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# Testing Methods and Pass/Fail Rates in Developmental Mathematics Classes at Southwest Virginia Community College

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Testing Methods and Pass/Fail Rates  
in Developmental Mathematics Classes  
at Southwest Virginia Community College

A Study Presented to the Graduate Faculty  
of the Department of Occupational  
and Technical Studies  
Old Dominion University

In Partial Fulfillment of the  
Requirements for the Master of Science  
Occupational and Technical Studies

By  
Charlotte Tiller  
October 2007

APPROVAL PAGE

This research paper was prepared by Charlotte E. Tiller under the direction of Dr. John M. Ritz in OTED 636, Problems in Occupational and Technical Studies. It was submitted to the Graduate Program Director as partial fulfillment of the requirements for the Degree of Master of Science in Occupational and Technical Studies.

APPROVAL BY: \_\_\_\_\_

DATE \_\_\_\_\_

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Charlotte Tiller

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## CHAPTER I

### INTRODUCTION

Southwest Virginia Community College (SwVCC) is a two year college located in Southwest Virginia on Route 19 between Tazewell and Lebanon. It serves Russell, Tazewell, Dickenson, and Buchanan Counties, but students from other counties, states, and countries also attend SwVCC.

Established in 1968 SwVCC offers more than 100 two-year associate degrees, one-year certificates, and continuing career studies programs. Students take courses on and off campus as well as video classes, classes available through fiber optic electronic classrooms, and internet web-based courses (General Information, 2006). Students can also choose to take day or evening classes. Enrollment in SwVCC has risen to near 7,000 credit students (General Information, 2006).

Incoming students are required to take a placement test as recommended by the Virginia Community College System Developmental Educational Implementation Task Force (Woodard & Sexton, 2005). Some mathematics classes have a standardized exit examination as well.

SwVCC offers a variety of mathematics classes since students have a variety of mathematical skills. Some of these classes are called developmental; these include basic mathematics, Algebra I, and Algebra II. Developmental Mathematics classes have standardized exit examinations. These examinations were the basis of the study.

## STATEMENT OF THE PROBLEM

The problem of this study was to determine the effect of exit examination methods on the pass/fail rate of students in developmental mathematics at Southwest Virginia Community College.

## HYPOTHESIS

To solve this problem the following hypothesis was developed:

$H_0$  : There is no correlation between examination method and pass/fail rate of students in developmental mathematics at Southwest Virginia Community College.

## BACKGROUND AND SIGNIFICANCE

This study developed as a result of the implementation of multiple-choice exit examinations in developmental mathematics courses at Southwest Virginia Community College. SwVCC changed from open-ended exit examinations to a multiple-choice answer exit examinations in their developmental mathematics courses in Spring 2004.

Southwest Virginia Community College implemented exit exams in its developmental mathematics courses in 2000. Students had to have a class average of 70% before they were allowed to take the exit exam. All classes in each course took the same exit exam, and to pass the course the students had to score 70% or better on the examination. If students failed the exit exam they were allowed to take a parallel exam a few days later.

From Fall of 2000 to Fall of 2003 the exit examinations given were open-ended with partial credit given. The Developmental Mathematics Department thought that the grading was inconsistent since different people graded the test and partial credit varied. Grading the test was also time consuming, and students needed to know quickly whether



they needed to retake the examination. Therefore, it was decided to change the testing method to a multiple-choice format with no partial credit.

The results of this study will be used in determining whether to stay with multiple-choice examinations or change back to open-ended examinations to assess student success in developmental mathematics. If there was a large difference in the pass rates then the validity of the exit exam will have to be evaluated. It will also be used to compare the change in pass/fail rate of the different developmental mathematics courses.

### LIMITATIONS

The following limitations guided this study:

- Students in basic mathematics, Algebra I, and Algebra II from SwVCC were considered.
- Both on-campus and off-campus students were used.
- Both day and evening classes were used.
- The data collection was done through the Research Department and Developmental Mathematics Department faculty of SwVCC.
- The data collected from the Spring of 2001 through the Fall of 2003 were used as the baseline data for open-ended examinations.
- The data collected from the Spring of 2004 through the Fall of 2006 were used as the baseline data for the multiple-choice examinations.

### ASSUMPTIONS

The following assumptions were made in this study:

- Any change in the pass/fail rate was attributed to the change from open-ended to multiple-choice examinations.

