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Relationship Between Mathematical and Radiation Science Scores to Graduation Success with Southwest Virginia Community College Radiography

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RELATIONSHIP BETWEEN MATHEMATICAL AND RADIATION SCIENCE SCORES TO GRADUATION SUCCESS WITH SOUTHWEST VIRGINIA COMMUNITY COLLEGE RADIOGRAPHY

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ABSTRACT

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A well trained radiographer is necessary in hospital settings, clinics and physician's offices. It is necessary for radiologic technologists to have mathematical skills, to possess knowledge of radiation science, to graduate from an accredited radiology program and to pass the national registry certification examination given by the American Registry of Radiologic Technologists. When looking at the attributes necessary for these individuals, a problem was determined. The problem of this study was to see if there is a correlation between grades of radiography students in mathematics and radiation science as predictors of program completion. To guide this study the following hypothesis was developed:

> H_1: Radiography students who score a B or higher in mathematics classes will score a C or higher in radiation science classes and complete the program for graduation.

The method used for this quasi-experiment was to assess the Radiologic Technology students enrolled in the tri-college program at Southwest Virginia Community College to facilitate this study. Data collection consisted of gathering mathematic grades from classes taken prior to admission into the radiology program and radiation science grades from classes taken during the program. The data were obtained from the master student files held by the Southwest Virginia Community College cooperative radiography program. The data from mathematic and radiation science classes were then divided into three groups. The first group were students who completed the program. The second group were students who did not complete the program due to academic reasons in radiation science classes. All data collected from the classes of 2013-2015 and 2014-2016 was used to establish whether there was a connection between mathematical scores and passing radiation science.

The data analysis concluded that there was no significant difference in mathematical grades and radiation science grades from this sample. The chi-square test result was X^2=0.5333 and the p value 0.465209. The degree of freedom was (2-1) (2-1) =1. The result was not significant at the $p< 0.05$ using software calculation and the Chi-square Distribution Table. The results concluded that the chi-square test did not support the hypothesis so the hypothesis was rejected.

TABLE OF CONTENTS

LIST OF TABLES

Table **Page**

LIST OF FIGURES

CHAPTER I

INTRODUCTION

The need for qualified radiologic technologists is a pressing reality for health care organizations. A knowledgeable radiographer is crucial for quality radiographs with limited patient exposure to radiation. A technologist must successfully complete an accredited radiography program which contains courses in radiation science, mathematics, procedures, pathology, and many more classes necessary to meet the requirements for the American Registry of Radiologic Technologists. It requires a strong academic student to complete this rigorous program of study. This makes it important to recruit students who have the greatest chance of successfully graduating from the radiography program and passing their national registry examination given by the American Registry of Radiologic Technologists.

Individuals accepted into the Radiography Program are intelligent students. Most students accepted into a radiography program have a 2.5 grade point average or higher. The higher the grade point average, the more likely a student is to gain admittance into the radiology program. Those students admitted with a low grade point average have a lower chance of completion. Students who fail out of the radiography program usually go on to other programs of study that usually do not contain high level mathematics requirements. This leads one to believe that being successful in mathematics may lead to graduation from the radiography program.

The American Registry of Radiologic Technologists (ARRT, 2016), American Society of Radiologic Technologists (ASRT, 2015), and Joint Review Committee on Education in Radiologic Technology (JRCERT, 2016) all have mathematics, as well as science, as a common core for radiology students. The curriculum has changed several times but the basics are the same, a strong mathematics foundation. A student preparing to gain entry into a radiology programs should obtain as much skill in mathematics as possible. The baseline requirements for most community college radiography programs in the Virginia Community College system are classes in Algebra I and Geometry but higher mathematical classes are seen as positive. A strong mathematics background should prepare a student to become a future radiographer (Achieve, 2008).

Statement of the Problem

The problem of this study was to see if there is a correlation between grades of radiography students in mathematics and radiation science as predictors of program completion.

Hypothesis

To guide this study the following hypothesis was developed:

H_1: Radiography students who score a B or higher in mathematics classes will score a C or higher in radiation science classes and complete the program for graduation.

