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**The Impact of Personal and Service-Related Factors on the Perceived
Academic Success Among College Students**

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Abstract

In recent years, student completion of the first year and second-year college curriculum has become a significant barrier to student success and retention especially at Historically Black Colleges and Universities. Despite low pass and retention rates, many degree programs in the U.S. require at least one college-level mathematics course, and the failure in this math course has contributed disproportionately to the failure to complete the first- and second-year curriculum.

The purpose of this study was to examine the predictability of the relationship between selected personal, academic, and service-related factors and the perceived academic success in mathematics among college students. Specifically, this study was concerned with the predictive power of the variables gender, ethnicity, course schedules, degree program, type of instructional

method, tutoring, advisement, and faculty mentoring on the perceived academic success in math among college students.

The present study provides pertinent data on the significant association between personal characteristics of college students and their academic performance in mathematics. By being able to identify the personal characteristics of these college students who are not successful in math courses, the institution will be able to develop programs to assist them in enhancing their academic performance in mathematics. Also, this study enhances college administrators' level of awareness of how student support service factors influence the academic achievement of college students in mathematics related courses. By understanding how these factors are related administrators on college campuses can develop insight into the type of service support college students will need to navigate mathematics courses, particularly at the freshman and sophomore levels.

Introduction

In recent years, student completion in the first year and second-year college mathematics curriculum has become a significant barrier to student success and retention. Despite low pass rates, many degree programs in the United States require at least one college-level mathematics course (Brathwaite et al. 2020; Ganga & Mazzariello, 2018; Ngo & Kwon, 2014). For example, college algebra is a course embedded in every degree plan in Texas' four-year and two-year colleges and universities. At these institutions, nearly half of the students enrolled in college algebra fail, withdraw, or receive incompletes due to several reasons (Ganga & Mazzariello, 2018; Gewertz, 2018; Gonzalez-Muniz et al., 2012; Saxe & Braddy, 2015).

One entry-level math course that serves as a core prerequisite is college algebra I (Nguyen, 2014). Students enroll in college algebra based on several factors such as completion of a remedial mathematics program, completion of algebra I and algebra II in high school, college placement exam scores, or standardized aptitude tests scores (Poulsen, 2019; Wilder, 2013). Scholars nicknamed college algebra as a gateway course due to its requirement in numerous undergraduate degree plans (Gonzalez-Muniz et al., 2012; Ichinose & Clinkenbeard, 2016). This epithet stems from the high number of students who receive a grade of D or F grades (Gonzalez-Muniz et al., 2012) or withdraw from the course-abbreviated as DFW (Acee et al., 2017). Research documented the nationwide DFW rate as high as 50%, while several institutions report a considerably higher rate (Gonzalez-Muniz et al., 2012; Harrell & Lazari, 2020; Saxe & Braddy, 2015). The American Mathematical Association of Two-Year Colleges (2018) reported consistent results concerning low college algebra success outcomes at large 4-year as well as small 2-year institutions. Low success outcomes have costly effects on the student as well as the institution. Students pay large amounts in tuition to repeat courses and often transfer or withdraw from the institution out of frustration (Nguyen, 2014; Snead et al., 2021). These actions affect the institution's retention and graduation rates (Buckey, 2021). For example, Wilder (2013) attributed the success of incoming freshman in a first-year math course to increased college retention rates. Several researchers supported similar results in their studies that associated unsuccessful outcomes in a college algebra course with institutional dropout or transfer rates (Ganga & Mazzariello, 2018; Ichinose & Clinkenbeard, 2016; Neumann, Jeschke, & Heinz, 2021; Wilder, 2013). The findings from the results of these researchers laid the groundwork for this study, regarding what possible service-related factors are associated with the perceived academic success in mathematics among college students.

