Mathematics Proficiency of Fashion Marketing and Fashion Merchandising Students

Christina Gordon Miles
Old Dominion University, cgmiles@aol.com

MATHEMATICS PROFICIENCY OF FASHION MARKETING AND

FASHION MERCHANDISING STUDENTS

by

Christina Gordon Miles
B.S. May 1976, Ball State University
M.S. May 2008, Old Dominion University

A Dissertation Submitted to the Faculty of
Old Dominion University in Partial Fulfillment of the
Requirements for the Degree of

DOCTOR OF PHILOSOPHY

EDUCATION

OLD DOMINION UNIVERSITY
August 2016

Approved by:

Mary C. Enderson (Director)

Ginger S. Watson (Member)

Patrick O'Shea (Member)

ABSTRACT

MATHEMATICS PROFICIENCY OF FASHION MARKETING AND FASHION MERCHANDISING STUDENTS

Christina Gordon Miles
Old Dominion University, 2016
Director: Dr. Mary C. Enderson

Fashion Marketing and Fashion Merchandising (FMM) students should be prepared with a sound mathematics background as they graduate from programs and enter today's workforce. Unfortunately, future employers within the fashion industry indicate that prospective employees often cannot pass entry level mathematics tests (Shirley & Kohler, 2012). This non-experimental descriptive study examined the mathematics proficiency of postsecondary students entering and completing FMM programs in order to determine if FMM students possess the mathematics skills needed for entry into the workforce. The Mathematics for Industry Test (MIT), a 40-item, timed, paper-and-pencil assessment was administered to 94 entering and 111 completing students enrolled in 13 university-based FMM programs in the East Central Region of the United States. Separate between-group t-tests were conducted to compare overall test scores and four subscales (number and computations, ratio and proportional reasoning, measurement, and statistics and graphing) for entering and completing students. No significant differences were found for post-secondary students entering and completing FMM programs on the overall test or on any of the four subscale scores. Test scores, subscale scores, and distributions of scores for entering and completing students were similarly low, indicating that the majority of FMM students do not possess the mathematics proficiency needed to function effectively in industry as measured by the MIT. While not significant, student performance on the number and computations and

statistics and graphing subscales were slightly higher than on the ratio and proportional reasoning and measurement subscales. This study provides evidence that more work is needed to increase the mathematics proficiency of FMM students to meet workforce demands. Recommendations are made for future research and for possible curricular changes needed to meet industry and workforce demands.

Keywords: mathematics skills, fashion marketing, fashion merchandising, mathematics test

DEDICATION

This dissertation belongs to my husband Paul who loved and encouraged me every step of the way; my daughter Beth Ellen who would not let me stop, and my beloved mother, Ruby Werner Gordon, who I know is applauding me from heaven. It also needs to be added that my mother-in-law, Sarah Hensley Miles has been wonderful through this process and never missed a chance to encourage and make me feel special. All of my in-laws and extended family, to include Amy and Vernon O'Berry probably tired of hearing about this degree but never failed to continue to nurture and inspire me throughout this process. I love you all!

ACKNOWLEDGMENTS

There are many people who have contributed to the successful completion of this dissertation. Foremost among these people are the members of my committee. Mary Enderson provided the direct advisement, insight and vision necessary for the definition and refinement of this research. Ginger Watson provided direction throughout in the methodology and research results. Patrick O'Shea was a constant supporter in excess of two years and more than occasionally a devil's advocate during our committee meetings. I acquired a great appreciation of scholarly interaction watching, listening, and absorbing the communications passed between all my dissertation committee. I extend many, many thanks to these committee members for their patience and hours of guidance on my research and editing of this manuscript. The untiring efforts of my major advisor deserve special recognition.

Many fellow students at Old Dominion University have positively affected my research. Dr.'s Diana Cantu and Scott Christman were at the top of the list. There are too many others to list individually, but they all wrote upon my slate of life when I needed encouragement and an occasional push to get busy.

That being said, Resource Associates, Incorporated provided me with the testing instrument utilized in this research. Dr. Lucy Gibson was instrumental in that provision. Lucy passed in June, 2015 and did not get to see the end results of this research. Without her help, encouragement, and interest, I would still be looking for that quintessential mathematics industry test. Thank you Lucy Gibson, until we meet again.

NOMENCLATURE

ACT   American College Test

CSs   Completing Students

ESs   Entering Students

FACS   Family and Consumer Science

FMM   Fashion Marketing and Fashion Merchandising

ITAA   International Textiles and Apparel Association

JEC   Journées Européennes des Composites

MIT   Mathematics for Industry Test

OECD   Organization for Economic Cooperation and Development

PISA   Program for International Student Assessment

RA   Resource Associates

RIE   Retail Industry Expert

SAT   Scholastic Aptitude Test

SIOP   Society for Industrial Organization Psychology

SHRM   Society for Human Resource Management

SPSS   Statistical Package for the Social Sciences

STEM   Science, Technology, Engineering, and Mathematics

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION AND LITERATURE REVIEW

Introduction

Fashion marketing and merchandising involves a multitude of processes through which a new fashion product progresses after it has been finalized by its designer to be available in large quantities and in demand by consumers (Buttle, 1993). From the design process to manufacturing for the global market, and onward to vendors, retailers, and consumers, the merchandising/marketing workforce is increasingly dependent on mathematics-related skills and knowledge (Garrett, 2008). In most instances, these skills are simple computations and applications of mathematics that are addressed early in one's education.

Current fashion marketing and fashion merchandising (FMM) students must be prepared for a different society and workforce than those of previous generations (Sproles, 1981). Personnel with mathematics expertise will have a greater impact and level of success in the workplace than their counterparts with weak mathematics capabilities (Breiner, Harkness, Johnson & Koehler, 2012). Secondary schools, community colleges, and four-year institutes across the United States should revitalize current mathematics competencies to meet students' evolving needs to remain competitive in the global marketplace (Business Higher Education Forum, 2011).

The Program for International Student Assessment (PISA) (Kelly, Nord, Jenkins, Chan, & Kastberg, 2012) reported that the United States (U.S.) fell far below its worldwide contemporaries in mathematics. Among the thirty-four member countries of the Organization for Economic Co-operation and Development (OECD), the U.S.

performed below average in mathematics and was ranked 27th (Kelly et al., 2012). In addition, U.S. students demonstrated weaknesses in performing mathematical tasks that required higher cognitive demands, such as translating real-world situations into mathematical terms and interpreting the mathematical aspects (Kelly et al., 2012). This report provides evidence that U.S. schools are not adequately preparing students for future retail and industry positions as well as studies at the university level.

Currently, producers and retailers in the fashion industries are faced with the challenge of doing more with less (Baker, 2004). Fashion marketers and merchandisers need to possess a requisite understanding of the construction of manufactured items and manufacturing processes to determine the types of suitable materials along with the estimation of material costs and how best to package and deliver items once produced (Borin & Metcalf, 2010). The title of "merchandiser" makes one think of money, implying that one must or should be knowledgeable of monetary mathematics (Lea-Greenwood, 1997; 1998). Mathematics in the fields of marketing and merchandising is an absolute essential skill. Therefore, it is important for curricula in FMM programs to integrate key mathematics concepts within the marketing and merchandising acumen (Hines & Bruce, 2007). The basic concepts and overall knowledge of mathematics in business will provide problem solving abilities to face challenges present in industry (Chandler, 1962). Emphasis on FMM is to make certain the right product is delivered to the customer at the right time, at the right price, in the right place, and in the right quantity (Jackson & Shaw, 2000). Mathematics is a tool that helps one accomplish all of these factors successfully.

In today's economy, fashion businesses often outsource much of their apparel manufacturing operations overseas. As a result of such practices, employees must have an expert understanding of cross-cultural complexities including import/export rates and tariffs/taxes (Sen, 2008). With increased globalization and innovations in technology, industry needs require the integration of additional mathematics skills and knowledge (Kincade, 2010; Sen, 2008). Familiarity with mathematics skills and applications empower students and future merchants with understandings that are critical for problem solving and decision-making in a globalized world of manufacturing and retail (Community Report, 2012).

Globalization induces changes in resources as well as fashion trends (Ko & Megehee, 2012). The International Textiles and Apparel Association (ITAA) defines globalization as the interaction of the design, product development, and merchandising processes in a global marketplace (2012). Designers focus on introducing a finely blended amalgamation of eastern and western trends. This increase in cross-cultural sources, as well as changing rhythms of fashion trends, requires exceptional decision-making skills of the fashion merchandiser/marketer to make appropriate assessments regarding the selection of the materials, manufacturing, packaging, and distribution to meet customers' demands of cost-effective business strategies. Projection of future business trends in fashion requires business mathematics acumen to be able to understand past losses and challenges as well as the ability to predict future expenditures and earnings (Behrman & Levin, 1984).

Although the field of FMM is diverse, one theme that runs throughout coursework and business aspects is the necessity of mathematics. In some instances, concepts are

fixed on simple facts and rules and in other cases, concentrated on critical thinking and problem solving. The importance of mathematics in FMM, combined with poor national and international test performance of U.S. students, motivated this research study. More specifically, this study was designed to assess the mathematical skills of current college/university FMM students and to determine areas of strength and weakness. By targeting specific mathematics content areas, FMM programs in conjunction with industry, will have evidence to address some of the challenges that exist in training future FMM students and/or professionals for the global economy.

For further clarification, the labels of fashion marketing and fashion merchandising are both used in this study as particular earlier programs used the term merchandising while newer programs take the marketing angle. In some instances, fashion merchandising programs are housed in colleges that include departments such as family and consumer sciences or occupational and technical fields, while fashion marketing programs often fall under the direction of business and fine arts. There are even cases where programs expand the fashion degree into design and hospitality (Nusbaumer, 2012). This study does not attempt to make any distinctions between these various programs and identifies both fashion marketing and fashion merchandising as "FMM" regardless of the program's name or location within the college/university structure.

Literature Review
History and Development of Fashion Marketing and Fashion Merchandising

The early stages of fashion marketing and fashion merchandising (FMM) began with the general store, which not only sold or traded goods, but also stocked clothing.

Prior to the 1850's, early merchandising consisted of catalogs and merchandise found in stores. Every town had a general store which carried ready-to-wear apparel ordered directly from small manufacturers typically located in New York or Chicago. Large department stores often only met the needs of the upper-middle class in ready-to-wear garments (Chandler, 1962), while families of distinction would have fashion houses design and produce one-of-a-kind wardrobes (Chandler, 1993). Department stores and design houses alike employed numerous staff to create wardrobes and ensembles for their customers (Gungor, 2014). In many cases, such business ventures resembled characteristics of the first sweat shops as pay was low and hours were long in meeting the needs of the customer (Hapke, 2004). Master seamstresses became the first fashion merchandisers as they worked directly with the patron in proposing apparel and complementary accessories during fittings and wardrobe completion consultations (Gungor, 2014). Such scenarios were inadequate in meeting the needs of all citizens and products were limited in supply.

In a study of marketing and retail, Richard Sears of the Sears Roebuck Company was a leader in the late 1800's using the mail-order system to sell products – more specifically watches and jewelry (Chandler, 1962). Sears had the insight to appoint two investors to the company who provided the capital needed to buy items in large quantities and sell lower. The target market was the rural community due to the limited stock of items carried at the general store with a higher purchase price. Sears published a semi-annual catalog, which included lower prices and more selection than any of the local competitors could offer to consumers (Hapke, 2004). Sears based his entire business acumen and strategy on sales promotion. Additionally, he started combining retail with

company owned industrial units that could manufacture the goods required for the retailers' mail order and retail outlets of consumer selling. Thus, a model of merchandising from designer to consumer was created for the Sears Company and was known as the multi-divisional structure concept (Sears Archives, 2014). Internal structuring became challenging as new issues related to advertising, department layout, management of departments, as well as budgetary controls between inter/intra state lines were components of company growth. With a downturn in the economy, these problems became fleeting. Many small stores, along with dressmakers and tailors, went out of business due to lack of consumer spending, while ready-to-wear businesses flourished (Sears Archives, 2014).

