to two-thirds of a group’s designated item loaded on the expected factor; cross-factor loading was common. Reasoning by analogy and Serial Reasoning was especially confounded, with the former tending to embed within the latter. Nevertheless, the Reasoning by Analogy items were retained because of their high loadings on the first unrotated factor. They are considered as a useful measure of the test’s overall non-verbal intellectual ability construct (Mental Measurement Yearbook, 1989).

Reliability

Median alphas across age groups are .93 for the total test and .835 for item groups. Test/retest reliability is lower (median = .75), using smaller, less representative samples. Means are given for the "pretest" and "posttest," although the treatment was (presumably standard). Standard
errors of measurement, given for each age, are based on the alphas (Mental Measurement Yearbook, 1989).

**Data Collection Procedures**

The short form of the Matrix Analogies Test was ordered from The Psychological Corporation, San Antonio, Texas. The letter was signed by the late Professor Thomas R. White, a noted scholar in the areas of Program Planning, Program Evaluation, Teacher Education, and Administration, and was written under the auspices of the College of Education, Department of Educational Studies of The Ohio State University, Columbus, Ohio.

The purpose and the use of the test was specified within the letter (See Appendix B).

The delivered package consisted of the examiner's manual, test booklets, and answer sheets.

Permission to conduct the test in the school was requested from the Columbus Public Schools (Division of Student Services) following the guidelines for the conduct of research studies in the Columbus Public Schools.

Permission to specifically conduct the test at the high school was honored and authorized by the school's authority, after reading through a formal memo of introduction from the assistant superintendent, Lucretia Williams, written under the auspices of the Columbus Public School, after going
through the content of the test and after studying the procedure for conducting the research.

Of the 320 students randomly selected from the population of 1,644 students to participate in the study, the test was administered at 10:00 a.m., March 20, 1995, to a total of 236 students who showed up to participate in the study. Each student was given an identical test booklet, answer sheets, pencil, and demographic sheet. On the demographic sheet, data concerning each student’s gender, grade level, socioeconomic status, age, race/ethnicity, program area, and ambition (post-high school plan) were requested (See Appendix E).

The actual administration of the test proceeded as follows: At 10:00 a.m. on March 20, 1995, the 236 students gathered at the auditorium. There were six teachers (assistants), including myself, throughout the administration of the test.

The testing procedure was as follows:

**Step 1.** "Having had the student’s attention, the researcher read the following statement: "Today you are going to look at pictures of shapes and then choose a missing piece for each picture. However, first, write your date of birth, your grade, and other requested information on the demographic sheet of paper given to you. Your name must
Step 2. "Open your test booklet to picture 1, the first picture page. Look up here (Students’ attention was directed to the correct page for the first item). Look for the number 1 in the corner (the lower right corner was pointed at). Look at the picture at the bottom of the page. There is a piece missing. Which one of the pictures here (pointing to the options), goes on the question mark (point to the question mark)? Look at all the choices before you choose your answer.

Step 3. "On your answer sheet for number 1, darken the circle with the number that is the same as your choice (pausing to allow students to answer the trial item). You should have marked number 2 because that picture is all yellow and fits best on the question mark (pausing). If you made the wrong choice, make an "X" on your first answer and fill in circle 2.

Step 4. "From now on, there will be two questions on a page. Work as carefully as you can. If
you are not sure about an answer, choose the one you think is best. Work this way until you come to the end or until you are told to stop. Then wait for more directions. Are there any questions? (pausing) Okay, you may start."

They were asked to stop at the end of 25 minutes, during which answer sheets, pencils, test booklets, and demographic sheets were collected. On a later date, the answer sheets were marked and individual scores determined.

**Statistical Analyses Employed**

**Data Analysis**

The data for this study was analyzed by comparing group to group without singling out individual subjects, using Scheffé test. The Scheffé test is appropriate for making comparisons involving a set of means (Gay, 1987). The Scheffé test was chosen over the Fisher's LSD test, Bonferroni t-tests or Dunn's test, the Newman-Keuls test, and Turkey's HSD test, because of its flexibility and ease of application for a variety of situations.

The study is based upon factorial design and investigates two independent variables: grade level and program area (vocational/non-vocational), and the interactions, if any, between them. The appropriate statistical analysis is a factorial or multifactor analysis
of variance such that the analysis yields a separate F ratio for each independent variable and one for each interaction.
CHAPTER IV
FINDINGS

The findings of the study are based on the student's performance on the MAT-SF. The test consisted of 34 items (questions) and each correct response was assigned one point. The maximum points a student could earn was 34. A student with a score of 32 or greater on the test was considered as having a "high performance" and a student with a score of 24 or below was considered as having a "low performance" (see Scaling Table on page 36).

A total of 200 student scores selected at random from a total 236 students that took the test was used by the investigator for the study. The sample was broken down as follows:

<table>
<thead>
<tr>
<th>No. Students</th>
<th>Grade Level/Program Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>12th-grade vocational</td>
</tr>
<tr>
<td>50</td>
<td>12th-grade non-vocational</td>
</tr>
<tr>
<td>50</td>
<td>11th-grade vocational</td>
</tr>
<tr>
<td>50</td>
<td>11th-grade non-vocational</td>
</tr>
<tr>
<td>Ratings</td>
<td>Score</td>
</tr>
<tr>
<td>-------------------------</td>
<td>-------</td>
</tr>
<tr>
<td>Outstanding Performance</td>
<td>34</td>
</tr>
<tr>
<td>Superior Performance</td>
<td>33</td>
</tr>
<tr>
<td>Well Above Average</td>
<td>32</td>
</tr>
<tr>
<td>High Average</td>
<td>31</td>
</tr>
<tr>
<td></td>
<td>30</td>
</tr>
<tr>
<td>Average</td>
<td>29</td>
</tr>
<tr>
<td></td>
<td>28</td>
</tr>
<tr>
<td>Below Average</td>
<td>27</td>
</tr>
<tr>
<td></td>
<td>26</td>
</tr>
<tr>
<td>Needs Further Observation/Testing</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>24</td>
</tr>
<tr>
<td>Poor Performance</td>
<td>23</td>
</tr>
<tr>
<td></td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>21</td>
</tr>
<tr>
<td></td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>19</td>
</tr>
<tr>
<td>Seriously Poor Performance</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>≤4</td>
</tr>
</tbody>
</table>
Demographic Characteristics of the Sample

Age:

The scores on the test showed that all the age groups 16-0 to 17-11 had a mean score of 28.21, percentile rank of 43 and an age equivalent of 14-0, meaning an average performance. The students in the age groups 18-0 or above had a mean score of 27.17, percentile rank of 34 and an age equivalent of 13-3, meaning performance was below average.