Background and Significance

The study of radiography requires a high degree of mathematical knowledge. Radiography students are required to have three semesters of radiation science. Radiation science uses mathematics and science to teach how the atomic development of x-radiation occurs. A student who has not had a mathematical, and to a certain degree scientific, background will struggle with even the basic radiographic principles presented in the three semesters of radiation science. This can lead the student to fail out of the program or at least be placed on probation. This is why the Southwest Virginia Community College radiology program requires students to have taken the Virginia Placement Test math modules 1-6 and to have successfully completed Algebra I and Geometry or the college equivalent of these classes as a minimal program admittance requirement (Radiology, 2015).

It is recommend that “students take a demanding set of mathematics courses at both secondary and postsecondary before pursuing a career in health care diagnostics” (Achieve, 2008, p.1). The radiology program at Southwest Virginia Community College only necessitates Algebra I and Geometry or Algebra II as a minimum requirement to apply to its program (Radiology, 2015). The Career Cluster Pathway Plan of Study for Health Science Diagnostic Services show “how courses such as Algebra I, Geometry, Algebra II, Statistics and Calculus equip high school students with mathematical knowledge needed for success” in health care careers (Achieve, 2008, p.1). It would appear that students with only the minimum requirements would not be as successful as those with classes in Calculus and Statistics.

This study could provide a radiographic program with valuable information concerning the prerequisite requirements prior to entry into a radiology program. This study could also assist with the radiology program statistically data required by the Joint Review Committee on Education in Radiologic Technology. The Joint Review Committee on Education in Radiologic Technology is an accreditation committee for education programs in radiology. A program accredited by JRCERT must submit statistical data annually by computer to the committee and have a complete program site review by JRCERT personnel every eight years (JRCERT, 2016).

Limitations of the Study

Since this study involves radiology students, the findings may not be accurate for other programs of study, such as nursing, respiratory therapy, occupational therapy, or emergency medical technologist. The data were obtained from one program, a tri-college cooperative program at Southwest Virginia Community College, so the results may not be precise for all hospital, community college, or university programs. The mathematical data frequency of when math courses were taken was not a factor studied in this research. The retained information may not be the same for all individuals. The more time between the mathematic classes and the start of the radiography program, the more likelihood of forgetting important mathematical concepts.

Assumptions

The researcher assumed that students who had taken the Virginia Placement mathematics test and were required to take remedial classes to satisfy the mathematics component were not as successful in radiation science classes as students who passed the mathematics portion of the Virginia Placement Test without remediation. The researcher assumed students who had taken more advanced mathematical classes prior to the radiography program would be more successful in the program curriculum and more successful in completing the program. It was assumed that students who completed <u>*Math 126*</u>, a required radiology class, with a grade of C or better were more successful in radiation science and thus able to complete the program. The quality of mathematical instruction was assumed to be equal for all students. The last assumption made by the researcher was that the students who remediated mathematical classes were as proficient upon completion of remediation as those who were not required to remediate.

Procedures

The Radiologic Technology students enrolled in the tri-college program at Southwest Virginia Community College were used to facilitate this study. The students were required to have a minimum of Algebra I and Algebra II or Geometry prior to entry into the program. The SWCC students' mathematics grade history was tabulated prior to entry into the radiography program. A comparison of students' level of mathematic was calculated from the basics, Algebra I, Algebra II, or Geometry, to advanced college Calculus II. The students' grades in *Math 126*, a SWCC program requirement, was added to the mathematics calculations. The students' radiation science grade histories were tabulated through the three semesters of radiation science (*RAD 110*, *RAD 112,* and *RAD 255*). The data obtained were all organized to compare how the student who had taken a higher level of mathematics did in radiation science compared with those students who had only the basic mathematics' aptitude. All the mathematics and radiation science data were correlated with program completion rate.

Definition of Terms

The following are a list of terms and definitions to assist the reader in comprehending this study.

1. American Registry of Radiologic Technology (ARRT): A credentialing organization that registers technologists in radiography, intervention, and radiation therapy by administering an examination, education, and ethics (ARRT, 2016).
2. American Society of Radiologic Technology (ASRT): A professional society for radiology professionals.
3. Joint Review Committee on Education in Radiologic Technology (JRCERT): An agency that accredits traditional and distance delivery educational programs in radiography, magnetic resonance, medical dosimetry, and radiation therapy (JRCERT, 2016).
4. Radiologic Technologists: Persons educated in the production of x-rays and obtaining medical images. Also known as radiographers and x-ray

technologists, technologists, and registered technologist in radiology or RT-R (ASRT, 2016)

5. Radiology: The study of applying ionizing radiation in the production of medical images; also known as radiography (ARRT, 2016).
6. Southwest Virginia Community College Radiography Program: A two year program of study in radiology. It is a tri-college education program that consists of Southwest Virginia Community College, Mountain Empire Community College, and Virginia Highlands Community College.