After the success of Sears's watch and jewelry venture, he expanded his business to include fashion departments for both genders, which was not well received (Chandler, 1993). Other companies such as Macy's of New York and Harrods's of London were also experiencing a breakdown in their ready-to-wear departments (Tamilia & Reid, 2007; Hilton, Choi, & Chen, 2004; Chandler, 1993). As a result, it was established that retail, merchandising, and marketing practices should not only pass from top management down but also to lower-level employees up, to meet the needs of the consumer (Lewis, 2005). Regardless of the route taken, studies of consumer retail needs, including how to acquire the merchandise along with its manufacturing, advertisement of acquisition to customers, education of retail staff, and projection of future needs, indicated that personnel who could enrich respective companies with marketing and merchandising expertise were necessary for successful operation. Thus, Richard Sears introduced a fashion merchandising class to employees which was so successful that a fashion merchandising

course was announced in the Sears catalog (Chandler, 1962). Upon successful completion

of the course, taught by the Sears Company, a certificate was issued which launched

fashion merchandising programs as they are known today (Sears Archives, 2014). Table

1 provides a chronology of the Sears Company's involvement in the fashion and retail

market and its progression towards a fashion program of study.

Table 1: A Brief Chronology of the Sears Company's History

1886	Richard Sears starts selling watches to supplement his income as station agent at North Redwood, Minn.
1887	Sears settles in the company's first Chicago location and hires a watchmaker named Alvah C. Roebuck.
1888	Date of the earliest catalog featuring only watches and jewelry.
1893	Corporate name becomes Sears, Roebuck and Co.
1896	First large general catalog.
1913	Sears launches the Kenmore® brand.
1925	First Sears retail store opens in catalog center on Chicago's west side.
1950	Sears launched Women's Fashion Department and failed.
1952	Sears introduced a merchandising education certificate.
1953	Sears promotes merchandising education program/department to educate personnel on how to sell fashion products.
1955	Sears offers Fashion Merchandising education certificate in catalog.

It was during the 1950's that mathematics began to emerge as a requirement for

managers and other leaders, which included a more thorough program of business and

mathematics courses in accounting, statistics, and algebra (Chandler, 1993). The need for

further study in mathematics as it related to FMM became more visible when Jackson and

Shaw (2000) addressed changes in fashion buying and merchandising management due to

globalization. Their research in this field was one of few to address the study of

mathematics as essential for entering the current workforce. Suggestions of particular subject matter to be included with varying degrees of importance have been collected from industry, marketers or merchandisers, educators, and students (Laughlin & Kean, 1995), but such points are not overly prominent in the research.

In the late 1980's, a group of researchers analyzed FMM literature and concluded that mathematics was an important aspect to include in FMM programs (Buckley, Peach, & Weitzel, 1989). What was lacking in this review was addressing the degree postsecondary students were prepared mathematically before beginning their FMM programs or upon completion of FMM programs prior to entry into the workforce. More importantly, in reviewing related literature for this present study, it was determined that many FMM studies are dated, which brings to the forefront the importance of a current study to address the mathematical skills of FMM students entering the workforce. The remaining review of literature presents mathematics as it relates to FMM programs and curriculum as well as the needs of industry and the workforce.

Mathematics in FMM Programs

The Sears catalog merchandising program was such a success that this initial certificate program was introduced into high school vocational programs in the 1960's (Threeton, 2007), and branched further into one-year diploma programs. By 1964, two-year Associate Degree programs at community colleges and higher education facilities had adopted their renditions of a fashion merchandising program. In 1968, California, Florida, and New York merged home economics, business, and marketing programs together to create a fashion merchandising bachelor's degree program (Sheldon, 1986). To have consistency in program expectations, competencies in merchandising grew

across the field (Greenwood, 1981). Garner & Buckley (1988), experts in textiles and clothing fashion merchandising curriculum, supported the notion of competency-based curriculum. Others supported competency-based curriculum as a method of determining educational objectives, which would be positioned in various content areas of the fashion merchandising curriculum (Dressel, 1968; O'Connell & Moomaw, 1975). In addition, educators, students, and future employers joined forces to consider the selection of curriculum content and competencies desired in all FMM programs (Greenwood, 1981; Taba & Taba, 1962; Tyler, 1949).

A review of studies targeted on FMM programs over the last five and a half decades and the inclusion of various content areas derived from home economics (now known as Family and Consumer Science or FACS), business, and marketing programs provided an in-depth look at the changing curriculum during the inception of FMM program curricula. Sheldon (1986) noted that retailers had the insight to emphasize the relevance of mathematics and accounting along with management and communication. Mathematics proficiency in negotiations and inventory management was deemed one of the most important areas for store buyers (Kean, 1985). Francis & Brown (1985) also supported the need for skills to mathematically negotiate purchases necessitated for store buyers.

With the movement for competencies in FMM programs, researchers began to look more closely at curricula and the mathematical needs of FMM professionals. Fiorito and Fairhurst's work (1989) with small apparel store buyers found that the ability to judge quality and compute simple mathematics quickly and correctly were the most important and frequently used job skills needed by buyers. Kotsiopulos, Oliver, & Shim

(1993) studied the perceptions of buying competencies among retail buyers, managers, and students. The competencies were developed by examining textbooks adopted during this time period in buying courses (Packard & Guerreiro, 1979; Packard, Winters, & Axelrod, 1983). Out of thirty-five noted competencies, mathematics was ranked in the top seven needed to be successful in the merchandising workforce (Kotsiopulos, Oliver, & Shim, 1993).

Trends in FMM were changing dynamically and as a consequence required radical adjustments in FMM programs of study (Winakor, 1988). According to Bergvall-Forsberg and Towers (2007), there was a need to focus on the practical perspective of disciplines such as mathematics, partly because merchandising and retailing as applied fields, had not been stressed enough to forecast the before and after perspective of the retail market. In addition, it was acknowledged that merchandise and retail researchers needed to create and maintain their own theory base in accordance with the practical perspectives of the FMM industry (Winakor, 1988). However, the need for integrating contemporary approaches to critical fields like mathematics could not be understated. University and college FMM programs began to look more carefully at ways to integrate mathematics standards within the curricula to enhance the competencies of their graduates in preparation of future challenges (Han, 2003). While this progress is to be celebrated, it is unclear if the mathematics covered in FMM coursework is necessary to meet the demands of the fashion industry.

This induces a responsibility by academics to serve the needs of FMM students in accordance with the trends and challenges of the fashion merchandising market to successfully enter the fashion industry workforce. FMM degree programs across the

United States should be designed to give students the appropriate mathematics education and technical skills to be successful in the job market. Launching FMM students with an engagement, appreciation, and competence in mathematics, that will support their interests, self-efficacy, and opportunity for success, should be accomplished by higher education curricula (Adams & LaFramenta, 2014). One role of an institution is to produce graduates who are prepared for the professional workforce. Postsecondary students need competence in mathematics to attain entry-level positions and allow progression to higher levels of marketing and management (Kotsiopulos, Oliver & Shim, 1993). Hence, educational standards and competencies should be designed to provide graduates with the appropriate and suitable mathematics knowledge and skills required by current workforce constituents that correspond to the fashion industry's needs, qualifications, and skills (BHEF, 2011).

The United States fashion industries facilitate employment opportunities for four million people yearly (Hines & Bruce, 2007). However, it is crucial to highlight that FMM career tracks require knowledge of the latest business trends to include extensive business mathematics (Djelic & Ainamo, 1999). The ITAA (2008) guidelines also include the ability to critically evaluate and compare diverse perspectives within their meta-goals for four-year baccalaureate programs. This includes creative thinking skills and the ability to apply quantitative and qualitative skills to problem solving situations specific to fashion. Han (2003) also suggests that negotiation skills are critical for fashion merchandisers to facilitate the desired contracts with both buyers and consumers. These skills are related to and components of the study of mathematics. In addition, business acumen education within the FMM curricula supports students with basic accounting

skills, buying-mathematics, and an understanding of national and international markets and project management (Moore & Fairhurst, 2003). Such practices are important in educating future employees and providing the necessary tools for their success.

Mathematics in FMM Workplace

Pathways associated with Family and Consumer Sciences (FACS), as well as clothing and textiles content, are linked to opportunities in postsecondary education as well as a host of career opportunities (Shirley & Kohler, 2012). In particular, the clothing and textile industry is employing individuals with expertise in manufacturing, distribution, and marketing. Although it may appear that mathematics or STEM (Science, Technology, Engineering, and Mathematics) coursework is not critical to fashion, it should be emphasized that in fashion industry-related programs, STEM concepts, particularly mathematical concepts, are necessary (Shirley & Kohler, 2012). For example, Cohen, Johnson, & Pizzuto (2016) claimed that in the production of cotton, which is one of the most widely produced fibers used in the fashion industry, mathematics plays an instrumental role. Assessing the process of manufacturing cotton fabric to produce apparel like jeans requires students to conceptualize mathematics (Cohen et al., 2016). Many may not be aware that it takes approximately twenty-four ounces of cotton fiber to create a pair of jeans, which may be important to note from a cost analysis perspective. Mathematics provides a tool to help interpret such costs and allows marketers and merchandisers to analyze components involved in the big picture of product development and sales.

In the domain of garment manufacturing, which consists of cutting, sewing, and finishing a final product, FMM students must exemplify skills needed not only to

produce, but also to alter or repair fashion-related products (Garner & Buckley, 1988).

This requires one to be well-versed in mathematical as well as technological concepts.

When students use a sewing machine or other tools to construct garments they must

possess some level of geometric understanding (Shirley & Kohler, 2012). Clothing is

designed and manufactured to fit the form of the human body which means that FMM

students should understand measurement concepts to accomplish the final output of the

manufacturer. Additionally, they should know how to utilize algebraic, spatial, and

logical reasoning to meet a variety of measurement notions (Bergvall-Forsberg &

Towers, 2009). A garment cannot be manufactured without applying mathematical, or

more specifically geometric, concepts and competencies throughout the entire

development process (Bergvall-Forsberg & Towers, 2007).

Mathematics also plays a critical role when it comes to the distribution phase of

the fashion industry. Finished products are disseminated across retail stores, online

websites, and wholesale locations worldwide. This requires graduates of FMM programs

be well-versed in the use of technology operations and concepts, which requires

knowledge and application of mathematics (Shirley & Kohler, 2012). In addition, they

should be aware of how to understand the environmental effects of their fashion products

from the beginning design process through its final delivery (Sproles, 1981). Having the

knowledge and ability to apply mathematics principles in order to calculate specific

metrics of energy consumption, emissions, water use, and sustainability of the fashion

product is vital to a company's success (Shirley & Kohler, 2012).

Training for employment in the FMM industry includes testing focused on simple

numerical skills and mathematical knowledge (Sweller and Cooper, 1985). The type of

position FMM graduates obtain determines which mathematical skills are required, how they will be tested, and how problem-solving or acquired schemas will need to be implemented (Wedege, 1999). Some industries require taking a suitability test, which has a range of different questions where most are mathematically oriented, to determine the best placement of employees. Numeracy skills are required for many of these entrance exams (Zevenbergen, 2011). In one case, jobseekers aiming for work producing foam textile products in the aerospace industry must take and pass a mathematics test prior to being eligible to complete an application (Schoof, 2013). Potential applicants must complete this eighteen problem test within thirty minutes with no calculator. The test includes problems where one must convert inches to feet, read a tape measure, and find the density of a block of foam (mass divided by volume). Only one in ten pass the test. Eric Hahn, vice president of organizational development with General Plastics Company in Washington, says this is a common problem throughout his state and industry. According to the American College Test (ACT) of 2012, 54 percent of high school students are not prepared to continue in mathematics. This is supported by the National Math and Science Initiative, a group working to improve student performance in STEM. It has been well established that employment opportunities are increasing in the fashion industry as universities offer more programs, but there remains a prominent gap in the mathematics ability of graduating FMM students with respect to industry needs (Labov, Singer, George, Schweingruber, & Hilton, 2009).

The integration of mathematics education standards in the fashion industry is crucial in providing FMM personnel with both the analytical and technical mathematical skills needed to accomplish marketing goals (Avery, 1989). Jackson and Shaw suggest

that proper mathematics standards at the undergraduate level enable students to secure

jobs on the basis of their proficiencies (2000). Mathematics knowledge empowers

students with insight to operate successfully in a globalized world of manufacturing and

retail (Yu & Jin, 2005). Additionally, projection of future business trends in fashion

requires business mathematics acumen to be able to understand past issues and losses and

predict future expenditures and earnings (Behrman & Levin, 1984). The volatility and

unpredictable demand of fashion products stimulate real problems in purchasing

materials and other essential accessories (Sen, 2008). Such circumstances require FMM

personnel to have mathematical expertise to keep ahead of market trends and consumer

demands (Kincade, 2010). World-wide fashion forecasting necessitates mathematical

insight to anticipate future trends of the fashion market and is critical that FMM

graduates have the background to exist in such work environments (Kincade, 2010).