The investigator's findings revealed that there was problem-solving skill deficiency across the board. All the age groups performed lower than what was expected for their age. The younger students were deficient on problem-solving skill and the older students were even more deficient. (See Table 1 for the score breakdown by age.)

Table 1

Mean Score of Problem-Solving Ability by Age Group

<table>
<thead>
<tr>
<th>Age</th>
<th>Frequency</th>
<th>Percent</th>
<th>Cumulative Frequency</th>
<th>Cumulative Percent</th>
<th>Mean Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>16-0 to 16-5</td>
<td>4</td>
<td>2.0</td>
<td>4</td>
<td>0</td>
<td>28.0</td>
</tr>
<tr>
<td>16-6 to 16-11</td>
<td>38</td>
<td>19.0</td>
<td>42</td>
<td>21.0</td>
<td>28.26</td>
</tr>
<tr>
<td>17-0 to 17-5</td>
<td>50</td>
<td>25.0</td>
<td>92</td>
<td>46.0</td>
<td>28.15</td>
</tr>
<tr>
<td>17-6 to 17-11</td>
<td>50</td>
<td>25.0</td>
<td>142</td>
<td>71.0</td>
<td>28.26</td>
</tr>
<tr>
<td>18-0 to 18-5</td>
<td>38</td>
<td>19.0</td>
<td>180</td>
<td>90.0</td>
<td>27.16</td>
</tr>
<tr>
<td>18-6 to 18-11</td>
<td>1</td>
<td>.5</td>
<td>181</td>
<td>90.5</td>
<td>27.75</td>
</tr>
<tr>
<td>Above 18-11</td>
<td>19</td>
<td>9.5</td>
<td>200</td>
<td>100.0</td>
<td>27.16</td>
</tr>
</tbody>
</table>
Gender:

The males had a mean score of 28.11, percentile rank of 43 and an age equivalent of 14-0, meaning an average performance. The females had a mean score of 27.53, percentile rank of 34 and an age equivalent of 13-3, meaning performance was below average on the rating scale. (See Table 2)

The investigator’s findings revealed that the males outperformed the females, however, both genders under performed because they performed at a much lower score than their age equivalent. (See Table 2)

Table 2
Mean Score of Problem-Solving Ability by Gender

<table>
<thead>
<tr>
<th>Gender</th>
<th>Frequency</th>
<th>Percent</th>
<th>Cumulative Frequency</th>
<th>Cumulative Percent</th>
<th>Mean Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Males</td>
<td>67</td>
<td>33.5</td>
<td>67</td>
<td>33.5</td>
<td>28.11</td>
</tr>
<tr>
<td>Females</td>
<td>133</td>
<td>66.5</td>
<td>200</td>
<td>100.0</td>
<td>27.53</td>
</tr>
</tbody>
</table>

Socioeconomic Background:

Students from homes with a family income in the range zero to $19,999 were classified as low income or below average income, while those in the range $20,000 to $39,999 were classified as middle income or average income. Those with a family income of $40,000 and above were grouped as high income or above average income.
The scores on the test showed that all the students from a family with income below average had a mean score of 26.40, percentile rank of 27 and age equivalent of 12-3, meaning a performance below average. Similarly, students from homes with an average family income had a mean score of 27.88, percentile rank of 43 and an age equivalent of 13-3, meaning a low average performance. Students from homes with family income above average had a mean score of 28.68, percentile rank of 54 and an age equivalent of 15-2 meaning an average performance (See Table 3).

Table 3
Mean Score of Problem-Solving Ability by Socioeconomic Background

<table>
<thead>
<tr>
<th>Income</th>
<th>Frequency</th>
<th>Percent</th>
<th>Cumulative Frequency</th>
<th>Cumulative Percent</th>
<th>Mean Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Below Average</td>
<td>30</td>
<td>15.0</td>
<td>30</td>
<td>15.0</td>
<td>26.40</td>
</tr>
<tr>
<td>Average</td>
<td>110</td>
<td>55.0</td>
<td>14</td>
<td>70.0</td>
<td>27.88</td>
</tr>
<tr>
<td>Above Average</td>
<td>60</td>
<td>30.5</td>
<td>200</td>
<td>100.0</td>
<td>28.68</td>
</tr>
</tbody>
</table>

The investigator's findings revealed that as family income increases, performance on the test increases (see Figure 1).
Figure 1: Graph of mean score versus family income
Racial/Ethnic Background

The scores based on the different races indicated a mean score of 26.19, percentile rank of 27 and an age equivalent of 12-3, meaning a performance below average for the Black participants. Followed by this was the White participants with a mean score of 28.13, percentile rank of 43 and an age equivalent of 14-0, meaning an average performance on the test. Similarly, Hispanics had a mean score of 29.14, percentile rank of 54 and an age equivalent of 16-2, meaning a better average performance.