Overview of the Chapter

Chapter I introduced the need for a strong mathematics background in becoming a successful radiographer. The three top professional organizations in radiology support the need for mathematics and science in the field of radiology. The problem of this study was to see if there was a correlation between grades of radiography students in mathematics and radiation science as predictors of program completion. Southwest Virginia Community College students' mathematical and radiation science grades were compared and the program completion rate was used to determine if there was a relationship between high mathematics and radiation science grades to successfully becoming a radiologic technologists.

Chapter II will emphasize the need for higher mathematics classes and scores as a forecaster of academic success in radiation science thus successfully finishing the radiology program. The Review of Literature will show the need for further investigation into the relationship between mathematics and understanding the production of radiation. Chapter III, Methods and Procedures, gives a description of methods and procedures used to collect data for this study. Chapter IV, Findings, contains data and the results of the study. Chapter V, Summary, Conclusions, and Recommendations, summarizes the study results, determines a conclusion found in the study, and states recommendations from the conclusion of the study.

CHARTER II

REVIEW OF LITERATURE

The purpose of this quasi-experimental study was to investigate whether mathematical skills are a significant determining factor in a student successfully completing the radiology program. Literature showed the use of mathematical knowledge as a determining factor in a student's accomplishments in radiation science, as well as, achieving graduation from the program. The purpose of this quasi-experimental study and the need to examine the effect of mathematics and academic success in a radiography program was shaped by literature.

History of Radiology

In the late1800s, several scientists throughout the world were working with a Crooke's tube. Heinrich Hertz and Philip Lenard experimented with cathode rays and an aluminum filter to produce fluorescence. In 1895 at a University of Würzburg laboratory, Wilhelm Conrad Roentgen began to repeat Hertz and Lenard's experiments. On November 8, 1895, Roentgen discovered barium platinocyanide screen fluorescing as he generated cathode rays from a Crooke's tube. This was the discovery of x-rays. Roentgen named this unknown ray x because that was the mathematical equation for the unknown (Assmus, 1995). The mathematical and scientific knowledge shown by these historical inventors made the discovery of x-ray possible.

History of Mathematics

The history of mathematics is uncertain due to the lack of records. The first school of mathematics can be traced back to the Ionian Greeks. Historians have little doubt that the Ionian Greeks attained much of their mathematical information from the Egyptians and Phoenicians. The only people that the Greeks of Asia Minor had frequent contact with were those from the eastern portion of the Mediterranean which would be Egypt and present day Syria, Lebanon, and northern Israel. Greek tradition assigned the development of geometry to the Egyptians and the science of numbers and applied mathematics to the Egyptians or Phoenicians.

The Chinese were known to have early knowledge of arithmetic, geometry, mechanics, optics, navigation, and astronomy. It is suspected, with little evidence, some mathematical information was passed across from Asia to the west. Investigations have shown the Chinese did not make any serious attempt to extend the few rules of arithmetic and geometry. The advancement of these mathematics appear to be done by the Egyptians. If not for the spread of mathematics throughout the world that occurred with the travels of explorers and missionaries to these remote countries, it seems mathematical concepts would have remained stagnant (Ball, 2010).

The fields of radiology and mathematics joined together when Dr. Wilhelm Conrad Roentgen started his career as a professor of mathematics at Hohenheim Agricultural Academy in Wurtemberg, Germany. He taught mathematics from 1872 to 1873 before becoming a professor of theoretical physics at the University of Strasbourg which was his actual field. He stayed at the University of Strasbourg until 1888 when he went to the University of Wurzburg as a professor and director of the Physics Institute and where he eventually invented the x-ray. It is important to understand mathematical principles in order to perform physics calculations in radiation science (Lakshminarayanan, 2005).