Research is lacking, and in many cases outdated, regarding how the absence of a

strong mathematics background affects FMM students, and what the requirements should

be for success both in academic programs and in the fashion industry workforce. This

suggests the need for a current study of fashion industry mathematics requirements.

Despite job availability and increases in FMM programs, there is a disconnect between

the demand and the supply of skilled FMM personnel. One possible cause for this gap is

the lack of mathematics standards to meet the needs, demands, and challenges of today's

fashion industry. This study proposes to investigate this possible break and to identify the

mathematical preparedness of FMM students for the workforce.

Purpose of Research

The purpose of this study was to assess the mathematical skills of students currently enrolled in Fashion Marketing and Fashion Merchandising (FMM) programs in the East Central Region of the U.S. in preparation for their entry into the 21st Century global market. This study sought to describe and compare the scores of students entering FMM programs and scores of students who completed all mathematics requirements of their respective FMM programs in order to determine if students possess the required mathematics skills and if FMM curricula are collectively preparing students for applied mathematics within the profession. Mathematics scores were assessed using the Math for Industry Test (MIT) (Resource Associates, 2015). Test performance in four specific mathematics content areas was assessed to determine if there were particular areas of mathematics where FMM students demonstrated strengths or weaknesses when entering or exiting their programs. This study addressed the following research questions:

RQ$_1$: What are the descriptive test score statistics and distributions of students entering and completing FMM programs as measured by the Math for Industry Test (MIT)?

RQ$_2$: Are the Math for Industry Test (MIT) scores of FMM students who have completed mathematics courses significantly higher than the scores of students entering FMM programs?

RQ$_3$: Are there specific mathematics content areas of the Math for Industry Test (MIT) where FMM students entering or completing their programs demonstrate strengths or weaknesses?

CHAPTER II

METHODOLOGY

This chapter describes the participants, research design, test instrument used to measure applied mathematics skills, data collection procedures, and data analysis methods adopted in this study. Each category, along with details, is presented in the following sections.

Participants

Participants in this study consisted of 205 undergraduate students enrolled in FMM programs throughout the East Central Region of the United States. They were drawn from 25 participating institutions including state, private, and proprietary colleges/universities of higher learning from the states of Kentucky, North Carolina, Tennessee, West Virginia, and Virginia. A brief snapshot of the institutes that participated is provided in Table 2.

Table 2

Frequency and Type of Institution of Higher Education with Fashion Merchandising/Marketing Programs Participating in the Study from Each U.S. Central Region State.

State	Type of Institution			Total
	State	Private	Proprietary	
Kentucky	3	1	2	6
North Carolina	2	2	1	5
Tennessee	2	3	1	6
West Virginia	3	0	1	4
Virginia	3	0	1	4
Total	13	6	6	25

FMM students who were entering their program (ESs) and FMM students who had completed all mathematics requirements of their program were included (CSs) in this

study. Summary statistics were compiled to describe study participants for both the ESs

and CSs groups to include age, gender, ethnicity, and highest education level attained. A

summation of this information is identified in Tables 3 through 5.

Table 3

Combined Entering and Completing Student Participant Demographics: Age Discrimination and Gender

	Age				Gender	
	18-25	*26-35*	*36-45*	*46+*	*Male*	*Female*
Entering Students	87	7	0	0	17	77
Completing Students	85	16	8	3	18	93

Table 4

Combined Entering and Completing Student Participant Demographics: Ethnicity

	Caucasian	Hispanic/Latino	African-American	Multiracial	Other	Native American	I Prefer Not to Answer
Entering Students	21	5	43	11	8	0	3
Completing Students	43	8	38	9	6	1	3

Table 5

Combined Entering and Completing Student Participant Demographics: Educational Levels

	High School	Skilled Trade*	GED	Other Professional Degrees**	Bachelor's Degree
Entering Student	78	4	0	4	8
Completing Student	98	2	1	6	4

Note: *The definition of "Skilled Trade" is having the training, knowledge, and experience needed to work in a particular occupation, craft, or trade. ** "Other Professional Degrees" include completion of a formal program of study which does not include a Bachelor's degree (Freidson, 1986).

The research protocol was reviewed and approved by the Human Subjects

Committee, part of the Institutional Review Board (IRB) process that is in place at Old

Dominion University. Permission for students to participate in this study was obtained

(see Appendix A). The data collection process was carried out in a consistent manner

across all participating institutes by identifying volunteer proctors, typically instructors of

courses, explain the study overall and its purpose to potential participants. They informed

students of the procedures that were to be followed, their rights in agreeing to participate

in this study, and a guarantee of anonymity.

Research Design

This research utilized a non-experimental, descriptive study design in correlation

with a quantitative analysis of a mathematics test FMM students completed. This test is

identified as an Industry Mathematics Aptitude Test (MIT) and was designed by

Resource Associates (RA) of Knoxville, Tennessee (2012). The MIT is used by clients of

RA to assess the mathematics ability of possible employees (see Appendix B). RA is an

accredited company and member of the Society for Human Resource Management

(SHRM), along with the Society for Industrial Organizational Psychology (SIOP), with a

specialty for creating tests on aptitude and personality for pre-screening interviewing

purposes. RA describes the mathematics aptitude test as a test that contains mathematics

problems for industry-focused jobs and possessing a difficulty level of ninth grade

mathematics (Resource Associates, 2015). RA recommends that the test be used for

entry-level industry and manufacturing workers, shipping and receiving clerks, and

quality assurance technicians. In addition, RA notes that candidates who score high on

the MIT tend to be efficient in handling duties, while candidates who score low on the

test have a tendency to depend on others to handle aspects of the job. This is consistent

with findings from Kulik and Kulik (1984), which reported testing results showed larger

gains for subjects of high ability than those of low ability.

A quantitative design was chosen over other methods as it is the most appropriate

method for studies involving pre- and post-test measures of attitudes (Creswell, 2003). In

this study, the researcher sought to determine if entering FMM students were

mathematically prepared for their chosen program of study. The researcher was also

interested in determining if FMM students, who had completed all mathematics

coursework required by their program of study, were mathematically prepared to enter

the fashion industry workforce.

Research Instrument

The Mathematics for Industry Aptitude Test (MIT) is an instrument designed to

measure fashion marketing/merchandising mathematics aptitude. The test contains 40-

items in multiple-choice format with five options for each question. Prior research found

the test to be significantly correlated with productivity ($r = .22$), quality ($r = .27$), overall

job performance ($r = .31$), and skill competence ($r = .29$). RA completed a series of

reliability and validity studies across three different companies – AK Steel in Middleton,

Ohio in 2003, ABC Manufacturing in Detroit, Michigan in 2012, and DENSO in

Nashville, Tennessee in 2013. The research on the test was conducted in three different

industrial settings and all testing was conducted on 103 to116 diverse personnel in

correlation with additional testing in reading and personality traits. It was determined that

the test achieved what it was designed to do, which was differentiate high performers

from low performers as witnessed by supervisors evaluating job performance of

employees (Resource Associates, 2015). The validity for both aptitude and personality

measures were solid (overall $r = .27$, $p = .008$) giving ABC Manufacturing ample reason to proceed with selection testing despite evidence of possible adverse impact on personnel promotion.

While originally developed as an aptitude test, it was administered and interpreted as an achievement test for the purposes of this study. The test developers recommend a total testing time of fifteen-minutes when administered as an aptitude test (Resource Associates, 2015). In this study, test takers were given one hour to complete the forty items. The timeframe was based on estimates of 75-100 seconds required for adult test takers to read and answer complex, multiple-choice items necessitating problem solving (Thorndike & Thorndike-Christ, 2010). No calculators or electronic devices were allowed for the completion of the test. In addition to the actual mathematics problems, participants were asked to respond to demographic questions including age, gender, ethnicity, and education (see Appendix C).

Mathematics Industry Test Validity and Use

The MIT is published and copyrighted by Resource Associates, Incorporated, a business who has used the test for various studies since 2002 (Resource Associates, 2013). For this particular study, the MIT was reviewed and endorsed by 70 Retail Industry Experts (RIE) to be representative of mathematics currently existing and applied in the current workforce with the exception of seven questions or 17.5% of the test. Depending on the industry (manufacturing versus retail), the indicated mathematics questions could still be considered essential within certain workplaces and for the advancement of employees looking for upper level management positions. It is this

comparison of the actual test to RIEs analysis of the test that supports it upholding criterion-related validity.

Predictive validity, a type of criterion-related validity, is the extent to which a score on the MIT predicts future success on some other measure like job performance. As was previously presented, the MIT has been studied using big companies and as a result has established expectations of employees in relationship to the outcome of this assessment. If an employee's score is high, it is suggestive or predictive that the employee will perform at a higher level than an employee who scores low on the same test. It also is a good predictor of employees who will be capable of moving into management level positions needing the mathematical skills employed in this test. It should be noted that for the purpose of this study, concurrent validity was not measured using this test.

Survey Data Collection

To add integrity to use of the MIT, a five-point Likert survey consisting of two statements were distributed to 70 industry experts at 35 business locations throughout the Hampton Roads Virginia area (see Appendix D). These experts, identified in this study as retail industry experts (RIE), have worked in marketing and/or management for at least five years and are considered authorities within a particular retail area (Chen, Heyer, Ibbotson, Salonitis, Steingrimsson, & Thiede, 2015). An RIE should also possess basic knowledge of other content areas in their particular area of expertise including industry mathematics. In addition, within their respective industries, they are required to support training experiences as well as develop necessary educational materials for employees (Ritter, 2003). In this study, two RIEs, a manager and an assistant manager, responded to

the survey questions at each business that participated. The first survey response asked

RIEs to determine if the mathematics questions in the MIT had face validity and were

representative of the type of mathematics concepts utilized in their retail and/or fashion

industry establishments (Thorndike & Thorndike-Christ, 2010). The results of the first

statement are presented in Table 6.

Table 6

Likert Survey Responses to Statement 1.

Question	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
The mathematics questions included in the Mathematics Industry Test (MIT) are representative of the math concepts utilized within your retail and/or fashion industry establishment.	57	13	0	0	0

Secondary to reviewing the MIT, RIEs were asked to identify any problems contained on

the test that were not representative of any fashion industry employee position within

their establishment. The results of the second survey statement are identified in Table 7.

Table 7

Likert Survey Response to Statement 2: Would you please circle any items or questions included in the MIT not representative for utilization within your establishment for any employee position.

	Number & Computations	Ratio & Proportional Reasoning	Measurement	Statistics (Graphing)
MIT Question Numbers	1, 2, 3, 4, 5, 9, 10, 37, 38, 39	11, 12, 13, 14, 15, 21, 27, 29, 40	16, 17, 18, 19, 20, 22, 23, 24, 25, 26, 28, 30, 31	6, 7, 8, 32, 33, 34, 35, 36
RIE Responses		***16** – ****12, **13 **14**	***44** – ****26 *53** – ****28 *62** - ****31**	***51** - ****36**

Note: *Denotes number of RIEs responding. **Denotes the mathematics question in the MIT not utilized by employees within RIE industry establishments.

Questions identified by the RIEs were the same mathematics problems noted as

challenging within the MIT difficulty parameters. Normal difficulty indices for the MIT

are found to be between 50 to 80 percent (Thorndike & Thorndike-Christ, 2010).

Marginal indices for the MIT are found to be between 30 to 50 percent (Thorndike &

Thorndike-Christ, 2010). Out of the seven questions, one (#12) was determined to be of

normal difficulty, three (#s 13, 14, & 28) were found to be of marginal difficulty, and

three (#s 26, 31, & 36) were determined to be difficult. Overall, the RIEs found the MIT

questions were representative of usage within their respective fashion industry business.

The seven questions that were labelled as not representative will be addressed in analysis

for future use.

Data Collection

Data collection for this study consisted of paper copies of the MIT distributed to

all participating sites. The tests were identified with institution alpha numeric codes along

with Scantron answer sheets and shipped via express courier to all respective program

coordinators at each institute. Return addressed express courier envelopes were provided

for a quick turnaround to the respective coordinators, who in some cases were the

proctors or who identified proctors at their respective site. Tests were completed and

returned to the researcher over the course of mid-January to early February 2016. This

time frame was considered to be acceptable as it is typically the beginning of the

semester for most higher education institutes.

To guarantee anonymity, participant names were not to be recorded on the tests.