The investigator’s findings revealed that all racial groups will need to improve on their problem-solving skills, however, the degree of improvement expected was much more for the Blacks than for the other two races (White and Hispanic) for a goal of superior or outstanding performance. (See Table 4)

Table 4
Mean Score Problem-Solving Ability by Race

<table>
<thead>
<tr>
<th>Race</th>
<th>Frequency</th>
<th>Percent</th>
<th>Cumulative Frequency</th>
<th>Cumulative Percent</th>
<th>Mean Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>White</td>
<td>90</td>
<td>45.0</td>
<td>90</td>
<td>45</td>
<td>28.13</td>
</tr>
<tr>
<td>Black</td>
<td>95</td>
<td>47.5</td>
<td>185</td>
<td>92.5</td>
<td>26.19</td>
</tr>
<tr>
<td>Hispanic</td>
<td>15</td>
<td>7.5</td>
<td>200</td>
<td>100.0</td>
<td>29.14</td>
</tr>
<tr>
<td>Other</td>
<td>0</td>
<td>0</td>
<td>200</td>
<td>100.0</td>
<td></td>
</tr>
</tbody>
</table>
Post High School Plan

Under the post high school plan, the students that indicated on the demographic sheets, "I intend to go to college or technical school after my 12th-grade education," were classified or grouped as college bound. Those that indicated, "I do not intend to go to college or technical school after my 12th-grade education," were classified as Non-college bound or work bound, and those that indicated, "I am undecided on what to do after my 12th-grade education," were classified as undecided.

Classification by post high school plan showed that the work bound and the undecided students had a mean score performance below average and average, respectively. The work bound had a mean score of 27.06, percentile rank of 34 and an age equivalent of 13-3, meaning performance was below average. The undecided students had a mean score of 27.61, percentile rank of 43, and an age equivalent of 14-0, meaning an average performance. The higher education bound students had a mean score of 28.51, a percentile rank of 54, and an age equivalent of 16-2 on the MAT-SF, meaning an average performance.

The investigator's finding revealed that with the exception of the work bound students who performed below average, the higher education bound and the undecided had an average performance. The higher education bound, however, had a better average performance. All students need an
improvement on problem-solving skills, but the degree of improvement expected for a goal of superior or outstanding performance was much more for work bound students. (See Table 5)

Table 5
Mean Score Problem-Solving Ability by Post High School Plan

<table>
<thead>
<tr>
<th>Classification</th>
<th>Frequency</th>
<th>Percent</th>
<th>Cumulative Frequency</th>
<th>Cumulative Percent</th>
<th>Mean Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Higher Ed. Bound</td>
<td>158</td>
<td>79.0</td>
<td>158</td>
<td>79.0</td>
<td>28.51</td>
</tr>
<tr>
<td>Work Bound</td>
<td>12</td>
<td>6.0</td>
<td>170</td>
<td>85.0</td>
<td>27.06</td>
</tr>
<tr>
<td>Undecided</td>
<td>30</td>
<td>15.0</td>
<td>200</td>
<td>100.0</td>
<td>27.61</td>
</tr>
</tbody>
</table>

Statistical Analysis

Data were analyzed using analysis of variance ANOVA with the Scheffé test as a selected Post Hoc multiple comparison technique.

The ANOVA was used to determine whether there was a significant difference between the means at a selected probability level. Following the determination of significant differences between the means, the researcher used a multiple comparisons procedure to determine which means were significantly different from other means. This involved a special form of the t-test, a form for which the error term is based on the combined variance of all the groups.
Of the many multiple comparison techniques available, the Scheffé test was used in this study because of its simplicity, flexibility, and ease of application.

The result of analysis showed that the interaction between the program and grade level was not significant (See Table 6) \(F[1,196] = .08, p > .05\). There was no interaction between vocational and non-vocational students based on grade level. (See Figure 2) There was no significant difference between the student's performance based on grade level \(F[1,196] = .000, p > .05\). There was, however, a significant difference between the mean performance based on program area \(F[1,196] = 20.63, P < .05\). (See Table 6)

Table 6

Summary Table

Analysis of Variance of Average Problem-Solving Skill Test Scores by Type of Program and Grade Level

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Program</td>
<td>1</td>
<td>367.21</td>
<td>20.63*</td>
</tr>
<tr>
<td>Grade</td>
<td>1</td>
<td>0.01</td>
<td>0.00</td>
</tr>
<tr>
<td>Program * Grade</td>
<td>1</td>
<td>1.45</td>
<td>0.08</td>
</tr>
<tr>
<td>(Within Cells)</td>
<td>196</td>
<td>17.80</td>
<td></td>
</tr>
<tr>
<td>TOTAL:</td>
<td>199</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*p < .05
Graphical Representation of No Interaction Between Program and Grade Level

Figure 2: Type of program as a function of grade level
Group-to-Group Comparison

The scores on the test showed that the 11th-grade vocational students (group 1) and the 12th-grade vocational students (group 3) performed below average on the test. The 11th-grade non-vocational students (group 2) and the 12th-grade non-vocational students (group 4) had an average performance. The investigator found that there was room for improvement on problem-solving skills for all the groups based on performance on the test. However, there was much more room for improvement for 11th-grade vocational and 12th-grade vocational students. (See Figure 3 for score breakdown)

Program

<table>
<thead>
<tr>
<th>Program</th>
<th>Vocational</th>
<th>Non-Vocational</th>
</tr>
</thead>
<tbody>
<tr>
<td>11th Grade</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group 1</td>
<td>$\bar{X}_1 = 26.38$</td>
<td>$\bar{X}_2 = 29.26$</td>
</tr>
<tr>
<td>Group 3</td>
<td>$\bar{X}_3 = 26.54$</td>
<td>$\bar{X}_4 = 29.08$</td>
</tr>
<tr>
<td>12th Grade</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

$\bar{X}_a = 27.82$

$\bar{X}_b = 27.81$

$n = 50$ for cell

Figure 3: Cell Means by Type of Program and Grade Level
\( \bar{X}_1 = \) Mean Score of 11th-Grade Vocational Students (Group 1)

\( \bar{X}_2 = \) Mean Score of Non-Vocational Students (Group 2)

\( X_3 = \) Mean Score of 12th-Grade Vocational Students (Group 3)

\( \bar{X}_4 = \) Mean Score of 12th-Grade Non-Vocational Students (Group 4)

\( \bar{X}_a = \) Mean Score of 11th-Grade Students Regardless of Program Area

\( \bar{X}_b = \) Mean Score of 12th-Grade Students Regardless of Program Area

\( \bar{X}_c = \) Mean Score of Vocational Students Regardless of Grade Level

\( \bar{X}_d = \) Mean Score of Non-vocational Students Regardless of Grade Level
Vocational and Non-Vocational Comparison: 11th-Grade Students

