A Study on the Mediating Role of Mathematics Anxiety in the Influence of Self Efficacy on Mathematics Skills of College Students Majoring in Hospitality Management

Min-Jung Kim[1] · Hyun-Jung Kim[2] · Dong-Jin Kim[¶]

Dept. of Hospitality and Tourism Management, Purdue University[1]
Dept. of Hotel and Tourism, Daegu University[2]
School of Food Science, Yeungnam University[¶]

호텔·레스토랑 전공 대학생들의 자기효능감과 수학실력의 관계에서 수학불안의 매개역할에 관한 연구

김민정[1] · 김현정[2] · 김동진[¶]
퍼듀대학교 호텔관광경영학과[1] · 대구대학교 호텔관광학과[2] · 영남대학교 식품학부[¶]

Abstract

This study examines the role of mathematics anxiety as a mediator between self efficacy and mathematics skills using a series of regression analyses suggested by Baron RM & Kenny DA(1986). The participants include college students who enrolled in the Food Service Production and Operation course in a department of hotel and restaurant management at a college in the United States. Descriptive analysis, principal component analysis, reliability test, and a series of regression analyses were used for data analysis using SPSS 19.0. In order to collect data for the study, General Self Efficacy Scale(GSES) and Math Anxiety Rating Scale(MARS) were utilized, and they turned out to be reliable(α=.906 and α=.890, respectively). A significant negative relationship was found between self efficacy and mathematics anxiety. In addition, it was found that self-efficacious students performed better mathematics skills than those who had lower level of self efficacy. However, the relationship was no longer significant when the concept of mathematics anxiety was added, which satisfies the condition of mediation.

Key words: mathematics anxiety, self efficacy, mathematics skills, mediation effect, culinary student

Ⅰ. INTRODUCTION

As the hospitality industry began to develop in 1970s, the industry enjoyed tremendous growth which was one of the primary reasons for the explosion in hospitality programs. Despite increased enrollment levels in hospitality programs, the in-dustry is still facing a shortage of qualified managerial workers(Enz CA 2004; Ward JB 2001). The success of a hospitality manager relies not only on quality of tangibles and services they provide, but also on sound financial management skills they possess(Schmidgall R et al 2002). In this sense, well educated, well trained, and skilled students

¶ : 김동진, 053-810-2959, dj-kim@ynu.ac.kr, 경북 경산시 대동 214-1번지 영남대학교 식품학부

are the highly desirable source of talent in today's hospitality job market(Lu T · Adler H 2009). Generally, there are five domains of management knowledge that hospitality students learn from college: financial, human resources, marketing, information, and production and operations management(Chen BH et al 2012). Among these, financial management is likely to be one of the most challenging study area to hospitality students in which mathematics skills are required for its successful achievement. It is not arguable that a comprehension of mathematics is essential in order to understand the basic principles of accounting and financial management.

As future hospitality managers, hospitality students' mathematics skills are essential for their success in the completion of their college degrees as well as for future careers. Quantitative courses are required in the curriculums of hospitality major including hospitality accounting, hospitality industry financial analysis, purchasing for hospitality organizations, revenue management in hospitality organizations, and more. Without sufficient mathematics skills, hospitality students face with potential failure of these required courses for their degrees. In addition, mathematics skills are necessary for successful hospitality operations because the ability to compute labor and material costs is a basic requirement for hospitality managers to manage accounting/finance-related work in operation. Thus, it is critical for hospitality students to improve their mathematics skills in order to meet the needs of the hospitality industry.

Unfortunately, however, many graduates of college hospitality programs do not have enough knowledge in arithmetic(Betz NE 1978; Johnson SB 2003). The major reasons for the lack of mathematics skills are closely related to self efficacy and math anxiety. Self efficacy is a self-belief on one's own capabilities to achieve cognized goals. Despite the same knowledge and skills on mathematical ability, students perform differently on mathematics depending on the level of their self efficacy(Bandura A 1993). In addition, the prevalent mathematics anxiety that are experienced by college students have shown great interests in the determinants of mathematics performance of students(Johnson SB 2003). Betz NE(1978) and Hembree R(1990) also supported that mathematics anxiety level negatively affects mathematics skills. Because hospitality educators need to motivate and assist students to prepare for future careers in the hospitality industry(Lu T · Adler H 2009), understanding these factors(i.e., self efficacy and mathematics anxiety) that influence students' learning attitudes is critical for educators to improve their teaching performance as well as for academic institutes to gain insight into the education(Chen BH et al 2012).