An upper case letter was applied before numerals to designate what institution was

participating. This enabled the researcher to match tests to groups (ESs and CSs),

schools, and programs. Participants could opt out of the study at any time without penalty or concern but had to make this appeal before submitting their test. In the event any participant or institute wanted to know the final results of this study, the researcher agreed to provide the findings for them upon request.

As was previously stated in the data collection, a Likert survey was distributed to 70 RIEs at 35 business locations throughout the Hampton Roads area of Virginia. They were in paper format and were collected by the researcher at each business speaking to the manager and assistant manager. The surveys were delivered and retrieved within a 48-hour timespan. All surveys were dropped off to identified manager or assistant manager on March 9, 2016 and picked up by March 11, 2016.

Data Analysis

Three separate analyses were performed to address each of the three research questions for this study. They are identified in Table 8.

Table 8

Data Analysis to be Addressed for Each Research Question.

Research Question	Groups	Measures	Analysis
RQ₁: What are the mathematic score statistics and distributions of FMM student entering and completing their program?	Entering and Completing FMM Students	Mean, Median, Mode, Standard Deviations, and Distributions of MIT Scores for Each Group	Descriptive Analysis
RQ₂: Are the collective mathematics scores of FMM students who have completed their mathematics courses significantly higher than the collective mathematics scores of FMM students entering their programs?	Entering and Completing FMM Students	Mean MIT Scores for Each Group	Independent Groups t-test
RQ₃: Are there specific mathematic content areas	Entering and	Mean MIT Subtest Scores	Independent Groups t-test for

where there are strengths and weaknesses for FMM students entering or completing their programs?	Completing FMM Students	(numbers/computation, ratio/proportional reasoning, measurement, & statistics) for Each Group	each subtest mean

Data was analyzed using an independent t-test due to division of sample into two groups (ESs and CSs). A t-test was used to determine whether there was a significant difference between the scores of these two groups within the participating institutions overall. No significant difference would indicate that these populations were similar and both capable of taking FMM mathematics coursework and entering the workforce upon graduation from FMM programs. Consequently, any differences could indicate that students in either group could be at a disadvantage with their mathematics background.

Additionally, the MIT was divided into four sub-scaled groups with MIT questions correlated into each group as mathematics concepts for analysis. These groups were identified as Number and Computations, Ratio and Proportional Reasoning, Measurement, and Statistics/Graphing. Table 9 summarizes the correlations between the MIT questions and sub-scaled groups. All data were processed using Excel and the Statistical Package for Social Sciences - SPSS (IBM, 2013).

Table 9

Table of Specifications

	Number & Computation	Ratio & Proportional Reasoning	Measurement	Statistics (Graphing)
Item Numbers	1, 2, 3, 4, 5, 9, 10, 37, 38, 39	11, 12 ,13, 14, 15, 21, 27, 29, 40	16, 17, 18, 19, 20,22, 23, 24, 25, 26, 28, 30, 31	6, 7, 8, 32, 33, 34, 35, 36
TOTAL ITEMS	10	9	13	8

Summary

In order to evaluate FMM students' mathematics skills across the U. S. Central Eastern Region this study examined both beginners and completers of FMM mathematics coursework by completion of the MIT. Participants consisted of first or second semester students without FMM mathematics coursework (Entering students = ESs) and students who have completed all FMM mathematics coursework (Completer Students = CSs). An independent t-test was used to analyze and compare the test scores between the two groups (ESs and CSs) to determine if there was a significant improvement of mathematics abilities/skills between entering and completing FMM students. Additional analysis was conducted using t-tests on each MIT sub-set group to determine strengths and weaknesses of targeted content areas of the entering and completing FMM students.

CHAPTER III

RESULTS

This chapter presents an overview of the findings of this study. Results are reported for each of the research questions posed. The findings were based on the forty-item Mathematics for Industry Test (MIT) completed by 205 undergraduate students enrolled in FMM programs throughout the East Central Region of the United States. Scores on the MIT were calculated as items correct and ranged from 0 to 40 where a zero indicated that none of the test items were answered correctly and 40 indicated that all questions were correct. Primary results for RQ1 and RQ2 were conducted using this 40-item score. Results for Q3 were derived from subscale scores of the MIT. For the purposes of comparison, a distribution of MIT test scores for all test takers (n=205) is presented in Figure 1.
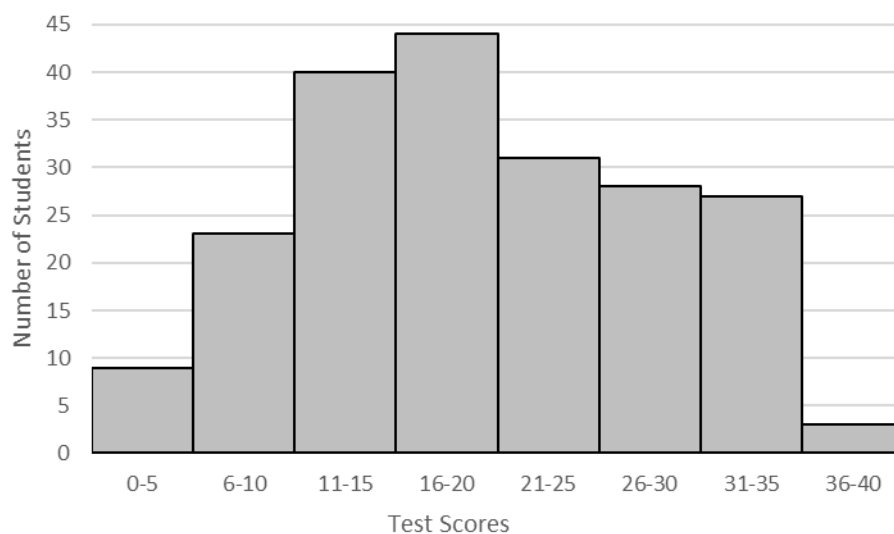

Figure 1. Distribution of MIT scores for all FMM students (n=205).

RQ₁: What are the descriptive test score statistics and distributions of student entering (ESs) and completing (CSs) FMM programs as measured by the Math for Industry Test (MIT)?

To answer this research question, test score statistics and test score distributions of entering (ESs) and completing (CSs) students were calculated and compared. Of the 205 students who completed the MIT, 94 were ESs and 111 were CSs. MIT test score statistics including the lowest score, highest score, mean, median, mode, standard deviation (SD), Kuder-Richardson Formula 20 (KR-20) reliability coefficients, and standard error of measurement for entering, completing, and all students combined are in presented in Table 10. Test scores distributions for entering, completing, and all students combined are presented numerically in Table 11 while individual score distributions for ESs and CSs are presented in Figures 2 and 3, respectively.

Inspection of the observed test statistics indicate an acceptable range, reliability, and standard error of measurement for the MIT test scores analyzed in this study, giving confidence in the scores. Review of both numeric and visual distributions of the test scores indicate comparable statistics and distributions for the ESs and CSs. The similarity of these distributions was contrary to generally expected differences where higher test scores and a more negatively-skewed distribution were anticipated for the CSs and lower test scores with a more positively-skewed distribution were projected for the ESs. Statistical analyses of these differences were tested in subsequent RQ2 and RQ3.

Table 10

Test Scores Statistics for Entering, Completing, and All FMM Students Combined

	Entering Students (ESs)	Completing Students (CSs)	Combined Entering and Completing Students
Lowest Score	1	2	1
Highest Score	34	37	37
Mean	19.91	18.96	19.40
Median	19	17	18
Mode	31	11	13
SD	7.93	9.16	8.61
KR-20	0.88	0.88	0.90
SEM	2.73	3.19	2.75
N	94	111	205

Note: SD denotes standard deviation, KR-20 denotes Kuder-Richardson Formula 20, and SEM denotes Standard Error of Measurement.

Table 11

Distribution of MIT Test Scores for Entering, Completing, and All FMM Students Combined

Test Score Range	Entering Students (ESs)	Completing Students (CSs)	Combined Entering and Completing Students
0-5	4	5	9
6-10	7	16	23
11-15	15	25	40
16-20	23	21	44
21-25	19	12	31
26-30	15	13	28
31-35	11	16	27
36-40	0	3	3
Total	94	111	205
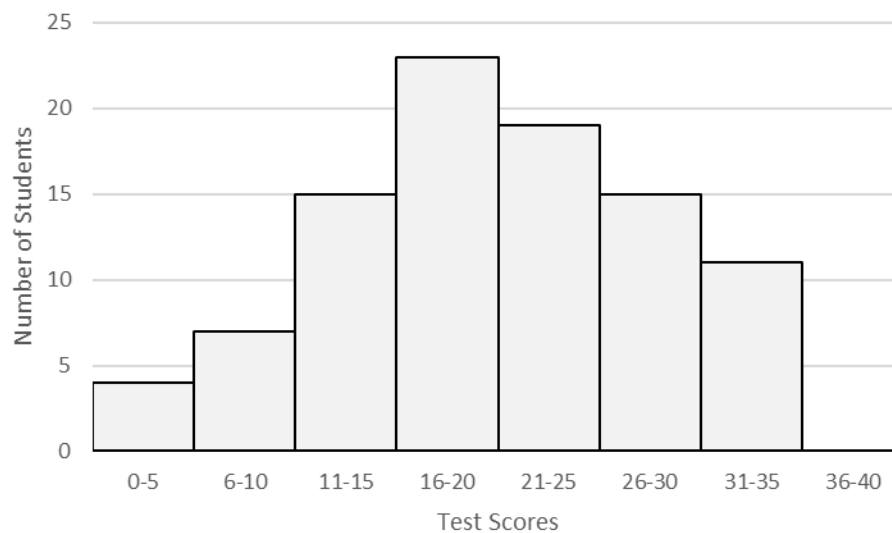
Figure 2. Distribution of MIT scores for entering students (ESs) (n=94).
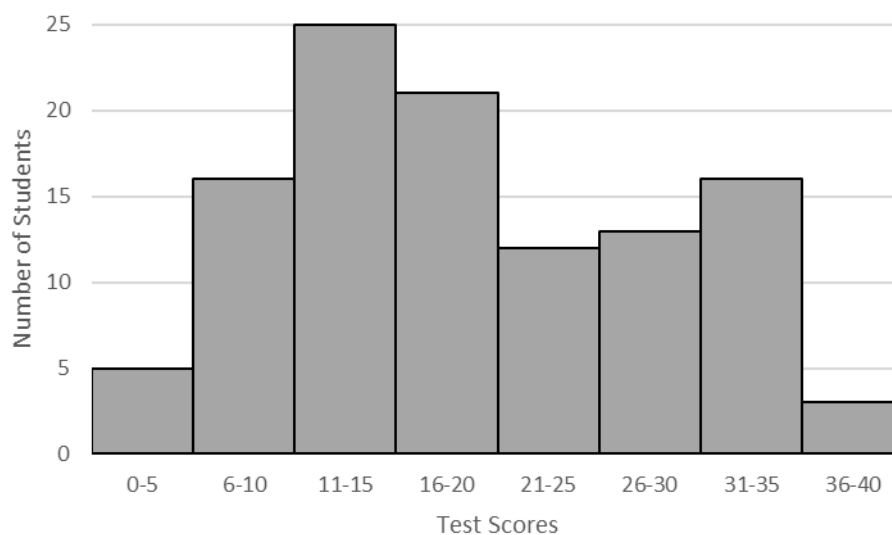

Figure 3. Distribution of MIT scores for completing students (CSs) (n=111).

For further analysis of this research question, descriptive test score statistics and distributions of entering (ESs) and completing (CSs) FMM students were analyzed for each of the four subscales of the MIT. Subscale statistics for the number and operations (10 items), ratio & proportional reasoning (9 items),

measurement (13 items), and statistics & graphing (8 items) subscales are

presented in Tables 13-15. Subscale score distributions for each are presented in

Figures 4-11.

As with the overall MIT scores, the observed statistics for all four subscale scores

are acceptable in range, reliability, and standard error of measurement. Inspection of the

numeric and visual distributions of the scores for each subscale indicate that the statistics

and distributions for the ESs and CSs are also very similar. As with the overall MIT,

there is little observable difference in these scores, regardless of subscale. These

observations are contrary to generally the expected differences where observably higher

subscale scores and a more negatively-skewed distributions were anticipated for the CSs

and lower subscale scores with a more positively-skewed distribution were expected for

the ESs. Statistical tests of these differences are address in RQ3.