- Having the answer in front of students on the multiple-choice test off set the fact that they no longer received partial credit.
- The open-ended examination was valid and reliable.
- The multiple-choice examination was valid and reliable.

## PROCEDURES

The procedure for this study commenced with the collection of pass/fail records of all developmental mathematics classes in the semesters of Spring 2001 through Fall 2003. These data reflected the pass/fail rate of students for nine semesters in developmental mathematics at SwVCC that took the open-ended examination.

Data were then collected from the semesters of Spring 2004 through the Fall 2006. These data represented the pass/fail rate of students for nine semesters in developmental mathematics at SwVCC that took the multiple-choice examination.

Data included day and evening classes as well as on- and off-campus classes. Data were collected from basic mathematics classes, Algebra I classes, and Algebra II classes.

Due to privacy issues the data were compiled by the Research Department of SwVCC. This information was given to the researcher in a table that listed the number of students per class, how many passed the class, how many failed the class, how many withdrew from the class, how many audited the class, and how many received incomplete grades.

## DEFINITIONS OF TERMS

The following terms were used throughout this paper.

Developmental Mathematics – This refers to lower level mathematic classes taught at

Southwest Virginia Community College. They included basic mathematics, Algebra I, and Algebra II.

Math 02 – This refers to the basic mathematics class.

Math 03 – This refers to Algebra I.

Math 04 – This refers to Algebra II.

Multiple-choice examination – An examination where students are given a choice of four answers from which to choose the correct one.

Open-ended examination – An examination where students are given a problem and are expected to work it and find the correct solution.

## OVERVIEW OF CHAPTERS

This study was undertaken to determine the effect on the pass/fail rate of students at SwVCC in developmental mathematics after the testing method was changed from open-ended format to a multiple-choice format. SwVCC was chosen because the researcher worked there in the Developmental Mathematics Department. The findings of this research will be used in determining whether to stay with multiple-choice examinations or changing back to open-ended examinations to assess student success in developmental mathematics.

In Chapter II literature with similar research about testing methods was gathered and presented. Chapter III describes the methods and procedures used in gathering the data, and Chapter IV reports the data that were gathered and analyzed. In Chapter V the results, either supporting or contradicting the hypothesis that the change in testing methods had no effect on the pass/fail rate, were presented.

## CHAPTER II

### REVIEW OF LITERATURE

In the review of literature conflicting opinions about the use of multiple-choice tests were found. Most said that multiple-choice tests were ineffective, while other said that they effectively measured knowledge. While doing the research the author found that multiple-choice tests are not as bad as the critics make them out to be as long as they are properly developed. The debate over the validity of multiple-choice tests will continue as long as they exist. The following section discusses these conflicts.

#### MULTIPLE-CHOICE TESTS, WHAT DO THEY MEASURE?

Multiple-choice tests are tests where subjects are given a choice of two to five answers from which to choose the correct one. Most multiple-choice tests do not give partial credit so the answer is either right or wrong.

In most literature reviewed the use of multiple-choice tests were criticized. “Multiple-choice tests are ill suited for assessing productive thinking and problem solving skills that often constitute important objectives of education” (Jones, 2003, p. 233). Cappel (2007) states that multiple-choice tests hinder the intellectual value of science courses because they limit the independent thought and creativity; they limit the amount of information students study and learn; and they unfairly favor students with certain learning styles. While Haladyna (1999) acknowledges that although they do not measure many highly prized human traits, multiple-choice tests are the best tool among those available for measuring knowledge.

A study by Bennett, Rock, and Wang tried to determine if the stereotype beliefs about multiple-choice and opened-test were true. “Specifically, multiple-choice tests

are depicted as assessing simple factual recognition and free-response tests are depicted as evaluating higher order thinking” (Bennett, Rock, & Wang, 1991, p. 77).

Bennett, Rock, and Wang (1991) looked at the College Board’s Advanced Placement Computer Science examination because it contained multiple-choice and free-response questions written to measure the same content. They looked at two samples of 1,000 randomly selected high school students who took the 1988 Advanced Placement Computer Science examination. They found that there was little evidence to support the stereotype that multiple-choice and free-response measure different constructs (Bennett, Rock, & Wang, 1991).