Although the relationship among mathematics anxiety, self efficacy, and mathematics skills were suggested in the previous literature, it has rarely been investigated in college hospitality programs. Considering the importance of mathematics skills of future hospitality mangers in their career pursue as mentioned above, it is imperative to study the relationship among the constructs. Thus, the purpose of the study is to investigate the relationship among self efficacy, mathematics anxiety, and mathematics skills of college students in hospitality major. Specifically, the current study tries to examine the mediating role of mathematics anxiety on the relationship between self efficacy and mathematics skills. It is possible that a hospitality student with high self efficacy may perform poorly on mathematical skill due to the high level of

mathematics anxiety. Therefore, the mediating role of mathematics anxiety on the relationship between self efficacy and mathematics skills is examined. The results of the study are expected to provide hospitality educators with practical implications about how to improve hospitality students' math skill.

Ⅱ. LITERATURE REVIEW

1. The Relationship between Self Efficacy and Academic Performance

Most educators agree that there are various factors affecting any given student's level of academic achievement. The concept of self efficacy is one of the most important factors that affect academic achievements. Zimmerman BJ & Kitsantas A(2005) reported that "self efficacy refers to beliefs about one's capability to learn or perform effectively, and self efficacy for learning refers to beliefs about using self-regulatory processes, such as goal setting, self-monitoring, strategy use, self-evaluation, and self-reactions to learn(p.398)." Stated differently, self efficacy is described as one's personal judgments of their ability to complete course works successfully and to achieve their goals(Bates MV 2007). In short, self efficacy can be defined as the the belief in one's capabilities to achieve desired goals.

Since the concept of self efficacy is closely related to self-regulation of learning, it is frequently studied in connection with self-regulation and turned out to play a crucial role in motivating students(Pajares F·Schunk DH 2001). According to Bandura A(1997), self-efficacious students tend to set higher goals for themselves and work more diligently to achieve their goals than those who doubt their personal capability. Bandura A(1997) also re-

ported that self efficacy is a significant factor to facilitate a student's goal achievement. Bates MV (2007) stated that self efficacy contributes to academic performance of a student by stimulating the motivation for success. Other related studies (Cooper SE·Robinson DAG 1991; Randhawa BS et al 1993) also provided evidences on the relationship between self efficacy and mathematics performance.

2. The Role of Mathematics Anxiety

According to Richardson FC & Suinn RM(1972), mathematics anxiety can be defined as "feeling of tension and anxiety that interfere with the manipulation of numbers and the solving of mathematical problems in a wide variety of ordinary life and academic situations(p.552)." This anxiety is a pronounced problem that causes incapable conditions and mathematics deficiency. As mentioned earlier, educators indicated that a number of college students perceive mathematics anxiety(Betz NE 1978; Waycaster P 2001; Johnson SB 2003). Earlier studies found that mathematics anxiety has a strong negative impact on mathematics performance(Betz NE 1978; Fennema E·Sherman VA 1978; Goldman RD·Hewitt BN 1976; Sherman V· Fennema E 1977). It is difficult for students with mathematics anxiety to concentrate and, consequently, academic performance measures reflect inaccurate learning.

It is important to note that it is not difficult to find a student with high self-efficacy still perform poorly on mathematics skills. To understand this phenomenon, we need to examine the relationship among self efficacy, mathematics anxiety, and mathematics skills. Because self efficacy is negatively related to mathematics anxiety(Cooper SE ·Robinson DAG 1991), it is plausible that the

positive effect of self efficacy on mathematics skills is significantly reduced as mathematics anxiety overrides the effect due to its negative relationship with mathematics skills. After integrating 151 studies related to mathematics anxiety using a meta-analysis approach, Hembree R(1990) concluded that mathematics anxiety depresses mathematics performance while it is negatively related to self efficacy. Therefore, this study posits that mathematics anxiety mediates the relationship between self efficacy and mathematics skills. Hypothesis 1 is established as such;

H1: Mathematics anxiety mediates the relationship between self efficacy and mathematics skills.