Table 12

Number and computations Subscale Score Statistics for Entering, Completing, and All FMM Students Combined

	Entering Students (ESs)	Completing Students (CSs)	Combined Entering and Completing Students
Lowest Score	0	0	0
Highest Score	10	10	10
Mean	6.35	5.57	5.93
Median	7	6	6
Mode	7	7	7
SD	2.61	2.96	2.82
KR-20	0.80	0.79	0.80
SEM	1.17	1.36	1.25
N	94	111	205

Note: SD denotes standard deviation, KR-20 denotes Kuder-Richardson Formula 20, and SEM denotes Standard Error of Measurement.

Figure 4. Distribution of number and computations subscale scores for entering students (ESs) (n=94).

Figure 5. Distribution of number and computations subscale scores for completing students (CSs) (n=111).

Table 13

Ratio and Proportional Reasoning Subscale Score Statistics for Entering, Completing, and All FMM Students Combined

	Entering Students (ESs)	Completing Students (CSs)	Combined Entering and Completing Students
Lowest Score	0	0	0
Highest Score	9	9	9
Mean	4.01	3.96	3.99
Median	4	3	3
Mode	6	2	2
SD	2.38	2.62	2.51
KR-20	0.81	0.79	0.80
SEM	1.04	1.19	1.13
N	94	111	205

Note: SD denotes standard deviation, KR-20 denotes Kuder-Richardson Formula 20, and SEM denotes Standard Error of Measurement.
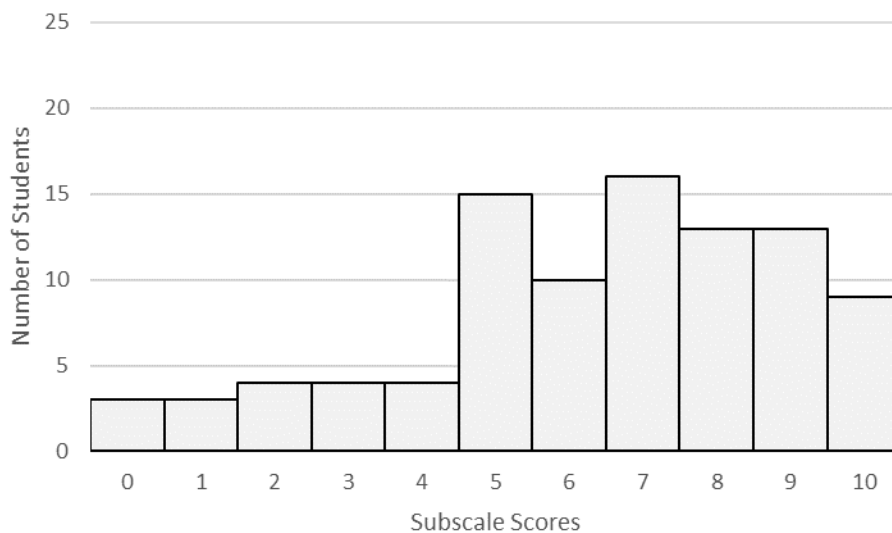
Figure 6. Distribution of ratio and proportional reasoning subscale scores for entering students (ESs) (n=94).
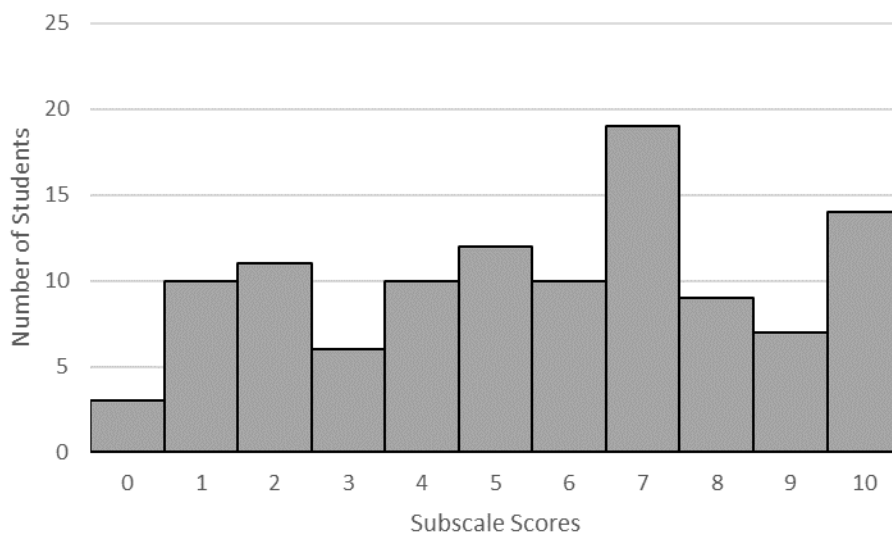

Figure 7. Distribution of ratio and proportional reasoning subscale scores for completing students (CSs) (n=111).

Table 14

Measurement Subscale Score Statistics for Entering, Completing, and All FMM Students Combined

	Entering Students (ESs)	Completing Students (CSs)	Combined Entering and Completing Students
Lowest Score	0	0	0
Highest Score	10	12	12
Mean	5.15	5.07	5.11
Median	5	5	5
Mode	3	4	4
SD	2.55	2.59	2.57
KR-20	0.79	0.79	0.82
SEM	1.18	1.18	1.10
N	94	111	205

Note: SD denotes standard deviation, KR-20 denotes Kuder-Richardson Formula 20, and SEM denotes Standard Error of Measurement.
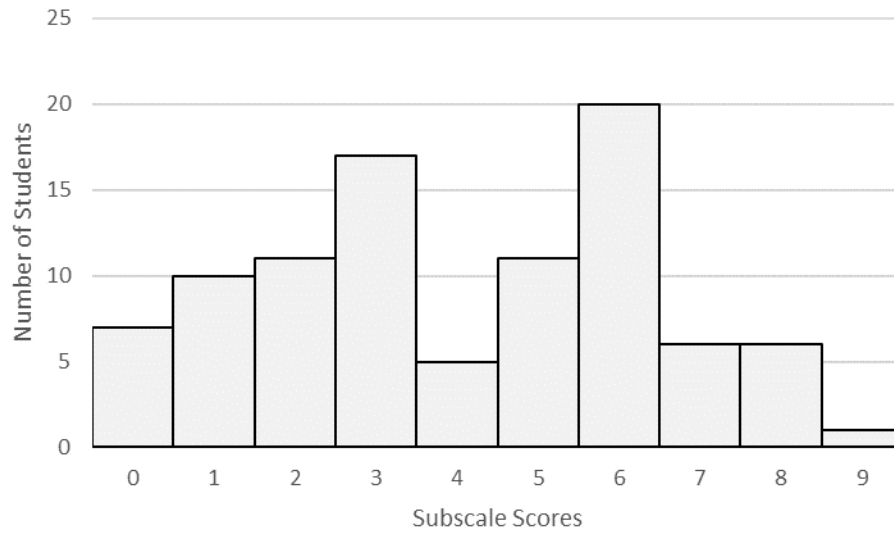
Figure 8. Distribution of measurement subscale scores for entering students (ESs) (n=94).

Figure 9. Distribution of measurement subscale scores for completing students (CSs) (n=111).

Table 15

Statistics and Graphing Subscale Score Statistics for Entering, Completing, and All FMM Students Combined

	Entering Students (ESs)	Completing Students (CSs)	Combined Entering and Completing Students
Lowest Score	0	0	0
Highest Score	8	8	8
Mean	4.40	4.36	4.38
Median	5	4	4
Mode	6	4	6
SD	1.85	2.19	2.03
KR-20	0.78	0.76	0.76
SEM	0.87	1.06	1.00
N	94	111	205

Note: SD denotes standard deviation, KR-20 denotes Kuder-Richardson Formula 20, and SEM denotes Standard Error of Measurement.

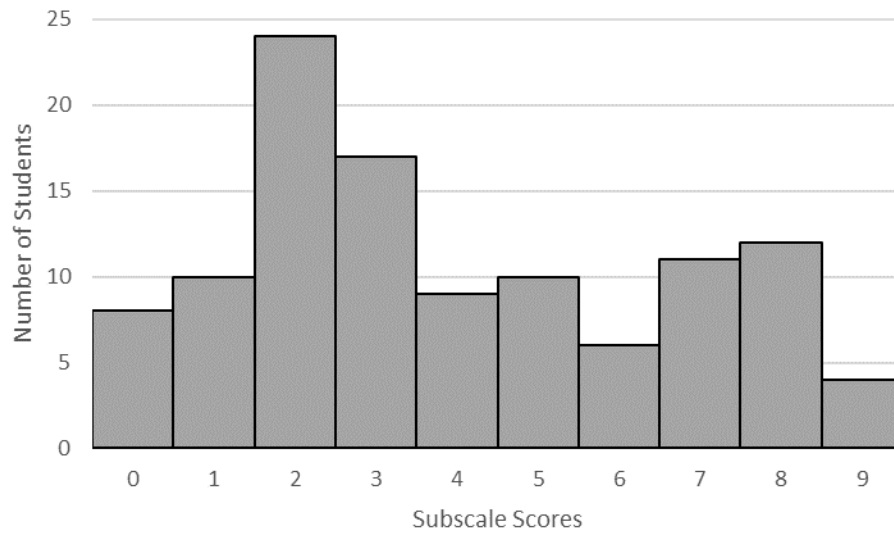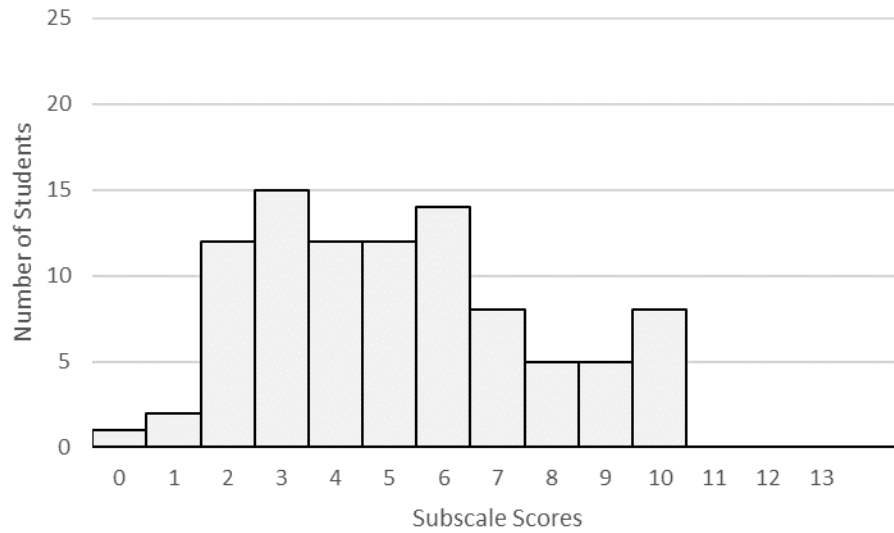Figure 10. Distribution of statistics and graphing subscale scores for entering students (ESs) (n=94).
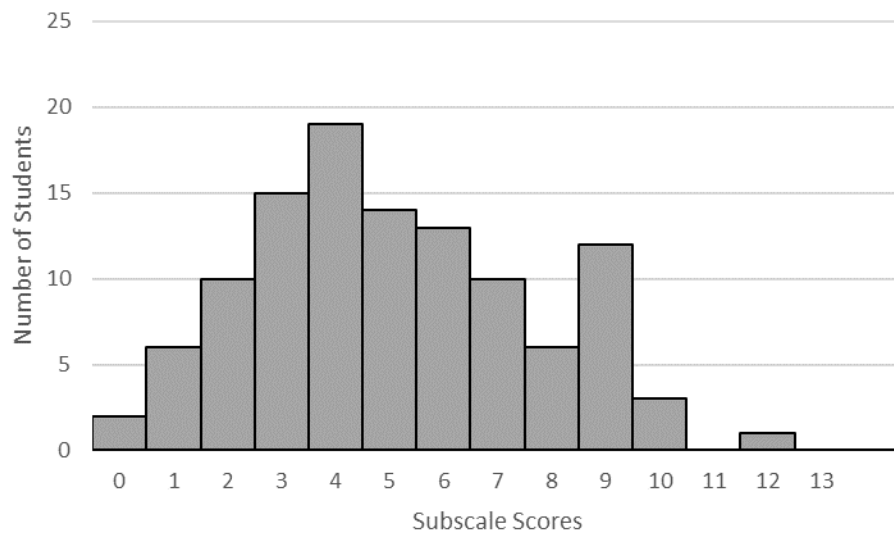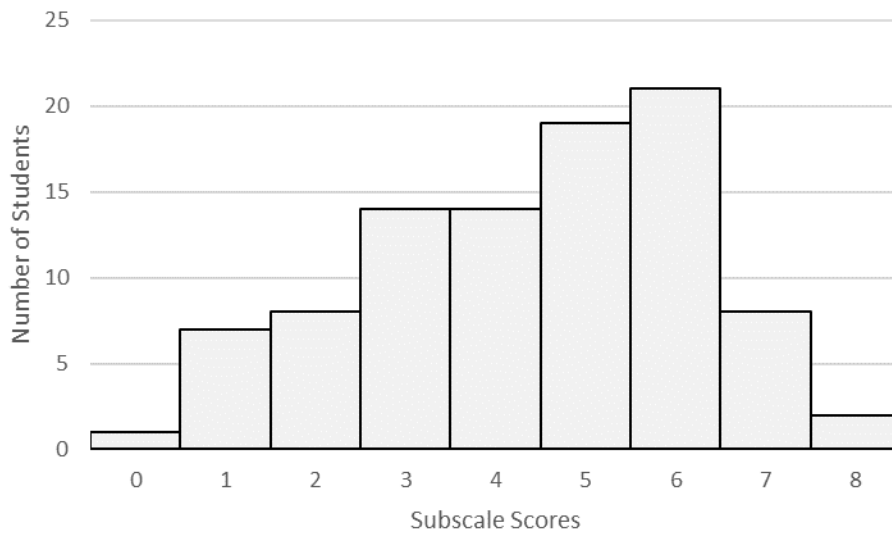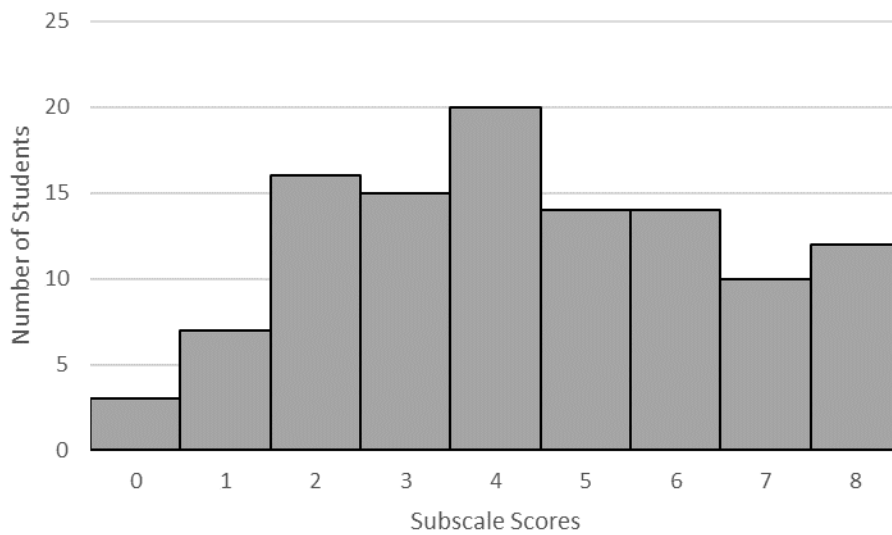

