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Investigating Students' Attitudes towards Mathematics and Sciences

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Abstract

Success and failure in math and science performance are greatly determined by students' attitudes towards the subject matter. A multidimensional survey, including motivation, usefulness, self-confidence, and enjoyment subscales was developed and administered in two New York City Private High schools. Student attitudes were examined and compared by sex, age, and number of mathematics and science courses taken. Majority of study participants regardless of their age, sex, and level of coursework found mathematics and science courses challenging and not enjoyable. Few students demonstrated understanding of the benefits of acquiring mathematical and scientific skills and expressed desire to pursue careers in science, mathematics, and related fields. The Spearman's rank-order correlation coefficient ρ was calculated to identify the strength and direction of relationship between student attitudes toward science and mathematics and possible career choices in these fields. Chi-Square and Kruskal-Wallis nonparametric tests were performed to compare student attitudes by gender, age, and number of math and science courses taken.

Introduction

According to Curtis (2006), students can express their attitude toward a course by either liking or disliking the subject matter. Students with positive attitudes about learning mathematics are more likely to understand the concepts and develop confidence in their mathematical abilities (Furner & Berman, 2003). Students' attitudes towards mathematics are affected by their beliefs in usefulness of mathematics, by the level of self confidence in their ability to succeed in mathematics, and by their previous learning experiences (Koehler & Grouws, 1992).

This article proposes a new multidimensional survey for analyzing important dimensions of students' attitudes toward mathematics and sciences, applies proposed survey to investigate students' attitudes in two New York City Private High School, analyzes differences in student attitudes by sex, age, and number of mathematics and science courses taken. The article also provides recommendations on how to increase student motivation, self-confidence, enjoyment, and participation in mathematics and science programs.

According to Curtis (2006), "attitude is a behavior that is measured by various evaluative processes" (p.48). Attitude for this study is defined as motivation to pursue careers in science and mathematics, belief in usefulness and practical applications of math and sciences, confidence in students' ability to learn math and science, and enjoyment of doing math and science. The next section describes research method, introduces problem and purpose statements and the survey. Section 2 provides descriptive analysis of data. Section 3 describes non parametric correlations and analyzes differences in student attitudes by sex, age, and number of math and science courses taken using Chi-square, and Kruscal-Wallis no-parametric tests. Section 4 provides conclusion, summarizes findings, and makes recommendations on how to increase student motivation, self- confidence, and participation in mathematics and science programs.

1. Research Method

Quantitative descriptive design is applied to investigate different dimensions of high school students' attitudes toward mathematics and sciences and to compare students' attitudes by sex, age, and number of math and science courses taken.

Statement of the problem

Unsatisfactory student performance on High School Proficiency Exams (HSPE) in math and science appears to be a serious problem in secondary education. A possible cause of this problem is students' negative attitudes toward the subject matter. Perhaps a quantitative descriptive study that investigates multiple dimensions of students' attitudes and analyzes differences in students' attitudes by sex, age, and number of math and science courses taken could remedy the situation.

Purpose of the Study

The purpose of this study is to investigate New York City private high school students' attitudes towards mathematics and sciences by the use of the proposed new multidimensional attitudinal scale and to identify statistically significant differences in students attitudes by sex, age, and number of mathematics and science courses taken.

Research Subjects

Research subjects were students selected semi-randomly from two private high schools located on Manhattan. Total of 94 students (60 female and 34 male) were surveyed. Table 1 represents the cross tabulations by age and sex.

Table 1: Cross Tabulations by Sex and Age

		Age of Participant					Total
		14	15	16	17	18	
Sex of Participant	Female	36	8	4	8	4	60
	Male	10	7	6	10	1	34
Total		45	15	10	18	5	94

Table 2a represents the cross tabulations by sex and number of math and science courses taken. One respondent didn't indicate number of courses taken. Therefore, the total count is 93 as opposed to 94.

Table 2a: Cross Tabulations by Sex and Number of Courses Taken

		Number of Math courses taken.					Total
		1	2	3	4	5	
Sex of Participant	Female	40	0	7	11	1	59
	Male	15	3	13	2	1	34
Total		55	3	20	13	2	93
		Number of Science courses taken.					Total
		1	2	3	4	5	
Sex of Participant	Female	40	0	15	3	1	59
	Male	15	4	14	1	0	34
Total		55	4	29	4	1	93

Limitations of the Study

Making generalizations of this study to other private high schools will be difficult because of the relatively small sample size. Surveys along with other necessary documentation were mailed to five New York City private high schools. However, only two schools returned the completed surveys. In total, 94 completed surveys were obtained, including 60 female and 34 male participants. Approximately 68% female and 44% male respondents took one math and one science course. The number of respondents who took three and more math and science courses was less than 37% (see Table 2a). Consequently, correlation between attitudes towards natural science and mathematics and the number of math and science courses taken may be difficult to generalize. According to Table 2b, majority of students took one math and one science course.