Mathematics and the field of radiology have evolved throughout history. One would assume that society would be capable in their study of mathematics. This is not a true assumption. It is estimated that 23 million people in the United States cannot read, write, or perform basic arithmetic. Sixty to seventy-five percent of community college freshmen need remedial mathematic courses and more than half are unsuccessful in their remediation on their first attempt (Verhovsek, 2003).

There are numerous students who would have the aptitude to complete an allied health curriculum and make satisfactory health care personnel. However, many programs require strong mathematical and scientific backgrounds. This requirement may make several students not apply for these health care programs and some students not to succeed in a medical field of study. Jobs are expected to steadily increase in allied health professions and the fear and lack of success can increasing demand for health care professionals. Some learning institutions are using problem based learning techniques to relate developmental mathematic to allied health careers. This method allows students to correlate material learned with material necessary in their chosen profession (Verhovsek, 2003).

Students whose chosen field is radiography need a firm foundation in mathematics. A student who aspires to become a radiologic technologist must be able to determine how the necessary exposure results in an x-ray. It is necessary for a technologist to be able to calculate the patient thickness to be x-rayed, the disease process, and the power of the x-ray machine to compute the exposure needed to for a quality radiograph. If these calculations are too little, the radiograph will be too light for the radiologist to diagnose the patient. If the analysis is too much, the radiograph will be too dark to diagnose and result in the dangerous effects of radiation (Achieve, 2008).

Usage of Mathematics in Radiology

Most lay people would assume that technical factors could be memorized and the necessity to perform frequent calculations would be unnecessary. This is not true. Radiographers need to determine exposure time, amperage, voltage, and other variables on each patient to successfully produce a safe radiograph of good diagnostic quality (Amis, 2007). There is a real danger in relying on memorization. Each person is unique and requires specific technical factor adjustments based on mathematical and scientific calculations. Different disease processes require a specialized increase or decrease in exposure factors specific to whether it is a subtractive or additive malady (Achieve, 2008).

Essentially a student who has a basis in simple algebra, graphic methods of geometry, trigonometry, and logarithms make for mathematically able radiographers. A radiologic physics or radiation science teacher who finds students taking patient measurements and calculating radiation dosages knows that the students have discovered the importance of mathematics in radiology (Roberts, 1952). Mathematics is an essential professional tool for radiographers.

Mathematics in Other Imaging Modalities

Setting the correct technical factors is not the only way mathematics is used in an imaging department. It is essential for good diagnostic quality images for the technologist to correctly position a patient for a procedure. This will require knowledge of geometry. Diagnostic x-ray is not the only imaging modality that uses geometry and other mathematical concepts. Computed tomography or CT requires radiologic technologists to use mathematical and computer skills which include geometry and spatial relations. These skills will assist the technologist in isolating the area of interest to create three dimensional images and it will also assist in understanding data storage and processing techniques (Achieve, 2008)

Magnetic resonance imaging (MRI) is an imaging modality that does not use radiation to produce images but produces specialized non-invasive images. MRI aligns hydrogen atoms by using a magnetic field then uses radio waves to "knock down" and disrupt their polarity. This is processed by a computer to produce images in slices (Mayfield, 2016). This modality involves a strong foundation in mathematics for technologists for specialization in this area. MRI uses a basic mathematical and algebraic foundation. The technologist must be able to calculate the gradients, signal, and time, as well as computer processing. Without mathematical knowledge, the technologist would have to rely on the computerized calculations which may not be the same for all patients (Hashemi, 2010).

Diagnostic x-ray, CT, and MRI are not the only modalities that require familiarity of mathematical concepts. Radiation therapy, ultrasound, nuclear medicine, positron emission tomography (PET), and dual-energy x-ray absorptiometry also require experience with it (Achieve, 2008). Regardless of a student's future aspirations in a diagnostic imaging department, they will need a strong foundation in mathematics. A well-rounded radiologic technologist will be taking care of their patients in all areas.

The literature found on the subject of mathematics in radiology is limited at best. Studies on the concept of mathematical ability and the success in the radiology sciences are basically not existent. More research and literature needs to be made available to those interested in this theory. The assumption that those with greater mathematical skill being more successful in the field of radiology has been tossed around the education community for a long period of time but the concepts have limited educational backing at this time. Private discussion among program directors have taken place at the Virginia Society of Radiologic Technologists but there is no documentation of these discussions.