Figure 11. Distribution of statistics and graphic subscale scores for completing students (CSs) (n=111).

RQ2: Are the Math for Industry (MIT) scores of FMM students who have completed required mathematics courses (CSs) significantly higher than the scores of students entering FMM programs (ESs)?

To answer this research question, an independent-samples *t*-test was conducted to compare MIT scores of students entering (ESs) the FMM program to completing students (CSs). Results indicated that the MIT scores of completing students (CSs) ($M = 18.96$, $SD = 9.16$) were not significantly different from scores of entering students ($M = 19.92$, $SD = 7.93$), $t(203) = .79$, $p = .432$, demonstrating no statistical differences in the mathematics skills between these groups.

RQ3: Are there specific mathematic content areas of the Math for Industry (MIT) where FMM students entering (ESs) or completing (CSs) their programs demonstrate strengths or weaknesses?

To address this research question, four separate *t*-test analyses were conducted to compare the scores of entering (ESs) and competing (CSs) students on each of the subscales scores of the MIT (number & computations – 10 items, ratio & proportional reasoning – 9 items, measurement – 13 items, and statistics/graphing – 8 items). The results of each *t*-test analysis are presented in this order here.

An independent-samples *t*-test was conducted to compare the scores of entering (ESs) and completing (CSs) students on the 10 test items represented on the Number and Computations subscale. Results revealed that MIT Number & Computations subscale scores of completing students ($M = 5.57$, $SD = 2.96$) were significantly lower than those of entering students ($M = 6.35$, $SD = 2.61$), $t(203) = 2.00$, $p = .047$. This finding was

opposite of what would be expected in that that entering students demonstrated statistically higher levels of mathematic skill in the area of number and computation than their counterparts who were completing FMM programs.

An independent-samples *t*-test was conducted to compare the scores of entering (ESs) and completing (CSs) students on the 9 test items encompassing the Ratio and Proportional Reasoning subscale of the MIT. Results indicated no significant difference between the MIT Ratio & Proportional Reasoning subscale scores of completing students ($M = 3.96$. $SD = 2.62$) and subscale scores of entering students ($M = 4.01$, $SD = 2.39$), $t(203) = .13$, $p = .895$.

An independent-samples *t*-test was conducted to compare the scores of entering (ESs) and completing (CSs) students on the 13 items comprising the Measurement subscale of the MIT. There was no significant difference found between subscale scores of completing students ($M = 5.07$, $SD = 2.59$) and those of entering students ($M = 4.40$, $SD = 1.85$), $t(203) = .15$, $p = .878$.

Finally, an independent-samples *t*-test was conducted to compare the scores of entering (ESs) and completing (CSs) students on the 8 items representing the Statistics/Graphing subscale. There were no significant differences between completing students ($M = 4.36$, $SD = 2.19$) and entering students ($M = 4.40$, $SD = 1.85$), for the MIT Statistics (Graphing) subscale scores, $t(203) = .15$, $p = .878$.

Summary

The findings of this study indicate that there are little to no observable or statistical differences in the mathematics test scores of students entering (ESs) FMM programs and the scores of students who had completed all mathematics requirements of

their respective FMM programs (CSs) as measured by the MIT. The one statistically significant difference found was for ESs who scored significantly higher than CSs on the number and computations subscale, indicating that entering students possessed higher computational skills than their peers who were nearing program completion. The higher ESs scores may be due in part to the fact that most entering students recently completed high school curricula that is traditionally focuses on these computational skills and that these students are likely to have studied computational mathematics in preparation for college entry testing.

It is important mention that neither ESs or CSs demonstrated extremely high levels of mathematics as measured by the MIT. However, of particular concern are the scores of CSs who are nearing program completion and entry into the FMM workforce. The collective findings indicate that FMM do not maintain or develop mathematical skills required by the FMM industry. Conclusions implicate that FMM programs need to address mathematics in their curricula to ensure that graduating students are prepared to enter the global workforce.

CHAPTER IV

DISCUSSION AND CONCLUSIONS

Findings

Current fashion marketing and fashion merchandising (FMM) students and their level of preparedness to meet the mathematical demands of today's workforce were explored in this research study. Three research questions guided the direction of this investigation.

1. What are the descriptive test score statistics and distributions of students entering and completing FMM programs as measured by the Math for Industry Test?

2. Are the Math for Industry Test scores of FMM students who have completed required mathematics courses significantly higher than the scores of students entering FMM programs?

3. Are there specific mathematics content areas of the Math for Industry Test where FMM students entering or completing their programs demonstrate strengths and weaknesses?

This study was conducted to examine two groups of FMM students – those beginning and those completing mathematics coursework – to determine if they met industry needs in the global workforce. A quantitative analysis, involving a descriptive breakdown of test scores and correlations between entering students (ESs) and completing students (CSs), was executed for the first research question. The Mathematics for Industry Test (MIT) was employed to measure ESs and CSs group proficiency in industry mathematics as well as identifying specific areas of strength and weakness for the second and third

questions. Lastly, a Likert survey was distributed to obtain retail industry experts' (RIEs) opinions on the practicality of the MIT.

Descriptive statistics were utilized for research question one to define and delineate the MIT results. The results and analysis of scores between CSs and ESs indicated that there was not a statistically significant difference. Overall, the scores for both entering and completing students were found to be quite low where 43% of the test takers scored above fifty percent and 57% of the test takers scored at or below the fifty percent mark. Out of the 205 test takers, thirty-one had between 21 and 25 problems answered correctly (out of 40), twenty-eight answered 26-30 problems correctly, twenty-seven had 31-35 questions correctly answered, and three answered 36-40 correctly. The total number of correct responses (out of 40 problems) or scores attained on the MIT provide evidence that students in FMM programs across the U.S. East Central Region are not well prepared mathematically to meet the needs of industry.

SPSS Statistics (IBM, 2013) is a software package that was utilized for research questions two and three. For the second question, a t-test was employed to analyze and compare the differences between entering and completing students' mathematics test scores. No significant difference was found between these two groups on the Mathematics Industry Test, although it was determined that entering students scored higher overall on the mathematics test (50%) compared to completing students' overall mathematics test scores (43%).

SPSS was also used to conduct a t-test to analyze research question three to determine strengths and weaknesses in four specific mathematics content areas between ESs and CSs groups. The four specific content areas were numbers and computation,

ratio and proportional reasoning, measurement, and statistics and graphing. Content areas of ratio and proportional reasoning, measurement, and statistics and graphing did not have any statistically significant differences between the ESs and CSs groups. An analysis of scores in the category of numbers and computation indicated that CSs scored significantly lower than ESs which raises concerns about both groups not being prepared to meet the needs of industry and retail markets but even more so that completers scored lower than early program students. Although analyses in ratio and proportional reasoning, measurement, and statistics and graphing did not indicate a significant difference between ESs and CSs, overall the scores from the MIT were low in all four sub-scaled categories. This provides evidence to study more deeply how FMM programs prepare students to be mathematically successful in future retail positions.

Discussion

Should greater attention be given to programs and companies treating FMM the same as other business professionals? In many business tracts, there are trends to progress to a professional level which is accomplished by initial certification, additional study, more testing, and concluding with licensure. The International Textiles and Apparel Association (ITAA, 2008) has set guidelines and meta-goals for conducting operations within the fashion merchandising industry of the United States. Within their four-year baccalaureate program 2008 meta-goals, ITAA professes that graduates should possess professional attitudes and skills in the category of "Critical and Creative Thinking" and should have the ability to:

- Demonstrate critical and creative thinking skills, including the ability to critically evaluate and compare diverse perspectives.

- Identify and understand the effect of social, cultural, economic, technological, ethical, political, educational, language, and individual influences on industry issues.

- Apply quantitative and qualitative skills to problem-solving within the textile and apparel complex.

- Use appropriate technology to facilitate critical, creative, quantitative, and qualitative thinking within the textile and apparel complex (p. 4).

It is of utmost importance for programs to address such goals in order to prepare future employees to obtain needed credentials and certifications in the retail industry. The ITAA's presentation and acceptance of these meta-goals provides the professional and academic communities understanding to appreciate the connections fashion has with mathematics.

The United States currently has in place through the American Association of Family and Consumer Sciences (AAFCS), a certification process for secondary education students to test and receive a certificate of credentialing in respective areas under the Career and Technical (CTE) Carl Perkins Act, 2006. Currently, a certificate program exists in Fashion, Textiles, and Apparel (Giddings, 2013). Certification signals to industry that personnel have acquired not only a degree, but also a defined set of skills and knowledge. The benefits include secondary and post-secondary programs that lead to associates degrees, certificates, and industry-recognized credentialing (Threeton, 2007). Although this is a win-win situation for industry and employees both, there is no credentialing process beyond the associate degree level. Further investigation could possibly indicate a need to expand credentialing past a two year program and move into

professional credentialing after a four year program. This is a rich area of retail merchandising and marketing that merits further study.

The United States fashion industries facilitate employment opportunities for approximately four million people yearly (Hines & Bruce, 2007). However, it is crucial to highlight that FMM career tracks require knowledge of the latest business trends to include extensive business mathematics and problem-solving skills, as well as the ability to make appropriate decisions in difficult situations (Djelic & Ainamo, 1999). Djelic and Ainamo (1999) suggest that problem-solving skills acquired in mathematics studies are critical for individuals in merchandising and/or marketing in order to proactively solve current and future business projections. Likewise studies have also revealed that mathematics competencies are crucial for FMM and need to be incorporated in FMM curricula for ensuring improved employment opportunities as well as to prepare students for successful workforce entry (Chambers, Anderson, & Dunlap, 1986; Fombrun & Shanley, 1990; Ferguson & Souza, 2016).