Ⅲ. METHODS

1. Procedure and Instrumentation

This study adopted a self-administered questionnaire method in order to fulfill the purpose of the study. The target population of the study was college students in the department of hotel and restaurant management in the United States. A convenience sampling was utilized to select a college to conduct the survey. The participants were students who enrolled within Food Service Production and Operation course in the department of hotel and restaurant management at a college in the southern part of the United States. Camp C(1992) claimed that the relationship between self efficacy and mathematics performance could differ in terms of the course format(i.e., lecture and lab courses). Thus, this particular course(Food Service Production and Operation) was selected because students enrolled in the course participated both in lecture and in laboratory. The college offered multiple classes for the course and a total of 150 students participated in the study.

The questionnaire utilized in the study was composed of four main sections. The first section asked participants about personal information such as gender, age, grade, and enrollment status. The second section examined the level of anxiety towards mathematics and a modified version of the Math Anxiety Rating Scale(MARS) was given, using a 5- point Likert-type scale, 1 indicates no anxiety and 5 indicates high level of anxiety. The third section of the survey assessed mathematics skills. Mathematics questions included six items which were basic algebra, order of operations, percentage, averaging, cost of goods sold, and food cost percentage. The answers were coded using a binomial scale of 0 and 1. It was coded as 1 when the respondent provides a right answer to each question. Thus, the mathematics skill score could vary from 0 to 6 in this study. The last section adopted General Self Efficacy Scale(GSES) developed by Jerusalem M & Schwarzer R in 1979, a 4-point Likert-type scale, to measure respondents' self efficacy. In this section, 1 indicated the statement is not true at all and 4 indicated the statement is exactly true.

As measurement items for self efficacy, the German version of General Self Efficacy Scale (GSES) is used in this study. It is developed by Jerusalem and Schwarzer in 1979. A measure of self efficacy is designed to measure individual's positive self-beliefs in their personal capability to overcome daily hassles(Schwarzer R·Jerusalem M 1995). In terms of mathematics anxiety, a modified version of the Math Anxiety Rating Scale(MARS) is adopted from the study of Ward(2001). The original version of MARS is developed by Richardson FC & Suinn RM in 1972. The original version contains 98 questions using a 5-point Likert-type scale. The MARS has been widely

used in the studies related to mathematics anxiety(e.g., Dew KM et al 1984; Llabre MM.·Suarez E 1985; Wadlmgton E et al 1992; Ward JB 2001) and some of them utilized shortened versions of the MARS.

2. Research Model and Data Analysis

As stated earlier, this research attempts to test the mediating role of mathematics anxiety in the influence of self efficacy on mathematics skills. The research model is presented in <Fig. 1>.
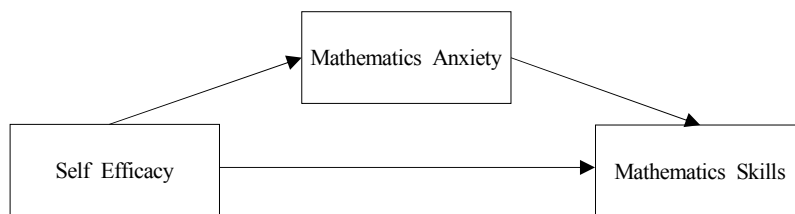
In terms of testing the mediating role of mathematics anxiety in the influence of self efficacy on mathematics skills among hospitality students, this study utilizes a series of regression models suggested by Baron RM & Kenny DA(1986). The logic of this relationship is that self efficacy affects mathematics anxiety, which in turn affects mathematics skills. Baron RM & Kenny DA(1986) suggested a series of regression analyses for mediational research in the realm of social sciences, which has been widely accepted in the related disciplines. Firstly, mathematics anxiety is regressed on self efficacy. Then, mathematics skills are regressed on self efficacy. Finally, mathematics skills are regressed on both self efficacy and mathematics anxiety. According to them, the following conditions must be satisfied in order to establish mediation. First, self efficacy must be shown to affect mathematics anxiety. Second, self efficacy must affect mathematics skills in the second regression analysis. Third, mathematics anxiety must affect mathematics skills in the third analysis. Finally, the effect of the self efficacy on mathematics skills must be less in the third regression analysis than in the second. The proposed research model delineates the mediating role of mathematics anxiety on the relationship between self efficacy and mathematics skills. This study utilizes statistical analyses using SPSS 19.0, including descriptive analysis, principal component analysis, reliability test, and regression analysis.