The 11th-grade vocational students had a score of 26.38, percentile rank of 27 and an age equivalent of 12-3, meaning performance was below average on the rating scale. The 11th-grade non-vocational students had a score of 29.26, percentile rank of 54 and an age equivalent of 16-2, meaning an average performance. The 12th-grade vocational students had a score of 26.54, percentile rank of 34 and an age equivalent of 13-3, meaning a performance below average. The 12th-grade non-vocational students had a score of 29.08, percentile rank of 54 and an age equivalent of 16-2, meaning an average performance on the MAT-SF. The 11th-graders, regardless of program area, had a score of 27.82, percentile rank of 43 and an age equivalent of 14-0, meaning an average performance. The 12th-graders, regardless of program area, had a score of 27.81, percentile rank of 43 and an age equivalent of 14-0, meaning also an average performance.

The vocational students, in general, regardless of grade level, had a score of 26.46, percentile rank of 27 and an age equivalent of 12-3 on the MAT-SF, meaning a performance below average. The non-vocational students, in general, regardless of grade level, had a score of 29.17, percentile rank of 54 and an age equivalent of 16-2 on the MAT-SF, meaning an average performance on the rating scale. (See page 36 for rating scale)
Table 7
Scheffé's Test for Program

<table>
<thead>
<tr>
<th>Scheffé</th>
<th>Grouping</th>
<th>Mean</th>
<th>N</th>
<th>Program</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>29.17</td>
<td>100</td>
<td></td>
<td>Non-vocational</td>
</tr>
<tr>
<td>B</td>
<td>26.46</td>
<td>100</td>
<td></td>
<td>Vocational</td>
</tr>
</tbody>
</table>

The test score showed that the 11th-grade non-vocational students performed better than the 11th-grade vocational students. The 11th-grade non-vocational students had a mean score of 29.26, percentile rank of 54 and an age equivalent of 16-2 on the MAT-SF, meaning an average performance. The 11th-grade vocational students had a mean score of 26.38, a percentile rank of 27, and an age equivalent of 12-3, meaning performance was below average.

The investigator's finding revealed that there was a significant difference in problem-solving skills of 11th-grade vocational students and 11th-grade non-vocational
students. Non-vocational students scored significantly higher on the test than vocational students.

Vocational and Non-Vocational Comparison: 12th-Grade Students

The test score showed that the 12th-grade non-vocational students performed better than the 12th-grade vocational students. The 12th-grade non-vocational students had a mean score of 29.08, a percentile rank of 54 and an age equivalent of 16-2, meaning an average performance. The 12th-grade non-vocational students had a mean score of 26.54, a percentile rank of 34 and an age equivalent of 13-3, meaning performance was below average.

The investigator’s findings revealed that there was a significant difference in problem-solving skills of 12th-grade vocational students and 12th-grade non-vocational students. The non-vocational students scored significantly higher on the test than vocational students. Program was a meaningful factor in problem-solving skills.

Vocational Students: 11th- and 12th-Grade Comparison

The test score showed that the vocational students, based on grade levels, had a performance below average. Their test score, in comparison, did not show a significant difference. The 11th-grade vocational students had a score of 26.38, percentile rank 27 and an age equivalent of 13-3
on MAT-SF, meaning a performance below average. The 12th-grade vocational students had a score of 26.54, a percentile rank of 27, and an age equivalent of 13-3 on the MAT-SF, also meaning performance was below average.

The investigator's findings revealed that no significant difference in problem-solving skills was found between the vocational students in the 11th- and 12th-grade, based on the MAT-SF test. Grade level was not a meaningful factor to problem-solving skills in this study.

Non-Vocational Students: 11th- and 12th-Grade Comparison

The test scores showed that non-vocational students, based on grade level, had an average performance. Their test score, in comparison (11th-grade versus 12th-grade non-vocational), did not show a significant difference. The 11th-grade non-vocational students had a score of 29.28, a percentile rank of 54 and an age equivalent of 16-2 on the MAT-SF, meaning an average performance. Similarly, the 12th-grade non-vocational students had a score of 29.08, a percentile rank of 54 and an age equivalent of 16-2, meaning an average performance on the MAT-SF.

The investigator's findings revealed that no significant difference in problem-solving skills was found between the non-vocational students in the 11th- and 12th-grade. Grade level was not a meaningful factor to problem-solving skills in this study. (See Table 8)
Table 8
Means and Standard Deviations of Scores by Grade Level and Type of Program

<table>
<thead>
<tr>
<th>Grade Level Regardless of Program Area</th>
<th>Vocational n=50</th>
<th>Non-Vocational n=50</th>
</tr>
</thead>
<tbody>
<tr>
<td>11th-Grade</td>
<td>26.38</td>
<td>29.28</td>
</tr>
<tr>
<td>x</td>
<td>4.19</td>
<td>3.60</td>
</tr>
<tr>
<td>12th-Grade</td>
<td>26.54</td>
<td>29.08</td>
</tr>
<tr>
<td>x</td>
<td>5.06</td>
<td>3.88</td>
</tr>
</tbody>
</table>

The test scores showed that the 11th-graders and the 12th-graders had an average performance. The mean score for 11th-grade students, when compared to the 12th-grade students, did not show any significant difference. The 11th-grade students, regardless of program area, had a mean score of 27.82, a percentile rank of 43 and an age equivalent of 14-0 on the MAT-SF test, meaning an average performance. The 12th-grade students, regardless of program area, had a mean score of 27.81, a percentile rank of 43 and an age equivalent of 14-0, meaning an average performance on the MAT-SF test.
The investigator's findings revealed that no significant difference in problem-solving skills was found between the 11th-grade students and the 12th-grade students, regardless of program area. Grade level was not a meaningful factor to problem-solving skills in this study. (See Tables 9 and 10)

Table 9
Means and Standard Deviations of Scores by Grade Level Regardless of Program Area