Goals, standards, certifications, and mathematics skill development in FMM programs are all critical to success in the global workforce. University and college programs should continue study and evaluation in these areas to prepare and strengthen FMM coursework and employment opportunities for their clientele. This study indicates that there is much work to be done where industry and higher education institutes could benefit working together to build stronger programs and thus, more qualified employees.

Implications for Future Study

As a result of carrying out this study, several significant problems arose that support continued research in the FMM field. This study, focused on the East Central

Region of the United States, covered a five state area. It would benefit the greater retail

community to consider a larger sample of FMM students to include other regions across

the United States. This would allow a more complete examination to assess if FMM

students and FMM programs are systemically lacking in mathematical skill-sets or if

problems are limited to the east central region.

This study adopted the Mathematics Industry Test (MIT), copyrighted and

provided by Resource Associates, Inc. (2012), to measure proficiency in mathematics

focused on computation, proportional reasoning, measurement, and statistics/graphing.

Although the MIT was presented as having reliability and validity, there may be other

mathematics industry tests that reflect FMM students' mathematics proficiency in a

different manner. Many parent companies of department store chains and large

manufacturing textile and clothing construction plants have other mathematics industry

examinations, some commercial and others company-owned, that might be better suited

to measure FMM student proficiency of mathematics. Consideration of collaborating

with such stores and companies to administer these different tests may show different

results as well as help facilitate a possible change or improvement to FMM programs of

study.

In many cases, there is the assumption that FMM students are mathematically

prepared to enter college and university programs. The American College Test (ACT)

and Scholastic Aptitude Test (SAT) scores often indicate students who are at risk

mathematically. A related study in industry mathematics should be considered to search

for a correlation between students' mathematics test scores and their ACT or SAT score.

Such a study has the potential to shed light on areas of deficiency before entering a FMM program of study.

Criticism from journalists and academics concerning curriculum with educational facilities suggest there is a failure to appropriately alter business and FMM curricula to increase student competencies to equip them on marketing challenges (Ferguson, 2007). Some critics highlighted overemphasis on quantitative analysis rather than entrepreneurial activities to enhance the competencies to confront real-world business situations (Armstrong & LeHew, 2014). More research is needed regarding a strong mathematics background for FMM students and what the requirements should be for success both in fashion merchandising academics and in the fashion industry workforce. Despite job availability and increases in FMM programs, there seems to be a gap between the demands of industry and skilled entering FMM personnel. A possible cause for the gap is the lack of mathematics curriculum, in particular mathematics needed in FMM curricula, to meet the needs, demands, and challenges of industry.

This study did not query FMM participants concerning their perceptions of FMM mathematics. Longitudinal studies to include student thoughts and perceptions of mathematics within the FMM industry would be of great value to the research community. It would be of interest to determine how FMM students see mathematics fitting into their program of study and how they view its role in future retail positions. In addition, it would add strength to the field to have insight more clearly documented from retail industry experts on how the acquisition of classroom knowledge, internship experience, and work related professional knowledge connects with mathematics concepts necessary for success.

Conclusion

This study focused on the ability of both early program students (beginning mathematics coursework) and later program students (completed mathematics coursework) to complete a mathematics test which was used to determine their mathematics abilities related to retail concepts and ideas. Descriptive statistics found there were not significant differences between these two groups overall. One point that was alarming was that completing FMM students have not significantly advanced in mathematics during postsecondary studies in their FMM programs. Overall, this study determined that FMM students appear to be lacking in the mathematics skill-set needed to be successful in the fashion industry workforce.

It can also be surmised that the fashion industry may require a different mathematics skill-set than is currently being taught in postsecondary FMM programs. FMM programs may need to recognize the lack of mathematics stability among FMM students and revamp the FMM curriculum in the required mathematics coursework. Postsecondary higher education FMM programs may need to assess the mathematics competencies to align more closely with what industry indicates is needed for today's workforce.

This study certainly adds needed research to the field of fashion merchandising and fashion marketing. The findings, although concerning, help inform higher education programs and industry about mathematics deficiencies of future employees. It also provides evidence for future work to be carried out related to FMM programmatic changes, consideration of standards that align with societal and industry needs, and how mathematics fits into the fashion industry. Ultimately, programs should strive to produce

well-qualified graduates who can enter the global workforce and develop into leaders in the world of fashion.

REFERENCES

Adams, T., LaFramenta, J. (2014). *Math know-how: Answers to your most persistent teaching issues.* Thousand Oaks, CA: Corwin Press.

Anderson, P. (2001). *The Skills Gap 2001*. National Association of Manufacturers, Center for Workforce Success, Washington, DC.

Armstrong, C., & LeHew, M. (2014). Barriers and mechanisms for the integration of sustainability in textile and apparel education: Stories from the front line. *Fashion Practice*, *6*(1), 59-85.

Avery, C. E. (1989). Profiling the career development of women fashion merchandising graduates: A beginning. *Clothing and Textiles Research Journal, 7*(3), pp. 33-39.

Baker, S. (2004). Next trends in apparel retail, manufacturing, fashion & merchandising. *Just-Style.* December, 12-18.

Behrman, J. N., & Levin, R. I. (1984). Are business schools doing their job? *Harvard Business Review, 62*(1), 140-147.

Bergvall-Forsberg, J., & Towers, N. (2007). Creating agile supply networks in the fashion industry: A pilot study of the European textile and clothing industry. *Journal of the Textile Institute, 98*(4), 377-386.

Borin, N., & Metcalf, L. (2010). Integrating sustainability into the marketing curriculum: Learning activities that facilitate sustainable marketing practices. *Journal of Marketing Education, 32*(2), 140-154.

Breiner, J., Harkness, S., Johnson, D., & Koehler, C. (2012). What is STEM? A discussion about conceptions of STEM in education and partnerships. *School Science and Mathematics, 112*(1), 3-11.

Buckley, R., Peach, E., & Weitzel, W. (1989). Are collegiate business programs adequately preparing students for the business world? *Journal of Education for Business, 65*(3) 101-105.

Business Higher Education Forum (BHEF). (2011). Meeting the STEM workforce challenge: Leveraging higher education's untapped potential to prepare tomorrow's STEM workforce. *BHEF Policy Brief*. Retrieved from: http://www.bhef.com/sites/default/files/BHEF_2011_untapped_potential.pdf .

Buttle, F. (1993). Merchandising. *European Journal of Marketing*, *18*(6/7), 104-123.

Chambers, T. M., Anderson, P. F., & Dunlap, B. J. (1986). Preferences, intentions, and behavior of organizational buyers under different reward conditions. *Journal of Business Research*, *14*(6), 533-547.

Chandler, A. D. (1962). *Strategy and structure: Chapters in the history of the American enterprise.* Cambridge, MA: Massachusetts Institute of Technology Press.

Chandler Jr., A. D. (1993). Learning and technological change: The perspective from business history. In *Learning and Technological Change* (pp. 24-39). London: Palgrave Macmillan.

Chen, D., Heyer, S., Ibbotson, S., Salonitis, K., Steingrimsson, J. G., & Thiede, S. (2015). Direct digital manufacturing: definition, evolution, and sustainability implications. *Journal of Cleaner Production*, *107*, 615-625.

Claessens, A. & Engel, M. (2013). How Important Is Where You Start? Early Mathematics Knowledge and Later School Success. *Teachers College Record*, *115*(6), 1-29.

Cohen, A. C., Johnson, I., & Pizzuto, J. J. P. (2016). *JJ Pizzuto's fabric science swatch kit*. Upper Saddle River, NJ: Prentice Hall.

Community Report. (2012). Career and Technical Education. Retrieved July, 18, 2012, from, http://www.bsd405.org/portals/0/Departments/CTE/2011-2012-CTE-Community-Report.pdf

Creswell J. W. (2009). *Research design: Qualitative and quantitative approaches* (3rd ed.). Thousand Oaks, CA: Sage Publications.

Creswell, J. W. (2008). *Educational research: Planning, conducting, and evaluating quantitative and qualitative research* (3rd ed.). Upper Saddle River, NJ: Pearson Education.

Creswell, J. W. (2003). *Research design: Qualitative, quantitative and mixed methods approach* (2nd ed.). Thousand Oaks, CA: Sage Publications.

Djelic, M. L., & Ainamo, A. (1999). The coevolution of new organizational forms in the fashion industry: A historical and comparative study of France, Italy, and the United States. *Organization Science, 10*(5), pp. 622-637.

Dressel, P. L. (1968). The meaning of a college education: A set of competencies and a degree of attainment in each. *The Journal of Higher Education*, *39*(9), 481-489.

Ferguson, J. G. (2007). *Careers in focus: Fashion* (3rd ed.). New York, NY: Infobase, Ferguson Publishing.

Ferguson, M. E., & Souza, G. C. (Eds.). (2016). *Closed-loop supply chains: New developments to improve the sustainability of business practices*. Boca Raton, FL: CRC Press – Taylor and Francis Group.

Fiorito, S. S., & Fairhurst, A. E. (1989). Buying for the small apparel retail store: Job content across four merchandise categories. *Clothing and Textiles Research Journal*, *8*(1), 10-21.

Fombrun, C. & Shanley, M. (1990). What's in a name? Reputation building and corporate strategy. *Academy of Management Journal*, *33*(2), 233-258.

Francis, S. K., & Brown, D. J. (1985). Retail buyers of apparel and appliances: A comparison. *Clothing and Textiles Research Journal, 4*(1), 1-8.

Garner, M. B., & Buckley, H. M. (1988). Clothing and textiles curriculum content needed for success in fashion marketing careers. *Clothing and Textiles Research Journal*. *6*(3), 32-40.

Garrett, J. (2008). STEM: The 21st century Sputnik. *Kappa Delta Pi Record, 44*(4), 152-153.

Giddings, V. L. (2013). The AAFCS body of knowledge. (Unpublished PowerPoint presentation.) Greensboro, NC: North Carolina Agricultural and Technical State University.

Greenwood, K. M. (1981). *Directions in the development of fashion merchandising curriculum in the 80's*. Association of College Professors of Textiles and Clothing Combined Proceedings, 201-221.

Greenwood, C. R., Delquadri, J., & Hall, R. V. (1984). Opportunity to respond and student academic performance. In W. L. Heward, T. E. Heron, J. Trap-Porter, & D. S. Hill (Eds.), *Focus upon applied behavior analysis in education* (pp. 58-88). Columbus, OH: Merrill.

Gungor, E. (2014). Fashion design. SUNY: The State University of New York, Türkiye

      Ofisi. Retrieved from: http://www.suny.edu.tr/m/page.php?id=39

Han, H. (2003). *Vault Career Guide to the Fashion Industry*. New York, NY: Vault

      Incorporated.

Hapke, L. (2004). *Sweatshop: The history of an American idea.* New Brunswick, NJ:

      Rutgers University Press.

Hilton, B., Choi, C. J., & Chen, S. (2004). The ethics of counterfeiting in the fashion

      industry: Quality, credence and profit issues. *Journal of Business Ethics*, *55*(4),

      343-352.

Hines, T., & Bruce, M. (2007). *Fashion marketing: Contemporary issues* (2nd ed.).

      Burlington, MA: Elsevier.

IBM Corporation. (2013). IBM SPSS Statistics for Windows, Version 22.0. Armonk,

      NY: IBM Corp.

International Textile and Apparel Association. (2008). *ITAA four-year baccalaureate*

      program meta-goals 2008. Knoxville, TN: Author.

International Textile and Apparel Association. (2012). *Globalization*. Retrieved from:

      https://www.ctr.sagepub.com/content/29/2/16.ref

Jackson, T., & Shaw, D. (2000). *Mastering fashion buying and merchandising*

      management. London: Palgrave Macmillan.

Kean, R. C. (1985). Perceived importance of selected skills to a group of discount store

      buyers. *Clothing and Textiles Research Journal*, *4*(1), 31-37.

Kelly, D., Nord, C. W., Jenkins, F., Chan, J. Y. & Kastberg, D. (2013). *Performance of US 15-year-old students in mathematics, science, and reading literacy in an international context. First Look at PISA 2012*. NCES 2014-024. National Center for Education Statistics. Retrieved from:
http://files.eric.ed.gov/fulltext/ED544504.pdf

Kincade, D. H. (2010). *Merchandising of fashion products*. Pearson Education India.