Radiation Science

Radiation science uses a team of professional health care instructors to provide information on diagnostic imaging. Technologist must possess knowledge, skill, and mature judgment to operate complex equipment safely and efficiently. The productions of quality images uses multiple sources of radiation and proper handling and skill is vital. The radiography program at Southwest Virginia Community College requires three semesters of radiation science to assure the radiology students possess these skills. The first semester, radiology students study image equipment and protection which discusses the basic components of a radiographic unit, principles of x-ray production, principles of image receptors, automatic processing, film evaluation, concepts in radiation protection, and radiobiology. The second semester, radiology students learn radiologic science which covers concepts of radiation, radiography physics, fundamental of electromagnetic radiation, electricity with magnetism, and application of radiography principles. It focuses on x-ray production, emission, and x-ray interaction with matter. The last semester of radiation science occurs when a student is in their second year, fifth semester of the program. It is radiographic equipment and studies principles and operation of general, as well as specialized, x-ray equipment (Southwest, 2016). Other programs may teach the subject matter in different semesters and different ways, but it is taught within their programs. All programs are required by the American Registry of Radiologic Technologists to provide students with information in image production, equipment operation, image acquisition, image evaluation, image procedures, patient care and education prior to their taking the national registry certification examination (ARRT, 2016)

Summary

The Review of Literature has indicated the importance of mathematical knowledge in the field of radiology, especially the radiation science portion. The literature supports the need for higher levels of mathematics for students to successfully become radiographers. If a candidate for the Southwest Virginia Community College radiography program wishes to succeed in the practice of radiology, advanced mathematic knowledge is indispensable. The need for this quasi-experimental study is supported by a lack of literature correlating student success in mathematical classes, radiation science classes and radiology programs.

Chapter III, Methods and Procedures, will describe the methods and procedures applied in this study by the researcher. A description of the composed population is included in Chapter III. The tools employed in the collection and gathering of data are presented in this chapter, as well as, the statistical instruments utilized to process and analyze the data.

CHAPTER III

METHODS AND PROCEDURES

Chapter III, Methods and Procedures, gives a description of the methods and procedures that were used to obtain data for this study. The focus of this study was to investigate whether there is a correlation between mathematical grades with success in radiation science classes, thus completion of the radiology program. This chapter will provide information on the population, research variables, instrument design, methods of data collection, and statistical analysis.

Population

The population was composed of radiology students at Southwest Virginia Community College. The program is a cooperative program between Mountain Empire Community College, Virginia Highlands Community College, and Southwest Virginia Community College in which Southwest Virginia Community College is the primary site, thus all students are Southwest students. This study used convenience sampling of two student groups between 2013 and 2016. The first group started with 28 students in July 2013 and 19 completed the program in June 2015. In the first group, 9 students did not complete the program, 1 was for personal reasons and 8 were for grades. The second group had 20 students who started in July 2014 and 11 completed the program in June 2016. The second group lost 9 students, 6 for personal reasons, 2 for failing grades in radiation science and 1 for failing grades in procedures that will not be included in this study.

Research Variables

The independent variables of this study were the mathematic grades or Virginia Placement Test mathematic scores and radiation science grades. All mathematic scores were completed prior to entrance into the radiology program at Southwest Virginia Community College. The radiation science scores were collected from *RAD 110*, *RAD 112*, and *RAD 255*. All scores were collected for individuals who started the program in July 2013 and 2014. The dependent variable of this study is the student completion rate from the radiologic technology program.

Instruments Used

The first set of data used was final math grades from mathematic classes taken prior to admission into the radiology program. The second set of data used was the radiation science final grades from the three classes taken during the program. The third set of data used for this study was a list of names of those who graduated from the program.

Method of Data Collection

Data collection consisted of gathering mathematic grades from classes taken prior to admission into the radiology program and radiation science grades from classes taken during the program. The data were obtained from the master student files held by the Southwest Virginia Community College cooperative radiography program. The data from mathematic and radiation science classes were then divided into three groups. The first group were students who completed the program. The second group were students who did not complete the program due to academic reasons in radiation science classes. All data were collected from the classes of 2013-2015 and 2014-2016. The students' names and other identifiable information were not used, instead the students were distinguished by letters. This study was reviewed and approved as an exempt study by the Human Subjects Review Committee of the College of Education at Old Dominion University (study # 905426-1).