<table>
<thead>
<tr>
<th>Grade</th>
<th>11th-Grade n=100</th>
<th>12th-Grade n=100</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \bar{x} )</td>
<td>27.82</td>
<td>27.81</td>
</tr>
<tr>
<td>( Sd )</td>
<td>4.15</td>
<td>4.66</td>
</tr>
</tbody>
</table>
Table 10
Scheffé’s Test for Grade Level

<table>
<thead>
<tr>
<th>Scheffé</th>
<th>Grouping</th>
<th>Mean</th>
<th>N</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>27.82</td>
<td>100</td>
<td></td>
<td>11th-grade</td>
</tr>
<tr>
<td>A</td>
<td>27.81</td>
<td>100</td>
<td></td>
<td>12th-grade</td>
</tr>
</tbody>
</table>

Critical Value of $F = 3.89$
Minimum Significant Difference = 1.18

(Means with the same letters are not significantly different.)

Type of Program Regardless of Grade Level

The test scores showed that the vocational students and the non-vocational students, regardless of grade level, performed differently on the test. The vocational students’ scores, when compared to the non-vocational students’ scores, showed a significant difference. The vocational students had a mean score of 26.46, a percentile rank of 27 and an age equivalent of 12-3 on the MAT-SF test, meaning a performance below average. The non-vocational students had a mean score of 29.17, a percentile rank of 54 and an age equivalent of 16-2 on the MAT-SF test, meaning an average performance.
The investigator's findings revealed that, although the non-vocational students had a better score than the vocational students, both groups of students, however, must have to improve their problem-solving skills in order to achieve a problem-solving skill goal of an outstanding performance or superior performance (see Table 11).

Table 11

Means and Standard Deviation of Test Scores by Type of Program Regardless of Grade Level

<table>
<thead>
<tr>
<th>Grade</th>
<th>Vocational</th>
<th>Non-Vocational</th>
</tr>
</thead>
<tbody>
<tr>
<td>11th- and 12th-Grade (combined)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \bar{x} )</td>
<td>26.46</td>
<td>29.17</td>
</tr>
<tr>
<td>( Sd )</td>
<td>4.62</td>
<td>3.73</td>
</tr>
</tbody>
</table>
CHAPTER V
SUMMARY, IMPLICATIONS, AND RECOMMENDATION
FOR FURTHER RESEARCH

Summary

The purpose of this study was to investigate problem-solving skills among the vocational students and non-vocational students in a high school. Two hundred students participated in the study, by completing the MAT-SF test. The participants were drawn from four groups. The first group, group 1, consisted of 50, 11th-grade vocational students; the second group, group 2, consisted of 50, 11th-grade non-vocational students; the third group, group 3, consisted of 50, 12th-grade vocational students; and the fourth group, group 4, consisted of 50, 12th-grade non-vocational students. Comparisons were made on a group-by-group basis without singling out individual students.

The instrument for this study was the Matrix Analogy Test-Short Form (MAT-SF). It contained 34 items (questions). The MAT-SF is a nonverbal measure of reasoning designed to be administered to elementary and high school students. It is Raven's-like in format and presents a visual stimulus with a missing element or sequence. There
are five options to each question. The testee selects the best option, completing the stimulus. Variables include size, shape, color, and direction (Mental Measurement Yearbook, 1989). Included in test booklets were demographic sheets with which demographic characteristics were obtained. The variables included: age, gender, race/ethnicity, and socioeconomic status. Additionally, participating students were questioned regarding their post high school plans.

(a) Intend to go to college or technical school after the 12th-grade education.
(b) Intend not to go to college or technical school after the 12th-grade education.
(c) Undecided on what to do after the 12th-grade education.

The demographic characteristics of the sample are summarized in Chapter IV.

A simple analysis of variance (ANOVA) was performed to determine whether there is a significant difference between the groups at the P. ≤ .05. The F ratio was significant, and since more than two means were involved, a multiple comparison technique, the Scheffé test, was used to determine which means are significantly different from other means.

Specifically, the study sought to answer the following research questions:

1. What are the demographic characteristics of the sample of vocational and non-vocational students.
2. Are problem-solving skills related to the type of program a student is completing?

3. Are problem-solving skills related to the grade-level of the students?

Additionally, the author hypothesized the following in relationship to research questions 2 and 3:

1. There is no significant difference between the mean problem-solving skill test scores of 11th-grade vocational and 11th-grade non-vocational students.

2. There is no significant difference between the mean problem-solving skill test scores of 12th-grade vocational and non-vocational education students.

3. There is no significant difference between the mean problem-solving skill test scores of 11th-grade vocational students and 12th-grade vocational students.

4. There is no significant difference between the mean problem-solving skill test scores of 11th-grade non-vocational students and 12th-grade non-vocational students.

5. There is no significant difference between the mean problem-solving skill test scores of 11th-grade students and 12th-grade students regardless of program area.
6. There is no significant difference between the mean problem-solving skill test scores of vocational education students and non-vocational education students regardless of grade level.

Implications

Theoretical

The findings of this study supported the basic contentions found within the literature that vocational or non-traditional students are lacking problem-solving skills. Kolda (1991) found deficiency of this skill among over half of the students. The study conducted by Dykman (1994) revealed that although vocational students are the backbone of our industries, they perform less on problem-solving skill test when compared to their non-vocational peers. This study showed that the vocational students had a poor performance on the MAT-SF test and non-vocational students had an average performance on the MAT-SF test.

A substantial body of research in cognitive science shows that providing students with real problems to solve is essential if they are to develop their problem-solving skills. This approach can also spur motivation to learn (Senta, 1990).

The major alternative to the increasing problem-solving skills of the students is to require students to take more traditional academic courses, such as basic arithmetic,
writing, and reading. These courses should be taught in hopes that it will improve students' problem-solving skills. So far, this has not worked (Klirt, 1991).

The reality of our changing society requires a critical examination of the curriculum and instruction of vocational education. How to prepare students for success in the workplace throughout their career is now a concern for vocational educators (The Ohio State National Center for Research in Vocational Education).