Nonetheless, data from previous research revealed personal and service-related factors were significantly related to the math performance among college students (Akessa & Dhufera, 2015; Crisp et al., 2017; Ganley et al., 2018). Personal factors, such as gender and ethnicity have had a significant impact on math achievement of college students (Martin, 2012). For African American students in mathematics, ethnicity has consistently impacted their performance in this academic area (Bradford et al., 2021; Martin D. B., 2012; McGee, 2014). Researchers have substantiated the need to understand the racialized mathematical experiences of Black students, including the experiences of those who have maintained high achievement in spite of encountering frequent marginalization (Bradford et al., 2021; McGee, 2013b, 2013c, 2014). Implying that failure is a predictable outcome for Black students studying mathematics leaves little room to explore Black students' success, agency, and resilience in the field. The lack of research on African Americans' success in mathematics leads to the mistaken conclusion - and widespread stereotype - that above-average achievement in this area is somehow nonexistent among Black students. In addition to intragroup differences, including the fact that some mathematically talented Black students endure racial bias within and beyond the classroom, fuels the perception of racial disparities in mathematics achievement (Martin, 2012; McGee, 2013a). Likewise, a relationship was found to exist between pass-fail frequencies within math courses, particularly intermediate algebra and gender. Male students continuously outperformed their female counterparts in mathematics (Ganley et al., 2018; Grigg et al., 2018; Rodriguez et al., 2020).

Service factors, such as tutoring and cooperative learning were found to be independent predictors of math achievement among college students. Various types of tutorial programs were found to have a positive impact on the math achievement of college students (Gillard et al., 2011; Rheinheimer et al., 2010). Additionally, research showed that cooperative learning improved student's performance and attitudes in math (Zakaria et al., 2010).

The purpose of this study was to examine the predictable relationship between selected personal and service-related factors and the perceived academic success in mathematics among college students. Specifically, this study was concerned with the predictive validity of the variables gender, ethnicity, tutoring and cooperative learning on the perceived academic success in math among college students. Thus, it was hypothesized that no statistically significant relationship existed between personal related factors (gender and ethnicity) and the perceived academic success in mathematics among college students. Also, it was hypothesized that no statistically significant relationship existed between service-related factors (tutoring and cooperative learning) and the perceived academic success in mathematics among college students.

Theoretical Framework

The present study was based on the Symbolic Interaction Theory and the Social Cognitive Theory. These theories are used to explain how personal and service characteristics can predict college student's perception of their success in an academic course such as mathematics.

The Symbolic Interaction Theory suggest that, through Social Interaction of Symbols and Symbolic-Communication such as language and gestures, college students will form concepts, ideas, and meaning that affect their academic behavior in mathematics (Wallace & Wolf, 1995). Specifically, this theory emphasized that a college student's perception of self and the role that his or her perception play in a mathematics class is greatly impacted by their math professors.

Moreover, this theory denotes the importance of a college student's sense of understanding and commitment to being successful in math (Wallace & Wolf, 1995). Thus, it is expected that college students who can perceive themselves as being successful in mathematics will develop the academic skills necessary to perform successfully in this academic course. College students will enhance their knowledge of mathematics by participating in student support services at the institution, which are designed to assist them in being successful in this academic area (Wallace & Wolf, 1995).

Furthermore, the Social Cognitive Theory state that new knowledge is built upon previous knowledge (Bransfeld et al., 2000). Vygotsky (1978), who is a proponent of this theory, believes that concept formulation and communication are vital components to understanding mathematics. Consequently, the types of communication in which college students are involved in their mathematics classrooms to a large extent influences the cultural meanings developed toward mathematics. In addition, the development of mathematical meanings helps them to create their own knowledge as they learn to explain and think about how to be successful in mathematics.

Operationalization of Variables

The following variables were operationally defined for this study:

- College Student - refers to a student receiving academic instruction in a four or two-year institution of higher learning.
- Cooperative Learning - refers to whether a college student perceives working independently or working in groups in his or her math class as being the most effective in contributing to academic success in mathematics.
- Ethnicity - refers to whether a college student's self-identified ethnic status is African American, White American, Asian American, Hispanic American, or other.
- Gender - refers to whether a college student is male or female.
- Institution of Higher Learning - refers to an academic institution that offers its student clientele an Associate degree, Bachelor's degree, graduate degree, and/or a professional degree.
- Lower-Level Undergraduate Student - refers to a college student who is classified as a freshman or a sophomore.
- Perceived Academic Success in Mathematics - refers to the mental disposition of college students regarding their academic success in mathematics.
- Personal Characteristics - refers to those aspects of college students that identify their demographic attributes.
- Service Characteristics - refers to those aspects of an institution of higher learning that provide support services to a college student to promote success in college. This variable is measured by tutoring and cooperative learning.
- Tutoring - refers to whether a college student receives tutoring in his or her math class in college.