Multiple-choice tests have thrived despite the attacks by experts (Haladyna, 1999). Most standardized tests like the SAT and the GRE are multiple-choice tests, although writing skills are tested via essay questions. Multiple-choice tests are used because they are easy, quick, and cheap to grade compared to other test formats (Lambert & Lines, 2000). Lambert and Lines (2000) go on to state that multiple-choice tests have high reliability, but they are often not valid. Therefore until open-ended tests become easy, quick, and cheap to grade, multiple-choice tests will continue to be the choice of many teachers and testing facilities. Consistency is also another problem when grading open-ended test. Even with a test rubric different people have different interpretations of the same material, so until the perfect test rubric is created inconsistencies will result in the grading of open-ended tests.

#### MULTIPLE-CHOICE TESTS AND HIGHER SCORES

Bridgeman studied the use of open-ended questions on the GRE using special grid-in answer sheets. These questions were randomly administered at the end of a

regular GRE test. Some examinees received the open-ended questions, while others received the same questions in multiple-choice format. In a separate data collection effort, paid volunteers used a computer keyboard to answer the same questions (Bridgeman, 1992). This study found that “if the intent of the test is to describe specific skills that students possess, the open-ended format seems to be clearly superior” (Bridgeman, 1992, p. 269).

Bridgeman’s study found that examinees scored higher on multiple-choice tests than open-ended tests, but he found that total test scores in the open-ended and multiple-choice formats appeared to be comparable. He went on to say that both “ranked the relative abilities of students in the same order, gender, and ethnic differences were neither lessened nor exaggerated; correlations with other test scores and college grades were about the same” (Bridgeman, 1992, p. 269).

Oosterhof’s and Coats’ (1981) study of a business finance course had similar results as Bridgeman’s. When results of an open-ended examination were compared to a multiple-choice examination the scores on the multiple-choice examination were 20% to 30% higher than those taking the open-ended examination.

Pajares and Miller (1997) found in a study of eighth grade pre-algebra and algebra students that students taking a multiple-choice test out scored those students who took the same test in an open-ended format. Students that took the multiple-choice test answered on average 3.67 more questions correctly than those that took the open-ended test. Although this study was more on how self-efficacy affects mathematical performance the results support Bridgeman’s study in that students can score higher on multiple-choice tests than on open-ended tests.

## MULTIPLE-CHOICE TESTS, GUESSING AND FEEDBACK

Critics of multiple-choice tests complain they allow the examinees to guess the correct answer, and they provide feedback to the examinees that allow them to better choose the correct answer. Multiple-choice tests do allow a student to guess the answer, but even if they have a 25% chance of guessing right on one question, they only have a 0.000095% of guessing 10 right answers (Haladyna, 1999). In mathematics and some science based classes, multiple-choice questions also provide feedback (Bridgeman, 1992). If the answer the examinee finds is not among the choices they know that it is wrong and can go back and try again. In questions involving mathematics, having the answer present allows the student to work some problems backwards (Bridgeman, 1992).

## TEST PREPARATION AND MULTIPLE-CHOICE TESTS

Some critics feel that if students know that the test will be multiple-choice they do not adequately prepare for the test because it is easy (Wehrle, 2004). Cappel (2007) agrees with Wehrle. He says that students only study enough to recognize the material, not to fully comprehend it when they are studying for multiple-choice tests. He goes on to say that the information then quickly fades from the short-term memory of students since long-term memory works through understanding.

Stuyven, Dochy, Janssens, Schelfhout, and Gielen (2006) contradict this. Struyven et al. (2006) studied the effect that the type of class assessment had on the effect of the end-of-course assessment in child development classes for first year elementary education students. The control group received standard lectures with multiple-choice tests. The four experimental groups learned in student-activating learning environments with case-based assessments, peer assessments, portfolio assessments, and multiple-

choice test assessments. They were then all given an end-of-course open-ended examination. The students that took multiple-choice tests throughout the semester, both in the lecture class and the student-activated class, out scored the three other assessment type classes. Thus the criticism that students do not study for multiple-choice tests was contradicted.

#### SUMMARY

In Chapter II, the Review of Literature, the author looked at the results of studies and found that even though students scored higher on multiple-choice tests, the multiple-choice test effectively measured knowledge, and ranked students as well as open-ended tests. Despite criticism, multiple-choice tests are widely used in classrooms and testing facilities. Until such time that open-ended tests become as easy and cheap to grade, the multiple-choice test will continue to be used. The Methods and Procedures used in this study will be explained in Chapter III.