Ⅳ. FINDINGS

1. Demographic Characteristics of the Participants

The participants of the study include college students, majoring in hotel and restaurant management, enrolled within Food Service Production and Operation course. This course was specifically selected because students participated both in lecture and in laboratory. Demographic characteristics of the participants are presented in <Table 1>. As shown, there were more female participants(56.0%) than male participants(44.0%). The participants consisted of 20.0% of 17 to 19 years old students, 42.0% of 20 to 21 years old students, and 38.0% of 22 years old or older students. In terms of the grade, there were 13.3% of freshman, 26.0% of

〈Fig. 1〉 **Research Model**

⟨Table 1⟩ **Demographic characteristics of the participants**

Variables	Frequency(n=150)	Percentage
Gender		
Male	66	44.0
Female	84	56.0
Age		
17-19	30	20.0
20-21	63	42.0
22 or older	57	38.0
Grade		
Freshman	20	13.3
Sophomore	39	26.0
Junior	61	40.7
Senior	30	20.0
Enrollment Status		
Full-time	144	96.0
Part-time	6	4.0

sophomore, 40.7% of junior, and 20.0% of senior. On the other hand, the majority(96%) were enrolled full-time.

2. Results of Principal Component Analysis and Reliability tests

In the current study, GSES which containing 21 measurement items was utilized as the survey instrument to examine students' level of self efficacy. It was measured using a 4-point Likert-type scale; 1 indicates the statement is not true at all and 4 indicates the statement is exactly true. A principal component analysis was utilized to identify the validity of the intended construct. The results showed that all the factor loadings were higher than .40. An internal consistency reliability was .906 which confirms that the measurement is reliable.

In addition, students' mathematics anxiety was measured by a modified version of MARS using a 5-point Likert-type scale(1=none, 5=high level). The results of a principal component analysis showed that all factor loadings were higher than .40. An internal consistency reliability rated .890

indicating the reliability of the measurement items.

In terms of mathematics questions, most students were good at percentage(n=147, 98.0% of right answers), basic algebra(n=146, 97.3% of right answers), and order of operations(n=141, 97.3% of right answers). However, students performed poorly on averaging(n=107, 71.3% of right answers) followed by food cost percentage(n=114, 76.0% of right answers), and cost of goods sold(n=126, 84.0% of right answers).

3. Mediating role of Mathematics Anxiety

In this study, a series of regression analyses was adopted to test the mediating role of mathematics anxiety in the influence of self efficacy on mathematics skills, which was suggested by Baron RM & Kenny DA(1986). The results of regression analyses are presented in ⟨Table 3⟩.

Firstly, mathematics anxiety was regressed on self efficacy. The result showed that self efficacy had a significant negative impact on mathematics anxiety(β=-.165, t=-2.041, p<.05). Secondly, mathematics skills were regressed on self efficacy. Likewise, the effect of self efficacy on mathe-