Methodology

A predictive Correlational research design was employed in this study. This type of research methodology provides the researcher with the opportunity to assess a set of hypothesized relationships between selected variables for the purposes of determining their predictive association. Additionally, according to Mertler et al. (2021), the predictive

correlational research design has two major purposes. First, this type of design allows the researcher to develop a statistical model that can be used to predict values on a criterion variable for all members of a population. Secondly, this type of research design can provide an explanation for establishing causal relationship among variables. Furthermore, in the current study, the predictive correlational research paradigm provides the researcher with direct path linkages in evaluating the predictable relationship between selected personal and service-related factors and the perceived mathematics success among college students.

Population and Research Setting

The population of this study consisted of freshmen and sophomore undergraduate students enrolled at two (2) institutions of higher learning located in the State of Texas. Both institutions offer similar math courses at the freshman and sophomore level. One of the institutions was a four-year university and the other institution was part of a large urban community college system.

Institution A, a four-year public institution, has a student clientele of over 20,000. The population data include 51% white, 22.6 % Hispanic American, 17.4 % African American, and 5.6% “other” students. This institution offers more than 80 undergraduate degree programs, along with master’s and doctoral degrees. Further, 21 percent of the students resided on campus and 79 percent lived off campus. The institution encompassed over 370 acres in a rural area.

Institution B is one of seven two-year public colleges under the auspices of a large urban community college system. The student population at this institution is 22,303 which is 26.16 percent of the community college system student enrollment. The student ethnic demographics is 27.98% white, 43.81% Hispanic American, 13.77% African American and 14.24 “other” students. This institution offers more than 200 programs and 30+ fully online programs designed to train students for a career or update their current job skills, including 3 undergraduate degree programs, 8 Associate of Science, 10 Associate of Art, 22 Associate of Applied Science degrees and a host of workforce development, continuing and technical education, and general programs and services, as well as customized contract training programs. Students commute to campus or enroll in fully online programs. This institution is located on 165 acres in the northern suburb of a large metropolitan city.

Instrumentation

A modified version of the Mathematics Attitudes and Perceptions (Map) Survey was used. The personal and service factors were modified in the instrument by the researcher. Personal and service- related factors were found to have some predictive power regarding attitudes and perceptions toward mathematics. This investigative instrument was employed in the study since it assesses how college students in mathematics perceived their success in this academic area. The modified MAP Survey was divided into four major sections. Section one entitled personal characteristics dealt with three items. Items two and three in this section were coded one to five (1 to 5). In addition, item one was coded one to two (1 to 2), respectively. Item 7 was coded one to three (1 to 3).

Section two of the investigative survey was entitled academic characteristics and contained four items. Items 4, 5, and 6 were coded one to two (1 to 2) respectively. Item 7 was coded one to three (1 to 3). Section three was entitled service characteristics and consisted of two items. Both items 8 and 9 were coded one to two (1 to 2). Section one, two, and three were

composed of the personal, academic, and service characteristics of the participants, the scoring of one to five does not represent a perceptual sequence, only categories.

Finally, section four contains twenty items in a Likert format. This section was entitled Perceptions Toward Mathematics Success. Items in this section required that the participants check one of five structured expressions: Strongly Agree, Agree, Neutral, Disagree, and Strongly Disagree. Each of the above close ended expressions were assigned the following score for analysis purposes: Strongly Agree, (5), Agree (4), Neutral (3), Disagree (2), and Strongly Disagree (1). The items in section were summated and a total score ranging from 20 to 100 was computed for each student participant. The higher the score in this area, the more favorable the perception was toward mathematics success.