Statistical Analysis

The researcher collected data about the Southwest Virginia Community College radiography students admitted to the program for the classes of 2013-2015 and 2014-2016. The information was collected to investigate whether there is a correlation between mathematical scores and radiation science scores and graduation success. The Chi square statistical analysis was used to determine if there was a statistical significance between the two categories. Chi-square allowed the questions presented to be answered.

Summary

Chapter III allowed detailed information about this research that included population, instrument use, data collection, and statistical analysis. The population included details about the students as well as the independent and dependent variables of the study. Chi square statistical method was presented as the test for the hypothesis. In Chapter IV, the researcher will present the findings of the study about the Southwest Virginia Community College radiography students' mathematical and radiation science grades.

CHAPTER IV

FINDINGS

The problem of this study was to investigate the relationship between mathematic and radiation science scores to graduation success with Southwest Virginia Community College radiography students. This chapter contains data that were obtained from the student's master file of the Southwest Virginia Community College cooperative radiography program. The data involves the students from the class of 2013-2014 and class of 2014-2016. These data were used to determine if mathematical grades and higher level of mathematical classes equal success in radiation science classes and thus graduation success.

RESULTS

The researcher analyzed individual mathematical grades from the radiology program. The mathematical grades were placed into the appropriate group. The first group were individuals who passed radiation science. While the second group were those who failed or obtained probation in radiation science. A Chi-square test was applied to the two groups of students. It was used to establish whether there is a connection between mathematical scores and passing radiation science thus graduation success.

Data Analysis

The graduate classes, 2015 and 2016, included a total of 26 students and the non-graduate classes, 2015 and 2016, included a total of 15 students. The average mathematical score for the graduate classes was 2.23 while the average for the non-graduates was 1.53. The average radiation science score was 2.46

for the graduates and 1.03 for the non-graduates. Data were analyzed using the Chi-Square test. The result was $X^2 = 0.5333$ and the p value 0.465209. The results were not significant at the $p < 0.05$. Hence, the hypothesis could not be accepted and there was not a direct correlation between mathematical scores, radiation science scores and graduation success with this sample. Table 1 contains individual mathematical and radiation science scores for both groups of students. Figure 1 has the chi-square formula. Table 2 includes the calculation of research data. Appendix A covers the chi-square distribution table.

FIGURE 1

Chi-Square Data Analysis Formula

$$\chi^2 = \sum \frac{(O - E)^2}{E}$$

X^2 is the value for chi-square.
Σ is the sum.
O is the observed frequency.
E is the expected frequency.

Summary

Chapter IV encompasses data analysis using a chi-square test to determine if there is a direct correlation between students' mathematical scores, radiation science scores and thus graduation success for the Southwest Virginia Community College radiography program. The results of the data analysis using the chi-square test found there was no correlation between mathematical scores and success in radiation science resulting in graduation success. Chapter V summarizes the content of the research conducted. It will contain the conclusions and recommendations for this study.

TABLE 1

Radiologic Technology Student

Student	Math	Rad. Sci.	Grad. Yr.	Student	Math	Rad. Sci.	Grad. Yr.
A	3	2	2016	N*	0	2	2015
B	3	3	2016	U*	0	2	2015
C	3	3	2016	Z*	2	2	2015
D	0	3	2016	DD*	2	2	2015
E	3	4	2016	EE**	3	0	NO
F	0	2	2016	FF**	2	1	NO
G	3	2	2016	GG**	0	0.5	NO
H	3	2	2016	HH**	2	1	NO
I	3	2	2016	II**	3	1	NO
J	0	2	2016	JJ**	3	0	NO
K	0	2	2016	KK**	0	0	NO
L	2	2	2015	LL**	0	0	NO
M	3	2	2015	MM**	3	1	NO
O	2	3	2015	NN**	0	1	NO
P	3	2	2015	OO**	3	2	NO
Q	2	2	2015	(15)			
R	0	3	2015	Total	23	15.50	
S	2	2	2015	Average	2 (1.53)	1 (1.03)	
T	3	3	2015				
V	3	3	2015				
W	3	3	2015				
X	3	3	2015				
Y	2	2	2015				
AA	3	2	2015				
BB	3	3	2015				
CC	3	2	2015				
(26)							
Total	58	64					
Ave.	2 (2.23)	3 (2.46)					

*Students who were on Probation for radiation science classes.
**Students who failed out of the radiography program.