〈Table 2〉 **Variables used in the study**

Construct	Variable	Factor loadings	Statistics
Self Efficacy (α=.906; 60.228%[c])	I can always manage to solve difficult problems if I try hard enough	0.560	3.21±0.72[a]
	If someone opposes or is against me, I can find a way to get what I want	0.436	2.92±0.75
	It is easy for me to stick to my plans and accomplish my goals	0.662	3.12±0.70
	I am confident that I could deal efficiently with unexpected events	0.727	3.25±0.64
	Thanks to my resourcefulness and ability to Figure things out, I know how to handle unexpected or unforeseen situations	0.676	3.21±0.65
	I can solve most problems if I invest the necessary effort	0.657	3.37±0.66
	I can get what I want from people if I make them feel sorry for me	0.411	2.23±0.87
	I can remain calm when facing difficulties because I rely on my coping abilities	0.424	2.99±0.83
	When I am confronted with a problem, I can usually find several solutions	0.781	3.13±0.69
	If I am in trouble, I can usually think of a solution	0.740	3.28±0.61
	I can usually handle whatever comes my way	0.813	3.27±0.65
	I spend time identifying long-range goals for myself	0.645	3.08±0.72
	If I want something from someone I should have a positive attitude	0.702	3.37±0.68
	I feel in charge of making things happen	0.737	3.31±0.66
	I feel responsible for my own life	0.760	3.61±0.63
	I feel driven by my personal values	0.778	3.61±0.57
	I am driven by a sense of purpose	0.718	3.53±0.65
	Most things happen to me because I am lucky	0.401	2.28±0.96
	I am able to choose my own actions	0.733	3.51±0.60
	I focus my efforts on things that I can control	0.651	3.39±0.63
	There are abundant opportunities that await me	0.600	3.56±0.63
Mathema-tics Anxiety (α=.890; 62.214%[c])	Given a different homework assignment	0.573	2.95±1.11
	Reading and interpreting graphs or charts	0.658	2.36±1.05
	Registering for a course in math or accounting	0.777	2.33±1.19
	Thinking about an upcoming math or accounting test	0.724	3.17±1.22
	Walking into a math or accounting class	0.828	2.25±1.18
	Starting a new chapter in a math or accounting book	0.847	2.25±1.13
	Taking a quiz in a math or accounting course	0.501	3.00±1.86
	Studying for a math or accounting test	0.808	2.92±1.19
	Picking up your book to begin work on an assignment	0.850	2.37±1.13
	Being given a pop quiz in a math or accounting class	0.723	3.21±1.17
	Reading a math or accounting formula	0.849	2.47±1.13
	Listening to lecture in a math or accounting class	0.782	2.15±1.04
	Waiting for the results of your math or accounting test	0.697	3.26±1.24
	Taking a final examination in a math or accounting class	0.405	3.73±2.59
Mathematics Skill	Basic algebra		0=4, 1=146[b]
	Order of operations		0=9, 1=141
	Percentage		0=3, 1=147
	Averaging		0=43, 1=107
	Cost of goods sold		0=24, 1=126
	Food cost percentage		0=36, 1=114

a: mean±standard deviation; b: 0=incorrect, 1=correct; c: total variance explained

matics skills was statistically significant(β=.159, t=1.958, p<.10). Finally, mathematics skills are regressed on both self efficacy and mathematics anxiety. It was found that mathematics anxiety negatively affected mathematics skills(β=-.231, t=-2.876, p<.01). On the other hand, the result

〈Table 3〉 **Testing the mediation role of mathematics anxiety**

Model	B	Std. error	β	t	Tolerance	VIF
1. Regression of MA on SE					-	-
Constant	3.877	0.559	-	6.933***		
Self Efficacy	-0.354	0.173	-0.165	-2.041**		
2. Regression of MS on SE					-	-
Constant	3.908	0.668	-	5.847***		
Self Efficacy	0.406	0.207	0.159	1.958*		
3. Regression of MS on SE and MA					0.973	1.028
Constant	4.978	0.751	-	6.627***		
Self Efficacy	0.308	0.205	0.121	1.502		
Mathematics Anxiety	-0.276	0.096	-0.231	-2.876***		

* p<.10, ** p<.05, *** p<.01

showed that self efficacy had no impact on mathematics skills(β=.121, t=1.502), which was significant in the second regression equation. This finding implies that the significant relationship between self efficacy and mathematics skills is no longer hold when the concept of mathematics anxiety is considered simultaneously, which satisfies the condition of mediation suggested by Baron RM & Kenny DA(1986). Therefore, hypothesis 1 is supported.

V. CONCLUSIONS

This study investigates if the concept of mathematics anxiety plays a role in mediating the effect of self efficacy on mathematics skills. In the first regression analysis, a significant negative relationship was found between self efficacy and mathematics anxiety. This result is consistent with the findings by Betz NE(1978) and Hembree R(1990). Higher levels of self efficacy were associated with lower level of mathematics anxiety.

In the second regression analysis, it was found that self-efficacious students perform better mathematics skills than those who have lower level of self efficacy. However, the relationship was no longer significant when the concept of mathe-

matics anxiety was added. According to Baron RM & Kenny DA(1986), finding no significant relationship between self efficacy and mathematics skills after mathematics anxiety addition confirms that mathematics anxiety is a mediator of the relationship between self efficacy and mathematics skills.