Ko, E., & Megehee, C. M. (2012). Fashion marketing of luxury brands: Recent research issues and contributions. *Journal of Business Research,* 65(10), 1395-1398.

Kotsiopulos, A., Oliver, B., & Shim, S. (1993). Buying competencies: A comparison of perceptions among retail buyers, managers, and students. *Clothing and Textiles Research Journal, 2*(4), pp. 38-44.

Kulik, J. A., & Kulik, C. C. (1984). Effects of accelerated instruction on students. *Review of Educational Research*, *54*(3), 409-425.

Labov, J. B., Singer, S. R., George, M. D., Schweingruber, H. A., & Hilton, M. L. (2009). Effective practices in undergraduate STEM education part 1: Examining the evidence. *CBE-Life Sciences Education, 8*(3), pp. 157-161.

Laughlin, J., & Kean, R. C. (1995). Assessment of textiles and clothing academic programs in the United States. *Clothing and Textiles Research Journal. 13*(3), 184-199.

Lea-Greenwood, G. (1997). *Visual merchandising: Its role in corporate brand management*. Manchester: The Manchester Metropolitan University.

Lea-Greenwood, G. (1998). Visual merchandising: A neglected area in UK fashion marketing? *International Journal of Retail & Distribution Management, 26*(8), 324-324.

Lewis, T. (2005). Coming to terms with engineering design as content. *Journal of Technology Education, 16*(2), 37-54.

Meakin, K. (2010). *Are We Delivering the Best Practice Curriculum for a Degree in Visual Merchandising?* Retrieved from: http://arrow.dit.ie/aaschadpoth/2/

Moore, M., & Fairhurst, A. (2003). Marketing capabilities and firm performance in fashion retailing. *Journal of Fashion Marketing and Management: An International Journal, 7*(4), 386-397.

Nusbaumer, J. A. (2012). *Services in the global market*. New York, NY: Springer Science & Business Media.

O'Connell, W. & Moomaw, W. (1975). A CBC Primer: Competency Based Curricula in General Undergraduate Programs; Report of a Conference. Atlanta, GA: *Undergraduate Education Reform Project*.

Packard, E. & Guerriero, B. (1979). Becoming a buyer when the fashion bug bites. *Career World*, *26*(2), 26-27.

Packard, S., Winters, A. A., & Axelrod, N. (1983). *Fashion buying & merchandising*. New York, NY: Fairchild Publications.

Resource Associates, Incorporated. (2012). *Math Aptitude Test for Assessing Industrial Sector Candidates.* Retrieved from: https://www.resourceassociates.com/tests/math-for-industry-aptitude-test/

Resource Associates, Incorporated. (2015). *Online Assessment Tests Help You Make*

    Great Hiring Decisions. Retrieved from:

    https://www.resourceassociates.com/online-assessment-tests/

Ritter, T. (2003). Interorganizational relationships and networks: An overview. *Journal of*

    Business Research, *56*(9), 691-697.

Schoof, R. (2013). Math problems are a problem for job seekers, employers say.

    Retrieved from: https://www.mcclatchydc.com/news/nation-

    world/national/article24747688.html

Sears Archives (2014). *From the archives*. Retrieved from:

    https://www.searsarchives.com/catalogs

Sen, A. (2008). The US fashion industry: A supply chain review. *International Journal of*

    Production Economics, 114(2), 571-593.

Sheldon, G. (1986). Attitudes of retailers and college educators toward fashion retail

    internships. *Clothing and Textiles Research Journal*, *4*(2), 9-15.

Shirley, L. M. & Kohler, J. (2012). Clothing and textiles: Reinforcing STEM education

    through family and consumer sciences curriculum. *Journal of Family &*

    Consumer Sciences Education, *30*(2), 46-56.

Sproles, G. B. (1981). Analyzing fashion life cycles: Principles and perspectives. *The*

    Journal of Marketing, 45(4), 116-124.

Sweller, J. (1983). Control mechanisms in problem solving. *Memory and Cognition*,

    11(1), 32-40.

Sweller, J. & Cooper, G. A. (1985). The use of worked examples as a substitute for

    problem solving in learning algebra. *Cognition and Instruction, 2*(1), 59-89.

Taba, H., & Taba, H. (1962). *Curriculum development: Theory and practice* (No. 37.013 TAB).

Tamilia, R. D. & Reid, S. E. (2007). Technological innovation and the rise of the department store in the 19th century. *International Journal of Technology Marketing*, *2*(2), 119-139.

Thorndike, R. M. & Thorndike-Christ, T. (2010). Measurement and Evaluation in Psychology and Education (8th ed.). Upper Saddle River, NJ: Pearson.

Threeton, M. D. (2007). The Carl D. Perkins Career and Technical Education (CTE) Act of 2006 and the Roles and Responsibilities of CTE Teachers and Faculty Members. *Journal of Industrial Teacher Education*, *44*(1), 66-82.

Tyler, R. W. (1949). *Basic principles of curriculum and instruction*. Chicago, IL: University of Chicago Press.

Wedege, T. (1999). To know or not to know – mathematics, that is a question of context. *Educational Studies in Mathematics, 39*(1), 205-227.

Winakor, G. (1988). Research in fashion merchandising – The need for a theoretical base. *Clothing and Textiles Research Journal, 7*(1), pp. 31-35.

Yu, H. & Jin, B. (2005). Enhancing international dimensions in apparel and merchandising curricula in the USA: A practitioner's perspective. *Journal of Fashion Marketing and Management, 9*(2), 232-243.

Zevenbergen, R. J. (2011). Young workers and their dispositions towards mathematics: Tensions of a mathematics habitus in the retail industry. *Educational Studies in Mathematics*, 76 (1), 87-100.

APPENDICES

APPENDIX A

Old Dominion University
College of Education
STEM ED. And Prof. Studies
228 Education Building
Norfolk, VA 23529-0157
(757) 683-4305

INFORMATION LETTER for a Research Study entitled:
Mathematics Proficiency of Fashion Marketing/Merchandising Students

You are invited to participate in a research study to examine the mathematics proficiency of fashion marketing/merchandising students early in their program of study as well as later in the program. This study is being conducted by Christina Miles, a doctoral candidate at Old Dominion University and her advisor, Mary C. Enderson, a faculty in the College of Education. You are selected as a potential participant because you are in a fashion program that agreed to participate in this study.

If you decide to participate in this research, you will be asked to complete a math test that consists of approximately 40 items of which should take you anywhere from 15 min. to one hour to complete. There are no foreseen risks associated with participating in this study. Although there are no direct benefits of participating in this study, findings from this study are hoped to increase our understanding of mathematics achievement in fashion programs across the United States.

Any data obtained in connection with this study will remain anonymous. Information collected through your participation may be presented at professional meetings and published in professional journals.

Your participation is completely voluntary. If you choose to withdraw in the middle of the test, you can stop completion of the test, mark a big X across the scantron, and either submit it or throw it away. Your decision about whether or not to participate or to stop participating will not jeopardize your outcome for the class in which the test is presented. Once you have submitted anonymous data, it cannot be withdrawn due to it being unidentifiable.

By completing the paper copy of the test that is distributed in your class, you are saying several things. You are saying that you have obtained the information contained in this letter and you are satisfied that you understand the information presented and you agree to participate in this study. If you have any questions throughout this study, the researchers should be able to answer them:

> Christina G. Miles by email, cmile006@odu.edu or telephone, (757) 572-4599
> Mary Enderson by email, menderso@odu.edu or telephone, (757) 683-5580

If at any time you feel pressured to participate, or if you have any questions about your rights, then you should call Dr. George Maihafer, the current IRB chair, at 757-683-4520, or the Old Dominion University Office of Research, at 757-683-3460.

NOW YOU MUST DECIDE IF YOU WANT TO PARTICIPATE IN THIS RESEARCH PROJECT. IF YOU DECIDE TO PARTICIPATE, THEN COMPLETE THE MATHEMATICS TEST THAT YOU RECEIVE AND SUBMIT ALL ANSWERS ON THE SCANTRON PROVIDED FOR YOU.

THANK YOU!

APPENDIX B

MATH TEST FOR INDUSTRY
INSTRUCTION PAGE
(Note that the test is not provided here in order to preserve the security of the instrument.
The cover page of this test with examples is provided for general information.)

Resource Associates, Inc.
MATH TEST FOR INDUSTRY© (VER. MCQ-1B)

Please confirm that the number on the top of the test booklet is the same as the number in the "Name" section of your Scantron sheet. If it is not, please notify your instructor now.

This test includes 40 math problems. Please choose the **one best answer** for each question by *marking the answer for each question at the corresponding number on the Scantron sheet*. You have one hour to complete all items on this test. Work quickly but carefully. You are free to use the extra space on your test copy sheet for working out your problems. **You are NOT allowed to use calculators during this test.**

Please complete all the problems on the test. Be sure to ask any questions before the test begins.

Example A: What is the weight of a case of 10 shelf units if each unit weighs 32 pounds? (a) 310   (b) 300   (c) 280   (d) 320   (e) 640
Example B: What will an employee make if there were 40 hours worked at $8.50 per hour, plus 6 hours worked at $11.25 / hour. (a) $407.50   (b) 410.00   (c) 378.50   (d) $408.50   (e) 417.50
Example C: What is the overall length of two (2) panels where each is 2 $3/4$ feet long? (a) 5 ¼   (b) 5 ¾   (c) 5 ½   (d) 4 ½   (e) 4 ¼

EXPLANATION OF THE PROBLEMS:

A. Multiply 10 x 32 = 320 lbs.

B. 40 hrs. at $8.50 = $340 and 6 hrs. at $11.25 = $67.50, so $340 + $67.50 = $407.50.

C. Multiply 2 x 2 $3/4$ = 4 $6/4$ which reduced to its lowest terms = 5 $1/2$ ft.

Do not turn the page until you are told to do so.

APPENDIX C

DEMOGRAPHIC GENERAL INFORMATION

General Information:
1. **Age**
   _____18 – 25
   _____26 – 35
   _____36 – 45
   _____46 – 55
   _____56 – 65
   _____Over 65

2. **Sex**
   ____ Male
   ____ Female

3. **What is your ethnicity?**
   _____Caucasian
   _____Hispanic/Latino
   _____African American
   _____Multiracial
   _____Other
   _____Native American
   _____I prefer not to answer

4. **Please describe your highest educational background.**
   _____GED
   _____High School Diploma
   _____Bachelor's Degree
   _____Skilled Trade
   _____Master's Degree
   _____Other Professional Degree

APPENDIX D

TABLE OF SPECIFICATIONS FOR MATHEMATICS INDUSTRY TEST (MIT)

	Number & Computations	Ratio & Proportional Reasoning	Measurement	Statistics (Graphing)
Item Numbers	1, 2, 3, 4, 5, 9, 10, 37, 38, 39	11, 12, 13, 14, 15, 21, 27, 29, 40	16, 17, 18, 19, 20, 22, 23, 24, 25, 26, 28, 30, 31	6, 7, 8, 32, 33, 34, 35, 36
TOTAL ITEMS	10	9	13	8

VITA

CHRISTINA GORDON MILES

STEM Education and Professional Studies
Old Dominion University
Norfolk VA 23592
cmile006@odu.edu
+1 757 683 4305

3160 Little Haven Road
Virginia Beach, Virginia 23452
cgmiles@aol.com

Education

- PhD, 2016, Occupational & Technical Studies, Old Dominion University, Norfolk, VA
- MS, 2008, Occupational & Technical Studies, Old Dominion University, Norfolk, VA
- BS, 1976, Vocational Home Economics and Business, Ball State University, Muncie, IN

Professional Affiliation

- International Textiles and Apparel Association (ITAA)
- American Association of Family and Consumer Science (AAFCS)
- Association for Career and Technical Education (ACTE)
- Virginia Association of Family and Consumer Science (VAFACS)
- Virginia Marketing Education
- Phi Beta Omicron – Professional Business and Professional Women
- Golden Key International Honor Society

Professional Experience

- Old Dominion University, Norfolk, VA, Adjunct Instructor, Fashion Merchandising
- Virginia Beach City Public Schools, Virginia Beach, VA, Family and Consumer Science Instructor, Retired
- Fairfax County Public Schools, Fairfax, VA, Alternative Education Teacher
- Macy's Department Stores, Inc., Washington, D. C., Homewares Buyer
- International Monetary Fund/World Bank, Washington, D. C., Loan Manager
- United States Air Force, Tinker Air Force Base, Oklahoma City, OK, Officer

References available upon request