## CHAPTER III

### METHODS AND PROCEDURES

Chapter III describes the methods and procedures used in this study. It includes the population, research variables, the instruments used, data collection, statistical analysis, and summary.

#### POPULATION

The population of this study was limited to developmental mathematics students at SwVCC from 2001 to 2006. The subjects were of various ages and backgrounds. They included traditional and nontraditional college students.

A population of 1,108 was used for Math 02, 654 subjects took the open-ended examinations and 454 subjects took the multiple-choice examinations. For Math 03 the sample size was 1,895, of these 915 subjects took the open-ended examinations and 980 subjects took the multiple-choice examinations. And, for Math 04 the population was 606, of these 272 subjects took the open-ended examinations and 334 subjects took the multiple-choice examinations. The total population was 3,609 of which 1,832 subjects took the open-ended examinations and 1,768 subjects took the multiple-choice examinations. These numbers do not include those students who received an incomplete grade, withdrew from a class, or audited a class.

#### RESEARCH VARIABLES

The dependent variable in this study was the pass/fail rate of developmental mathematics courses at SwVCC. Students must have a class average of 70% before they are allowed to take the examination and must make at least 70% on the examination before they pass the class.

The independent variables in this study were the open-ended examinations given from the Spring of 2001 through the Fall of 2003, and the multiple-choice examinations given from the Spring of 2004 through the Fall of 2006. The examinations were given at the end of each semester to all developmental mathematic students.

#### INSTRUMENTATION

The instruments used in this study were the exit examinations developed by the Developmental Mathematics Department at SwVCC. For the spring of 2001 through the fall of 2003 an open-ended examination was used, and for spring of 2004 through the fall of 2006 a multiple-choice examination was used.

#### DATA COLLECTION

A request for data was sent to the Research Department of SwVCC. Due to privacy issues the data were compiled by the Research Department. This information was given to the researcher in a table that listed the number of students per class, how many passed the class, how many failed the class, how many withdrew from the class, how many audited the class, and how many received incomplete grades.

#### STATISTICAL ANALYSIS

Statistical analysis was done by examining the type of tests used and the pass/fail rates. A Chi-Square correlation was done for Math 02, Math 03, Math 04, and for all three courses combined. The results of these four correlations were then analyzed.

#### SUMMARY

Chapter III presented information about the population of the study, the dependent and independent variables, the instruments, how data were collected, and the method of

statistical analysis chosen. The results of the statistical correlation will be presented in Chapter IV.

## CHAPTER IV

### FINDINGS

This study was to determine if the examination method of developmental mathematics students at SwVCC affected their pass/fail rate. The study included nine semesters of open-ended examinations and nine semesters of multiple-choice examinations. This chapter presents the statistical calculations of the experiment. Each developmental mathematics class was analyzed individually, and then all three classes were combined. A Chi-Square correlation was done on each course and on the total population.

#### DATA ANALYSIS

A population of 1,108 was used for Math 02. The Chi-square correlation produced a value of 0.00, which does not exceed the level of significance of 3.84 at  $p > 0.05$ . The degree of freedom was one. Table 1 shows the data collected from Math 02.

**Table 1. MATH 02**

<b>Type of Exam</b>	<b>Passed</b>	<b>Percent</b>	<b>Failed</b>	<b>Percent</b>
Open-ended	379	58.0%	275	42.0%
Multiple-choice	263	57.9%	191	42.1%

A population of 1,895 was used for Math 03. The Chi-square correlation produced a value of 1.94, which does not exceed the level of significance of 3.84 at  $p > 0.05$ . The degree of freedom was one. Table 2 shows the data collected from Math 03.

**Table 2. MATH 03**

<b>Type of Exam</b>	<b>Passed</b>	<b>Percent</b>	<b>Failed</b>	<b>Percent</b>
Open-ended	522	57.0%	393	43.0%
Multiple-choice	590	60.2%	390	39.8%

A population of 606 was used for Math 04. The Chi-square correlation produced a value 2.09, which does not exceed the level of significance of 3.84 at  $p>0.05$ . The degree of freedom was one. Table 3 shows the data collected from Math 04.

**Table 3. MATH 04**

<b>Type of Exam</b>	<b>Passed</b>	<b>Percent</b>	<b>Failed</b>	<b>Percent</b>
Open-ended	162	59.6%	110	40.4%
Multiple-choice	218	65.3%	116	34.7%

The overall population was 3,609. The Chi-square correlation produced a value of 3.71, which does not exceed the level of significance of 3.84 at  $p>0.05$ . The degree of freedom was one. Table 4 shows the combined data collected from Math 02, Math 03, and Math 04.