Table 2

Calculation of Research Data – Chi-Square

	Math grades	Rad. Sci. grades
Completed program	2 B	3 A
Failed program	2 D	1 C

$p < .05 = 0.465209$ – software calculation
1=degree of freedom
Chi-square Distribution Table: Critical value is to the right of $p < 0.05$.

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

The problem of this study was to compare grades of the Southwest Virginia Community College radiography students in mathematics and radiation science as predictors of program completion. The students' mathematical and radiation science grades were compared and the graduation rate was used to determine if there was a relationship between high mathematics and radiation science grades to successfully becoming a radiologic technologists. Chapter V provides a summary of the research study, lists interpretations from the data analysis, and contains recommendations based upon the conclusions.

SUMMARY

Assuring student success in Southwest Virginia Community College Radiologic Technology Program is a menacing task. The students' graduation success is tied to the accreditation status of the program by the Joint Review Committee on Education in Radiologic Technology. For this reason, it is imperative to utilize tools that may help in student success. Future research needs to focus on students who have a desire to work in the medical profession. The researcher supported the need for this quasi-experiment with a lack of literature in correlating student success in the mathematics classes, radiation science, and radiology programs.

The problem of this study was to see if there was a correlation between grades of radiography students in mathematics and radiation science as predictors of program completion. To guide this study the following hypothesis was developed:

> H_1: Radiography students who score a B or higher in mathematics classes will score a C or higher in radiation science classes and compete the program for graduation.

This study was limited because it only involves radiology students at one community college, the findings may not be accurate for other programs of study, such as nursing, respiratory therapy, occupational therapy, or emergency medical technologist. The data obtained were obtained from one program, a tri-college cooperative program at Southwest Virginia Community College, so the results may not be precise for all hospital, community college, or university programs. The data may not be relevant for students who have taken mathematics classes, regardless of how advanced, five years or more from the start of the radiography program. The retained information may not be the same for all individuals. The more time between the mathematics classes and the start of the radiography program, the more likely it is of students forgetting important mathematical concepts.

The population of this research was composed of radiology students at Southwest Virginia Community College. The program is a cooperative program between Mountain Empire Community College, Virginia Highlands Community College, and Southwest Virginia Community College in which Southwest Virginia Community College is the primary site, thus all students are Southwest students. The two groups of students were between 2013 and 2016. The first group started with 28 students in July 2013 and 19 completed the program in June 2015. In the first group, 9 students did not complete the program, 1 was for personal reasons and 8 were for grades. The 2013 class had four students who were placed on probation. The second group had 20 students who started in July 2014 and 11 completed the program in June 2016. The second group lost 9 students, 6 for personal reasons, and 3 for grades. Those who did not complete the program due to personal issues were eliminated from the study.

After all data were collected, the researcher compared mathematical scores with radiation science grades. Data were collected from the master files of the radiology program at Southwest Virginia Community College. The students' names and other personal information were not used. Each student was assigned a letter and divided into graduates, non-graduates, and those on probation. The chi-square test was used to analyze collected data. A comparison was used to determine if mathematical scores influenced radiation science scores and thus graduation success.

Conclusion

The purpose of this study was to determine if there was a correlation between mathematical success and success in radiation science classes which may influence graduation success.

The data analysis concluded that there was no correlation between mathematical grades and radiation science grades for this sample. The chi-square test result was X^2=0.5333 and the p value is 0.465209. The degree of freedom is (2-1) (2-1) =1. The result was not significant at the $p < 0.05$ using software calculation and the Chi-square Distribution Table (Appendix A). The results of the chi-square test do not support the hypothesis so the hypothesis was rejected.

Recommendations

Although the data and testing for this sample indicated no correlation between mathematical scores and radiation science scores, it does not mean that students who apply to the radiography program do not need a good understanding of basic algebraic calculations and geometric concepts. A higher caliber of mathematical courses could only assist the students in the radiology program and other imaging modality programs that might be pursued later. The Southwest Virginia Community College radiography program will continue to require Algebra I, Algebra II, and/or Geometry. The students who apply to this program will still be required to take *Virginia Placement Test* 1 thru 6 in mathematics. Students who are interested in the radiographic program and seek advisement will continue to be encouraged to take higher mathematical classes due to the numerous calculation required in the radiation science curriculum.