The findings of this study suggests that hospitality students have a high level of anxiety toward math subject, and students' level of mathematics anxiety and their confidence impacted on mathematics performances. In other words, the level of mathematics anxiety inhibits students from improving math skill. Since mathematics anxiety is a pronounced problem in hospitality students, it is imperative that instructors are aware of their roles in motivating students. Specifically, instructors must be aware of their impact on the levels of performance that students display with regards to mathematics. They should be willing to commit the time to assist with student academic performance. Student academic performance would increase if instructors encourage individuals and give confidence to them.

Several recommendations to reduce students' mathematics anxiety are provided as follows. First, institutes should provide a training session for in-

structors to increase their sensitivity to student mathematics anxiety(Johnson SB 2003). The training session should address the appropriate ways to enhance their own communication styles and sensitivity to students' feelings. Second, instructors need to utilize examples and illustrations to motivate students and adjust curriculum based on students' learning process(Chen BH et al 2012). Third, group learning method is a good way to improve students' learning performance in which students with good performance team up with students with poor performance(Chen BH et al 2012). Fourth, students should be encouraged to be well-prepared before class and review after class to boost their confidence on mathematics. Finally, students should be aware of their responsibilities for poor mathematics performance. They are to be informed that anxiety cannot be an excuse for poor performance and taking time and effort on mathematics leads toward success in this subject(Johnson SB 2003).

Understanding student perception is crucial for tactical evaluation of classroom performance(Duke C·Reese R 1995). Therefore, instructors need to realize that students need education as a path to successful academic performance and career goals. Instructors need to be reminded the competencies (analytical thinking, math performance, and problem solving) they are teaching today have a direct impact on the success of a potential future manager in the hospitality industry.

This study has several limitations. Thus, care should be taken in interpreting the results. First of all, this research was restricted to undergraduate students enrolled in Food Service Production and Operation course in one college. Also, the limited sample size(n=150) prohibits generalizing the findings to all college hospitality students. This re-

search confirmed that mathematics anxiety perceived by students compounds the effects in students' academic performances. However, it does not include techniques that facilitate the alleviation of mathematics anxiety. Therefore, it would be desirable if techniques that can remedy mathematics anxiety are investigated in the future study.

한글 초록

본 연구는 호텔·외식을 전공하는 대학생들의 자기효능감과 수학실력의 관계에서 수학불안이 갖는 매개역할을 조사하기 위해 수행되었으며, 이를 위해 Baron RM과 Kenny DA(1986)가 제시한 3단계에 걸친 일련의 회귀분석을 실시하였다. 본 연구는 미국 특정 대학 내 조리 관련 과목을 수강하고 있는 호텔·레스토랑 학과 학생들을 대상으로 진행되었다. 자료분석을 위하여 SPSS 19.0을 이용한 기술통계, 주성분분석, 신뢰도분석, 회귀분석이 사용되었다. 자료수집을 위해 자기효능감척도(GSES)와 수학불안척도(MARS)가 이용되었으며, 신뢰도분석 결과 내적일관성이 각각 α=.906과 α=.890으로 신뢰도가 높은 것으로 나타났다. 분석결과 자기효능감은 수학불안에 유의적인 음의 영향을 미치는 것으로 나타났다. 또한 자기효능감이 높은 학생들은 낮은 학생들에 비해 수학실력이 높은 것으로 나타났다. 그러나 수학불안을 매개변수로 포함하여 분석한 결과 자기효능감이 수학실력에 미치는 영향은 유의적이지 않은 것으로 나타나 자기효능감과 수학실력 사이에 수학불안이 미치는 매개효과가 밝혀졌다.

Appendix

Mathematics Questions
1. Find the value of "x" if $10 + 5x = 60$
2. What is the value of $7 + (14 \times 3) - 4$?
3. What is 25% of 200 ?

4. You have three test scores of 80, 75, and 65. What grade will you need to receive on your fourth exam to finish with a 70 average for the course?

5. Beginning Inventory = 20,000, Purchase = 30,000, Ending Inventory = 10,000

What is the cost of goods sold?

6. If food cost is $6.00 and food sales are $24.00, what is the food cost percentage?

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