Statistical Analysis

Since the present study attempted to examine the predictable relationship among variables, the researcher employed two correlational statistical procedures: multiple correlational analysis and the simultaneous (standard) multiple regression analysis. According to Tabachnick and Fidell (2018), the multiple correlation procedure is used to assess complex interrelationships between independent and dependent variables.

Once the multiple correlation procedure was applied and significant relationships were found between the independent and dependent variables, the principles of the simultaneous multiple regression technique were employed by the researcher. The simultaneous (standard) multiple regression procedure is a statistical procedure whereby all the independent variables are placed into the regression model at once, each one being processed as if it had entered the regression equation after all other variables had been processed. Finally, this procedure assessed each independent variable in terms of what it adds to the overall prediction of the dependent variable that will be different from the predictability afforded by all the other independent variables (Tabachnick & Fidell, 2018).

Results

The following two statistical hypotheses were generated and tested in this empirical study:

H_{0_1} : There is no statistically significant relationship between personal related factors (gender and ethnicity) and the perceived academic success in mathematics among college students.

H_{0_2} : There is no statistically significant relationship between service-related factors (tutoring and cooperative learning) and the perceived academic success in mathematics among college students.

To test hypothesis one, the variable ethnicity was dummy coded and four distinct variables were created for this investigation. The variable African American was coded "1" for African American and "0" for non-African American. The variable White-American was coded "1" for White American and "0" for non-White American. The variable Hispanic American was coded "1" for Hispanic American and "0" for non-Hispanic American. In addition, the variable Asian American was coded "1" for Asian American and "0" for non-Asian American. Thus, the Asian American group was used as the reference group in the regression model.

Presented in Table 1 were the Standard Multiple Regression findings with respect to the relationship between personal related factors of gender and ethnicities and the perceived academic success in mathematics among college students. The multiple regression model yielded

a multiple correlation (R) of .330. The four personal related factors combined accounted for 10.9 percent (Adjusted = 7.8%) of the variance in the perceived academic success in mathematics of college students.

A statistically linear relationship existed between the personal related factors (gender, African American, White American, and Hispanic American) and perceived academic success in mathematics ($F(4,116) = 3.549, P < .01$). When the variables African American, White American, and Hispanic American were controlled, gender was found to contribute significantly to the perceived academic success in mathematics of college students. Therefore, hypothesis one was rejected.

Table 1

Multiple Regression Results Regarding the Relationship Between Selected Personal Related Factors and the Perceived Academic Success in Mathematics

Model	B	SE	Beta	t	P
(Constant)	81.388	3.410			
Gender	6.147	2.092	.270	2.092	.004***
African American	-6.995	3.815	-.277	-1.833	.064
White American	-5.520	3.672	-.236	-1.503	.135
Hispanic American	-5.238	3.782	-.207	-1.385	.169

Note: $R = .330$; $R^2 = .109$; Adjusted $R^2 = .078$; $F = 3.549$; $df = 4,116$; $P = .009^{**}$

Reference Group = Asian American

**Significant at the .01 level

Reported in Table 2 were the Standard Multiple Regression results, for hypothesis two, regarding the predictable relationship between service-related factors of tutoring, and cooperative learning and the perceived academic success in mathematics among college students. The regression model yielded a multiple correlation coefficient (R) of .213. The two service-related predictors together accounted for 4.5 percent (adjusted = 2.9%) of the variance in the perceived academic success in mathematics of college students.

A significant linear relationship was not found to exist between service-related factors (tutoring and cooperative learning) and the perceived academic success in mathematics of college students ($F(2,119) = 2.832, P > .05$). Additionally, the variable cooperative learning was an independent predictor ($t = 2.258, P < .01$) of perceived academic success in mathematics of college students. Consequently, hypothesis three was not rejected.