A marketing campaign should be formed to increase awareness about the radiography program at Southwest Virginia Community College and radiology as a profession. The marketing promotion should include an open house for high school guidance counselors, career coaches, students, parents and radiology faculty in which information, including mathematical requirements, would be discussed. Using the media is another form of marketing strategy that could be worthwhile in promoting the program and its requirements and pre-requisites. Social media such as Facebook and Twitter could provide a design to educate the public concerning the Southwest Virginia Community College's radiography program. Using these marketing campaigns might promote general awareness and possibly improve the application group with a higher caliber of students who have a higher mathematical history.

While the data for the classes of 2015 and 2016 did not support the stated hypothesis, future classes may need to be monitored to see if the statistics and thusly, test results change. Perhaps a larger sample would provide evidence that mathematical knowledge is important to future radiographers. The instructor of the radiation science classes will be advised of the research outcomes. A survey of graduates is completed every two years. Survey questions may need to be added concerning whether graduates feel an increase in mathematical coursework would be helpful to future students' success in the program. This study could be useful to other allied health programs and may result in a different outcome.

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APPENDIX

APPENDIX A – CHI-SQUARE DISTRIBUTION TABLE

TABLE IV

Chi-Square (χ^2) Distribution

Degrees of Freedom	Area to the Right of Critical Value 0.99	0.975	0.95	0.90	0.10	0.05	0.025	0.01
1	—	0.001	0.004	0.016	2.706	3.841	5.024	6.635
2	0.020	0.051	0.103	0.211	4.605	5.991	7.378	9.210
3	0.115	0.216	0.352	0.584	6.251	7.815	9.348	11.345
4	0.297	0.484	0.711	1.064	7.779	9.488	11.143	13.277
5	0.554	0.831	1.145	1.610	9.236	11.071	12.833	15.086
6	0.872	1.237	1.635	2.204	10.645	12.592	14.449	16.812
7	1.239	1.690	2.167	2.833	12.017	14.067	16.013	18.475
8	1.646	2.180	2.733	3.490	13.362	15.507	17.535	20.090
9	2.088	2.700	3.325	4.168	14.684	16.919	19.023	21.666
10	2.558	3.247	3.940	4.865	15.987	18.307	20.483	23.209
11	3.053	3.816	4.575	5.578	17.275	19.675	21.920	24.725
12	3.571	4.404	5.226	6.304	18.549	21.026	23.337	26.217
13	4.107	5.009	5.892	7.042	19.812	22.362	24.736	27.688
14	4.660	5.629	6.571	7.790	21.064	23.685	26.119	29.141
15	5.229	6.262	7.261	8.547	22.307	24.996	27.488	30.578
16	5.812	6.908	7.962	9.312	23.542	26.296	28.845	32.000
17	6.408	7.564	8.672	10.085	24.769	27.587	30.191	33.409
18	7.015	8.231	9.390	10.865	25.989	28.869	31.526	34.805
19	7.633	8.907	10.117	11.651	27.204	30.144	32.852	36.191
20	8.260	9.591	10.851	12.443	28.412	31.410	34.170	37.566
21	8.897	10.283	11.591	13.240	29.615	32.671	35.479	38.932
22	9.542	10.982	12.338	14.042	30.813	33.924	36.781	40.289
23	10.196	11.689	13.091	14.848	32.007	35.172	38.076	41.638
24	10.856	12.401	13.848	15.659	33.196	36.415	39.364	42.980
25	11.524	13.120	14.611	16.473	34.382	37.652	40.646	44.314
26	12.198	13.844	15.379	17.292	35.563	38.885	41.923	45.642
27	12.879	14.573	16.151	18.114	36.741	40.113	43.194	46.963
28	13.565	15.308	16.928	18.939	37.916	41.337	44.461	48.278
29	14.257	16.047	17.708	19.768	39.087	42.557	45.722	49.588
30	14.954	16.791	18.493	20.599	40.256	43.773	46.979	50.892