The content of vocational educations needs to be expanded to include problem-solving.

An integrated knowledge structure should be taught involving general problem-solving.

Critical problem solving methods should be developed so vocational students can use them automatically to solve problems.

Educators should have and use curriculum materials that require students to process information for concept formation.

Have and use curriculum material and experiences that help students develop procedures for problem solving.

Provide firsthand experience to students on problem-solving tasks.

Problem solving should be incorporated into vocational programs.

Students should be taught to learn by rules, discovery and reflecting on their own thoughts throughout the vocational education curriculum.

Teacher education programs should be designed to enable vocational instructors to help vocational students acquire problem-solving skills.
The findings of the present study showed that non-vocational students obtained higher scores on the MAT-SF test than vocational students. Thus, the findings of this study have major implications for the students in vocational programs, in schools, and in society. The future and economic/technological competitiveness of any society is dependent on how well-equipped its technical manpower are in terms of problem-solving skills. Wirt (1991) indicated that the future of vocational education is at stake. The challenge is to find ways of broadening the vocational curriculum and ensuring that problem-solving skills are a part of the curriculum. Problem solving is an essential skill that is necessary for effective human functioning. An ability to resolve problems insures survival and increases the possibility of growth and development of individual problems which can be conquered. It means that group problems can be conquered (Carkhuff, 1973). Adams (1986) revealed that it is beyond question that children will be faced with a world that is rapidly and continually changing. Children will have to tackle new knowledge, learn new skills, and solve new problems. Thus, the teaching of problem-solving could be seen as the ultimate important "task" of any educational program.

It is not unreasonable to believe that school authorities are unaware that vocational students are lacking
problem-solving skills, and, moreover, the effects of it could be detrimental to the students and society, in general. Often the first step in alleviating a problem is recognizing that a problem exists. Knowledge of the problem's existence, in this situation, could go far in making school authorities remedy the situation.

Knowledge of the findings of this study and related studies will provide a basis for school authorities, the government, and other organizations to improve the problem-solving skills of vocational education students. Additionally, knowledge of these findings emphasize the critical needs of students from government and schools.

Knowledge of the results of this study and the resulting practical implications should provide impetus for curriculum and course restructuring. Emphasis should be laid on courses to focus on problem-solving skills and broad concepts rather than how to use tools. The challenge is to devise a way of broadening the vocational curriculum and to make applied learning a part of the curriculum. To do this will require transforming the occupational content of vocational education and expanding the opportunities for students to explore all areas in order to be creative. By ensuring this, students will be able to take an initiative in problem solving. Equipping vocational students with these valuable skills could allow for more opportunity in
high-paying jobs and competitive advantages over peers in the workforce of the future.

Additionally, problem-solving skills will be crucial for participation as a citizen in an increasing, complex society. Presently, the majority of school programs designed for the preparation of vocational students do not emphasize problem solving as a necessary skill. Planners of these programs have failed to realize and act upon the fact that problem-solving skills have gained considerable importance in recent times. The importance placed on problem solving will vary in the future with the weakening American economy and the struggle of America to remain more competitive in the world economy. The weakening of America's position in a global economy will create the ever-growing demand for vocational students with problem-solving skills.

**Recommendations for Future Research**

The following recommendations are made for further research:

1. Conduct a similar study using other school districts to see if there is a significant difference in performance between the different school districts.

2. Conduct a similar study using individual vocational programs instead of vocational, in
general. (For example, business and office, construction, health, mechanical, and personal services are a few of the vocational programs to consider.

3. Conduct a similar study using a verbal form of instrument.

4. Conduct a similar study using a private school versus a public school.

5. Conduct a similar study using parents' occupation or educational background.

6. Conduct a similar study using different geographical location such as different counties, cities, and states.

7. Conduct a similar study using other grade levels.

8. Conduct a similar study using intervention. To one group teach problem-solving skills, to the other do not. See if there is a significant difference in performance.
APPENDIX A

LETTERS OF APPROVAL BY DIFFERENT AGENCIES OR ORGANIZATIONS
Research Involving Human Subjects

ACTION OF THE REVIEW COMMITTEE

With regard to the employment of human subjects in the proposed research protocol:

Educational Studies

THE BEHAVIORAL AND SOCIAL SCIENCES REVIEW COMMITTEE HAS TAKEN THE FOLLOWING ACTION:

• APPROVED

* Conditions stated by the Committee have been met by the Investigator and, therefore, the protocol is APPROVED.

• DISAPPROVED

X APPROVED WITH CONDITIONS* • WAIVER OF WRITTEN CONSENT GRANTED

* It is the responsibility of the principal investigator to retain a copy of each signed consent form for at least three (3) years beyond the termination of the subject's participation in the proposed activity. Should the principal investigator leave the University, signed consent forms are to be transferred to the Human Subjects Review Committee for the required retention period. This application has been approved for the period of three years. You are reminded that you must promptly report any problems to the Review Committee, and that no procedural changes may be made without prior review and approval. You are also reminded that the identity of the research participants must be kept confidential.

Date: August 12, 1994

(HS-023B (Rev. 2/94))

(Chairperson)
September 12, 1994

Dear Administrator:

I write this letter to introduce Ernest Efetevbia, a researcher from The Ohio State University. His research proposal has been reviewed and approved by the Research Proposal Review Committee.

Be that as it may, this letter does not obligate you or your staff to participate in the study. Rather, it serves as an introduction and official notification that Ernest Efetevbia has followed established procedures and has been granted permission to solicit subjects and/or schools to participate in this study.

If you have any questions or concerns, please call me.

Sincerely,

Lucretia Williams
Assistant Superintendent

LW/hlm
APPENDIX B

LETTER TO PSYCHOLOGICAL CORPORATION
FOR INSTRUMENT PERMIT
April 25, 1994

Rights and Permission Supervisor
The Psychological Corporation
555 Academlc Court
San Antonio, TX 78204-2498

Gentlemen:

This will confirm that Ernest Efetovia plans to use the Matrix Analogies Test-Short Form in
his dissertation research at The Ohio State University. Subjects will be 11th and 12th grade
students in a Central Ohio high school. The test administration will be conducted personally by
Mr. Efetovia and the test itself will remain secure. Grouped data only will be presented and all
individual scores will remain confidential.