Table 2**Multiple Regression Results Regarding the Relationship Between Selected Service Factors and the Perceived Academic Success in Mathematics**

Model	B	SE	Beta	t	P
(Constant)	75.20	1.753			
Tutoring	-.812	2.092	-.035	-.388	.698
Cooperative	4.613	2.039	.025	2.258	.026**

Note: R = .213; R Square = .045; Adjusted R Square = .029; F = 2.832; df = 2,119; P = .063

**Significant at the .01 level

Discussion

One of the most interesting findings of the present study was the significant influence of personal related factors on the perceived academic success in mathematics among college students. Specifically, the personal related factors of gender and ethnicity were found to have a linear relationship with perceived academic success in mathematics among college students. The variable gender was found to be a significant independent predictor of perceived academic success in mathematics among college students. These findings were consistent with those of Ganley, et al. (2018), Geddes (2015), Grigg et al. (2018), Jett (2013), and Rodríguez et al. (2020). The aforementioned researchers found that gender was significantly related to perceived academic success in mathematics. However, in their study, Rodríguez et al. (2020), found that gender was not significantly related to perceived academic success in mathematics.

Likewise, the present study regarding gender, findings revealed that male college students perceived more favorably their academic success in mathematics than their female counterparts. These findings may be supported by the fact of the stereotypical belief that females tend not to do well academically in mathematics (Geddes, 2015). Because of this position, male college students seem to exhibit more positive attitudes towards mathematics and are more likely to perform better in this academic area than female college students.

Moreover, the variable ethnicity was linearly related to perceived mathematics success in conjunction with gender, but not as an independent predictor. These findings were not consistent with those of Crisp, et. al., (2017), Martin (2012), and McGee (2013c, 2014). The previously identified researchers found that the variable ethnicity was found to be statistically related to mathematics success. An explanation for the present findings may be that regardless of the college students' ethnicity they seem to possess similar perceptions with respect to their ability to be successful in mathematics.

Perhaps the most surprising finding in the present study was the significant independent influence of the service-related factor cooperative learning on the perceived academic success in mathematics among college students. The variable cooperative learning was found to be an independent predictor of perceived academic success in mathematics. These findings were consistent with those of Shaughnessy (1997) and Zakaria, et al., (2010). The aforementioned researchers found that the variable cooperative learning was related to academic success. An explanation for these findings may be that college students who are able to work independently in math are also those who have less anxiety about math. Because of this, they have a more positive perception about being successful in math than those who work in groups.

Finally, another somewhat astonishing finding of the current study was the lack of predictive power that the service-related factor tutoring had on the perceived academic success in mathematics among college students. These findings were not supported by the works of Marx et al., (2016), and Rheinheimer et al., (2010). Previous researchers found a significant relationship between tutoring and the academic success in math among college students. A plausible explanation for these findings may be that college students who needed and received tutoring were enthusiastic about learning math in their sessions. This probably helped them to reduce their degree of math anxiety, and, in the long run, helped how they perceived their success in mathematics.

Implications

The following implications were drawn from the results of the study:

1. The significant impact of demographic factors on the perceived academic success in mathematics among college students suggests that college officials who are responsible for the academic side of the institution should implement various strategies to alter the perceptions of students toward mathematics. An awareness of the predictive power that demographic factors have on how college students perceive their success in mathematics will provide college administrators with vital information to identify those types of students who probably will have academic difficulties in math courses.
2. Finally, the lack of a predictable relationship between service-related factors and their influence on the perceived academic success in mathematics of college students highlighted the significance of these factors in understanding how students will perform in mathematics. Understanding the causal effects of these variables in conjunction with other variables associated with math performance can give a more parsimonious picture of their effects on the math preparations of college students.

Based on the findings of this study, it is recommended for further study:

1. A follow up study should be conducted to include a much more global population from various geographic regions of the United States. Such a study will provide more relevant data on the perceived academic success in mathematics among college students.
2. A study should be conducted to examine the interaction effects between demographic, and service-related factors and the perceived academic success in mathematics among college students.

Conclusions

It can be concluded from this empirical study that any regression model developed to predict the perceived academic success in mathematics of college students should include the personal related factors of gender and ethnicity. Male college students exhibited significantly more favorable perceptions toward mathematics than female college students.

Additionally, it appeared that any attempt to develop a regression model to predict the perceived math success in mathematics should not include the service-related factors of tutoring and cooperative learning. Finally, the service-related factor of cooperative learning was found to be an independent predictor of the perceived academic success in mathematics of college

students. College students who work math independently had more favorable perceptions regarding being successful in mathematics.

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