Table 2b: Cross Tabulations by Age and Number of Courses Taken

		Number of Math courses taken.					Total
		1	2	3	4	5	
Age of Participant	14	43	0	1	1	1	46
	15	12	3	0	0	0	15
	16	1	0	9	0	0	10
	17	0	0	10	8	0	18
	18	0	0	0	4	1	5
Total		56	3	20	13	2	94
		Number of Science courses taken.					Total
		1	2	3	4	5	
Age of Participant	14	43	0	1	1	1	46
	15	12	3	0	0	0	15
	16	1	0	9	0	0	10
	17	0	1	15	2	0	18
	18	0	0	4	1	0	5
Total		56	4	29	4	1	94

Survey Instrument

According to Cohen at al. (2000), a survey is applicable for research that intends to “gather data at a particular point in time with the intention of describing the nature of existing conditions, or identifying standards against which existing conditions can be compared, or determining the relationships that exist between specific events” (p. 169).
A new multidimensional scale for analyzing important aspects of students’ attitudes was developed. The proposed instrument includes the following four subscales:

1. *Motivation subscale* to investigate students interest to acquire advanced mathematical and scientific skills and to pursue careers in these fields.

2. *Usefulness subscale* to analyze students beliefs in practical applications of math and science.

3. *Self-Confidence subscale* to investigate students beliefs in their ability to learn math and science.

4. *Enjoyment subscale* to investigate students emotional feelings while learning math and science.

The survey we developed included 25 statements. Responses to each statement were ranked on five -point Likert scale in order to measure participant agreement or disagreement with each statement. Demographic questions about age, sex, and number of mathematics and science courses taken were included as well.

2. Descriptive Data Analysis

Motivation subscale

According to Yunus and Ali (2009), "Effort is synonym to motivation. An individual who shows greater effort is considered to be motivated, whilst one who is motivated will also show greater effort" (p. 94). Motivation influences whether or not one engages in a given pursuit (Ames, 1992). Intellectual curiosity is one of the important motivational factors. Developed motivation subscale included seven survey items listed on Table M. Calculated means were between 2.0 and 4.03 on five point scale. Standard deviation varied between 0.855 and 1.316 and the distribution was not normal. A majority of study participants lacked intellectual curiosity towards the subject matter. Only 3% of respondents (both males and females) agreed to the statement that they read articles on mathematics and less than 26% of participants agreed to the statement that they read articles on science. About 67% female and 85% male participants expressed their interest in understanding how things work, and 72% of participants (64% female and 85% male) agreed with the statement that they ask for explanations on how things work.

Table M: Motivation Subscale. Descriptive Statistics

	N	Mean	Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
I am interested in understanding how things work	94	4.03	.909	-.590	.249	-.522	.493
I read articles on math	94	2.00	.855	.633	.249	.419	.493
I read articles on science	94	2.69	1.136	.141	.249	-.794	.493
I imagine myself using math in my career	94	3.01	1.240	-.124	.249	-.830	.493
I imagine myself using science in my career	94	3.20	1.316	-.152	.249	-1.057	.493
I would consider a career in math	94	2.55	1.275	.324	.249	-1.025	.493
I would consider a career in science	94	3.15	1.375	-.173	.249	-1.141	.493
Valid N (listwise)	94						

Lack of intellectual curiosity toward the subject matter, especially in female participants, could be one of the contributing factors to poor performance scores. Less than 35% of participants (both male and female) agreed that they imagine themselves using math in their careers. The corresponding numbers were slightly higher for sciences (42% female and 50% male).

Table 3: Sex of Participant * I would consider a career in math

		I would consider a career in math					Total
		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	
Sex of Participant	Female	17	13	13	12	4	59
	Male	8	11	6	6	3	34
Total		25	24	19	18	7	93

Data analysis demonstrated gender gaps in student career choices. Only 27% of female participants as opposed to 74% males agreed that they would consider careers in mathematics (See Table 3). Percentage of female participants considering career in science (41%) was slightly less compared with the percentage of males (44%) as reported on Table 4.