Sincerely,

Thomas R. White, Professor
Educational Studies: Vocational-Technical
University Village
484 Stinchcomb Dr., #2
Columbus, Ohio 43202
April 22, 1994

Psychological Corporation
Attention Rights and Permission Supervisor
555 Academic Court
San Antonio, TX 78204-2498

Dear Sir/Madam:

I am a student working on my Ph.D. dissertation at The Ohio State University, Columbus, Ohio. I shall be very pleased if you could send me, as a matter of urgency, at university student research discount rate, the Matrix Analogies Test (short form) by Jack A. Naglieri.

Examination Manual #9540-758 ---- 1 = 1
Test Booklets (15) #8540-775 ---- 14 packets = 210
Answer Sheets (25) #8540-783 ---- 9 packets = 225

The purpose of the test is to be used as an instrument for conduct of my research on relationship between problem-solving skills of vocational education students and non-vocational education students in a comprehensive high school in a metropolitan city.

The test is to be administered to approximately a total of 200 students in a group in one session.

Enclosed is a letter of endorsement from my adviser. Thank you. I am looking forward to hearing from you soon.

Sincerely,

Enclosure
APPENDIX C

INSTRUCTIONS FOR TEST CONDUCT
Test Administration

Materials required: Test Booklet, Answer Sheets, Pencils, Demographic Sheets

Manpower

For each of the four groups of students participating in the test, three official (administrators) will be needed in the room throughout administration of the test. One administrator will read the directions while the other two administrators circulate around the room to provide help when needed, such as distribution of test materials (test booklet, answer sheets, pencils, and demographic sheets). Also, the administrators are to ensure that the students are marking their answer sheet correctly and have understood the test directions. They are also to encourage the students to mark what they think is the best possible guess among the options rather than waste too much time on a particular question. The students will also be instructed to make no marks on the test booklet and to mark all answers on the answer sheet. Before beginning the test, the students will be instructed to give their date of birth and other background information as requested on the demographic sheet. No name is required. This is to protect the confidentiality of the student. By ensuring this, the most useful data possible can be obtained.
The study will be administered during a regular school day. There will be two groups of 100 students each (vocational vs. non-vocational), with two sub-groups each (11th grade and 12th grade). Twelve officials would be needed if the test is to be conducted simultaneously for the entire 200 students. If there is a shortage of manpower, however, three people could be used to administer the test at four different times for the four groups. Similarly, six people, divided into two groups, could also be used in administering the entire test at two different times.

The test administration will proceed as follows. After the researcher has all the students' attention, each student will be given a pencil, an answer sheet, a test booklet, and a demographic sheet, which has to be completed for background information. Thereafter, the following steps will be followed:

**Step 1.** After you have the student's attention, and they are ready, say: "Today you are going to look at pictures of shapes and then choose a missing piece for each picture. However, first, complete the demographic sheet."

**Step 2.** Open your test booklet to picture 1, the first picture page. Look up here (direct the students' attention to the correct page for the first item). Look for the number 1 here in the corner (point to the lower right corner). Look at the picture at the bottom
the bottom of the page. There is a piece missing. Which one of the pictures here, look where I'm pointing (point to the options), goes on the question mark (point to the question mark)? Look at all the choices before you choose your answer.

**Step 3.** On your answer sheet for number 1 darken the circle with the number that is the same as your choice. (Pause to allow students to answer the trial item.) You should have marked number 2 because that picture is all yellow and fits best on the question mark. (Pause.) If you made the wrong choice, make an "X" on your first answer and fill in circle 2.

**Step 4.** From now on there will be two questions on a page. Work as carefully as you can. If you aren't sure about an answer, choose the one you think is best. Work this way until you come to the end or until I tell you to stop. Then wait for more directions. Are there any questions? (Pause.) Okay, you may start.

Start timing the students. After 25 minutes say:

"STOP—put your pencils down. Now I will collect the answer sheets and test booklets." (Collect materials.)
APPENDIX D

SOLICITATION/CONSENT FORM
Dear Student:

You have been randomly selected to participate in the Matrix Analogies test scheduled on March 20, 1995, at 10:00 a.m. The test score is to be used by the investigator for research purposes in regards to problem-solving ability. A table of random numbers was used in the selection process. A random number table is a set of integers generated so that in the long-run the table will contain all ten integers (0, 1, ..., 9) in approximately equal proportions, with no trends in the pattern in which the digits were generated. If one number is selected from a random point in the table, it is equally likely to be any of the digits 0 through 9.

This process of selection was carried out by matching your name and those of other students to an assigned three-digit number in the form of an arithmetic progression. Thereafter, going to the table of random numbers to make a random pick from a random point, until a total of 200 required number of students were obtained. These 200 three-digit numbers obtained from the table were later matched to their respective corresponding names to determine the individual students for this study.
The purpose of the test is to see how many of the questions (represented in a pictorial or diagrammatical form) you and your peers can correctly answer within 25 minutes. Your group’s scores will be compared to group scores in other program areas. Under no circumstance will your score, as an individual, be singled out. Based on the outcome of the study recommendation for curriculum restructuring, upgrading or modification with respect to problem-solving skills may be recommended.

For your information, your name or any other form of identification will not be required on the test sheet. This will ensure the confidentiality of your performance on the test.

Your prompt arrival for the test at the time specified above will be highly appreciated. Please indicate your consent or non-consent by signing and checking (✓) the appropriate box on the attached sheet.

Thank you for your cooperation and time. Looking forward to seeing you.

(Principal Investigator)      (Co-Investigator)
Professor                   Doctoral Candidate
Please indicate if you will be willing or will not be willing to take part in the test by checking (✓) the appropriate box.

☐ I will be participating in the Matrix Analogies Test, scheduled for March 20, 1995. I hereby freely and voluntarily signify by signing below. Thank you for this opportunity to participate.