**Table 4. COMBINED CLASSES**

<b>Type of Exam</b>	<b>Passed</b>	<b>Percent</b>	<b>Failed</b>	<b>Percent</b>
Open-ended	1063	57.4%	788	42.6%
Multiple-choice	1071	60.6%	697	39.4%

## SUMMARY

In Chapter IV the researcher performed the statistical analyses for the experiment. The researcher performed chi-square correlations. The correlations resulted in the following results: Math 02  $X^2 = 0.000$ , in Math 03  $X^2 = 1.94$ , in Math 04  $X^2 = 2.09$ . When all three courses were combined a  $X^2 = 3.71$ . The results will be discussed in Chapter V.

## CHAPTER V

### SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Multiple-choice tests are the test of choice for many educators. They are easy, quick, and cheap to grade, but their validity is often questioned by the experts. Some agree that they may measure knowledge, but not problem solving skills (Jones, 2003). This chapter will summarize the research study. Conclusions will be drawn and recommendations for further study will be made.

### SUMMARY

The problem of this study was to determine whether changing from open-ended exit examinations to multiple-choice exit examinations affected the pass/fail rates of developmental mathematic students at Southwest Virginia Community College. Exit examinations in developmental mathematics courses were implemented at SwVCC in Fall of 2000; they were open-ended examinations that allowed for partial credit. In the Spring of 2004 SwVCC changed to multiple-choice examinations with no partial credit.

Developmental mathematic classes were pass/fail classes. Students must have a 70 percent average in class before they were allowed to take the examination. They must then make at least a 70 percent on the examination to pass the class.

This study used data collected from Spring 2001 through the Fall of 2003 for the open-ended examinations and the data collected from Spring 2004 through the Fall 2006 for the multiple-choice examinations. A total of 3,609 subjects were studied. A total of 1,832 subjects took the open-ended examinations and a total of 1,768 subjects took the multiple-choice examination. The population was then separated by subject. A population of 1,108 was used for Math 02, 654 subjects took the open-ended

examinations and 454 subjects took the multiple-choice examinations. For Math 03 the population was 1,895; of these 915 subjects took the open-ended examinations and 980 subjects took the multiple-choice examinations. And, for Math 04 the population was 606; of these 272 subjects took the open-ended examinations and 334 subjects took the multiple-choice examinations. These numbers do not include those students who received an incomplete, withdrew from a class, or audited a class.

The statistical correlation used to compare the data was the chi-square test. It was used to compare the number of students that passed and the number that failed in each course and each type of examination used. Since the hypothesis was a null hypothesis a two-tailed test was used for comparison.

### CONCLUSIONS

The hypothesis for this study was:

$H_0$  : There is no correlation between examination method and pass/fail rate of students in developmental mathematic at Southwest Virginia Community College.

After analyzing the results of the Chi-square test, the hypothesis was accepted. The pass/fail rate of the students at Southwest Virginia Community College in the Developmental Mathematics classes did not change a significant amount with the changing of the testing method. Table 5 shows the Chi-squared values from each analysis with their degree of freedom.

**Table 5. Chi-Square Values**

Critical chi-square value at $p > .05$ (df = 1)	Chi-square value for Math 02	Chi-square value for Math 03	Chi-square value for Math 04	Chi-square value for combined courses
3.84	0.00	1.94	2.09	3.71

Since the level of significance is 3.84 at  $p > 0.05$  and  $\chi^2$  values do not exceed this, the hypothesis that the testing method did not affect the pass/fail rate was accepted. Thus the examination form does not affect the pass/fail rate of developmental mathematics courses.

### RECOMMENDATIONS

This study was undertaken to determine if the change in examination methods changed the pass/fail rate of developmental mathematics students at SwVCC. Since change was not observed in the pass/fail rate, the Developmental Mathematics Department faculty should continue to use multiple-choice examinations.

The following are recommendations for further study into multiple-choice testing:

1. Similar research at other community colleges or junior colleges could be undertaken to see if the results can be duplicated.
2. Similar research could be done in the college mathematics courses at SwVCC, since they also use multiple-choice tests.
3. If at anytime the multiple-choice tests in developmental mathematics are revised at SwVCC this study could be repeated.



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