Signature of student

☐ Sorry, I will not be able to participate in the Matrix Analogies test. I hereby signify by signing below. Thank you for the opportunity given to me.

Signature of Student
APPENDIX E

RESEARCH INSTRUMENT
Matrix Analogies Sample Test
Short Form (Naglieri, 1985)
DEMOGRAPHICS

Please respond to the following:

1. School:_____________________________________________________

2. Date of Birth: __________________________ (day) (month) (year)

3. Grade:_________

4. Sex: _____Male _____Female

5. Which is your program area?
   a. _____ Vocational   b. _____ Non-vocational

6. If vocational, please specify program area.
   ____________________________________________________________

7. What is the average salary of your parent or guardian?
   _____a. (0-$19,999) Below Average
   _____b. ($20,000-$39,999) Average
   _____c. ($40,000 or above) Above average

8. With what ethnic group do you identify?
   _____a. African-American/Black (Non-Hispanic)
   _____b. Asian
   _____c. Hispanic
   _____d. Pacific Islander
   _____e. Native American (Indian/Eskimo)
   _____f. White (Non-Hispanic)
   _____g. Other (Specify)_______________________________________

9. Which of this best describes your post-high school plans?
   _____a. I intend to go to college or technical school
           after my 12th grade education (higher
           education bound or college bound)
___b. I do not intend to go to college or technical school after my 12th grade education. Non-college bound (work bound).

___c. I am undecided on what to do after my 12th grade education (undecided).
APPENDIX F

INSTRUCTION FOR TEST CONDUCT FOR

NON-PARTICIPANTS
Test Administration for Non-Participating Students
in the Research Study

The test administration for non-participating students will proceed as follows: having had all the students' attention, each student will be given question/answer sheets and those students without a pencil or pen will be given one. Thereafter, the following steps will be followed:

Step 1. After you have the student's attention and they are ready, say: "Today you are going to have some problems that require an answer. However, first, complete the sheet given to you by filling in your age, sex, grade, and your school. You have five minutes to complete this information."

Step 2. "After that, look at your question/answer sheets. There are eight questions in all. You are to spend an average of two minutes on each question and a total of 16 minutes on the entire eight questions. It is not necessary to answer the questions in the order in which they are presented. Do those that are easiest for you first and those that appear difficult last."
Step 3. "Your score will remain confidential. It is, however, hoped that this exercise will be stimulating, interesting, challenging, and hereafter will create an awareness of problem solving for you."

Step 4. "It is 10:00 a.m. by my time. You have 16 minutes to answer all the questions. Now have fun. You may begin."

Step 5. At the end of 16 minutes, have all the students stop writing. Collect all the question/answer sheets and thank the students for their participation.
APPENDIX G

TEST SAMPLE FOR STUDENTS

NOT PARTICIPATING IN RESEARCH
Please fill in the following information and then answer the questions that follow:

School  

Date of birth ___/___/____ Sex ___|___ Grade ___  
Month Day Year Male Female

Program Area  

The following are 8 questions on problem solving. You are to write down your answer on the space provided. You have two minutes to answer each question and a total of 16 minutes to answer all of the ten questions. It is permissible to write with a pencil or a pen. If you do not have a pen or pencil, please raise your hand so the supervisor can provide you with one.

1. Problem: David is taller than Lisa. Lisa is taller than William. Who is the shortest of the three children?

Answer:  

2. Problem: Mary and Paula leave school at 3:00 p.m. and start toward home. Their homes are on the same street, but lie in opposite directions from the school. Mary lives 4 miles from the school, while Paula lives 3 miles from the school. How far apart are their homes from each other?

Answer:  

3. Problem: Mike is 15 years old and his brother Tony is 3 years older. How old is Tony?

Answer:  
4. Problem: Below is a program on a computer. Simply write down the output or the result for C.

Let A = 10
Let B = 5+4
Let C = AxB
Print C

Answer for C: ________________________________________

5. Problem: Lucy is in training. She did 3 sit-ups the first day; 4 sit-ups the second day; 5 the third day in that order of arithmetical progression. How many sit-ups did she do on the 6th day?

Answer: ________________________________________

6. Problem: What follows?

(a) 1, 2, 3, 4, ____
(b) 2, 4, 6, 8, ____
(c) Δ, □, O, Δ, □, O, Δ, ____

7. Problem: In our classroom, I have geography before art. I have math right after art. Which class comes first?

Answer: ________________________________________

8. Problem: Complete the pattern.

2 -----> 2
34 -----> 7
45 -----> 9
19 -----> 10
39 -----> 12
49 -----> ?

Answer: ________________________________________
APPENDIX H

INSTRUCTIONS FOR USING TEST INSTRUMENT
April 26, 1994

Mr. Ernest Efetevbia
University Village
484 Sinchcomb Drive, #2
Columbus, Ohio 43202

Dear Mr. Efetevbia,

Thank you for your recent letter concerning your use of the Matrix Analogies Test - Short Form, in your dissertation research.

As a responsible test publisher, we believe it is our duty to protect the security and integrity of our test instruments. Therefore, we cannot allow copies of the test instruments to be included with or stapled in your dissertation. If available, sample items may be included, but actual test items cannot.

Also, all testing must be conducted in your presence or that of your faculty advisor or another qualified individual to ensure that all materials will remain secure.

We will gladly grant permission for the use of these test instruments if the above restrictions will be followed. Please indicate your agreement to these terms by signing and returning this letter for our files. You may then contact Sarah Sanchez in Qualifications at (600) 228-0752, ext. 5427, to order your materials. As a student, you are eligible for a 50% discount; however, you must request this discount at the time you place the order, and you personally must pay for the materials (rather than using a university purchase order, professor's account, etc.).

Thank you for your interest in our test materials. If you have further questions or needs, please contact us.

Sincerely,

AGREED:

Christine Deebbler
Supervisor
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BIBLIOGRAPHY


Stinht, T. G. (1980). Literacy and Vocational Competency. Columbus, OH: Ohio State University National Center for Research in Vocational Education.