Table 4: Sex of Participant * I would consider a career in science

		I would consider a career in science					Total
		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	
Sex of Participant	Female	10	10	15	12	12	59
	Male	6	4	9	8	7	34
Total		16	14	24	20	19	93

Usefulness subscale

Students often question whether they will ever use math or science in real life. “Math becomes more meaningful when students can make a connection between what is learned in the classroom and their personal experiences” (Curtis, 2006, p. 56). Students need to realize that solid math skills are necessary not only in the contemporary business world but also in everyday activities, such as balancing a family budget or figuring out the cost of an item that is on sale. The usefulness subscale included seven survey items listed on Table U. Means were between 2.99 and 3.99 on a five point scale. Standard deviations varied between 0.864 and 1.166, and all responses were negatively skewed. Percentage of female students who agreed to the statement that math majors get better jobs was significantly low (28%) compared with the one for male participants (85%), whereas 51% of females and 54% of males agreed that science majors get better jobs.

Table U: Usefulness Subscale Descriptive Statistics

	N	Mean	Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
I use math in my everyday life	94	3.99	.886	-.453	.249	-.646	.493
Math has practical applications	94	3.95	.795	-.955	.249	1.752	.493
I check discount rates when I shop	94	3.32	1.166	-.278	.249	-.859	.493
Science has practical applications	94	3.90	.868	-.617	.249	.390	.493
I often think critically about problems	94	3.50	.864	-.255	.249	-.124	.493
Math majors get better jobs	93	2.99	.915	-.240	.250	-.446	.495
Science majors get better jobs	94	3.50	1.075	-.371	.249	-.422	.493
Valid N (listwise)	93						

It is important to encourage students to check out the latest information about job rankings. Apparently, majority of female respondents were not aware that, according to the 2011 comprehensive ranking of 200 different jobs (Ranking 200 Jobs from Best to Worst, 2011), mathematicians took second place after software engineers and outranked prestigious jobs in legal, medical, financial, and engineering fields. Underestimating the usefulness of scientific and mathematical skills could be another factor negatively influencing student motivation to take advanced courses in these subjects. Surprisingly, only 56% female and 41% male participants agreed with the statement that they check discount rates when they shop. Meanwhile, 80% of participants (both male and female) agreed to the statement that math had practical applications in everyday life.

Table 5: Sex of Participant * I use math in my everyday life

		I use math in my everyday life				Total
		Disagree	Neutral	Agree	Strongly Agree	
Sex of Participant	Female	2	12	25	20	59
	Male	3	10	10	11	34
Total		5	22	35	31	93

Table 5 shows that percentage of female participants using basic math in everyday life (76%) is higher than the percentage of males (62%). Less than half (45%) of female respondents agreed that they think critically about problems compared with 62% of males (Table 6).

Students often do not realize how basic science skills such as making predictions, gathering evidence, weighting the evidence and drawing conclusions manifest in daily decision making and problem solving.

Table 6. Sex of Participant * I often think critically about problems

		I often think critically about problems					
		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Total
Sex of Participant	Female	1	9	22	22	5	59
	Male	0	1	12	16	5	34
Total		1	10	34	38	10	93

Self-Confidence Subscale

Turner, et al. (2002) studied 1,197 middle-school students in 65 classrooms and determined that when students are not confident with their mathematical abilities, they avoid completing the tasks and dislike the subject that is intimidating. Sax (1992) indicated that women are less confident than men about their mathematical abilities, and this kind of disparity is based on women's self-confidence and preparation during the high school years and their experiences during college.

Table C: Confidence Subscale Descriptive Statistics

	N	Mean	Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
I can use basic math in my everyday life	94	4.36	.760	-1.020	.249	.518	.493
I ask for explanations about how things work	94	3.85	.879	-.671	.249	.423	.493
I like to solve problems by working them out myself	94	3.86	.875	-.512	.249	-.291	.493
I feel confidence with using concepts from math in my life	94	3.44	.990	-.431	.249	.007	.493
I feel confidence with using concepts from science in my life	94	3.26	1.173	-.310	.249	-.636	.493
Valid N (listwise)	94						

"Among experiences contributing to women's self-concept, the number of math and science courses taken and level of satisfaction within these courses have positive effect on women's self-rating"(Sax, 1992, p.17). The self-confidence subscale included five survey items listed in Table C. Means were between 3.26 and 4.36 on five point scale. Standard deviation varied between 0.760 and 1.173 and all responses were negatively skewed.

Table 7: Sex of Participant * I feel confidence with using concepts from math in my life

		I feel confidence with using concepts from math in my life					Total
		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	
Sex of Participant	Female	4	4	21	22	8	59
	Male	0	6	11	13	4	34
Total		4	10	32	35	12	93

As Tables 7 and 8 indicate, only half of the male respondents agreed to the statement that they felt confident using concepts from math and sciences in their lives. As for females, their self confidence level in using science concepts was less (40%) compared with their self confidence level in using math concepts (51%). Percentage of female participants feeling confident in using basic math in everyday life (90%) was higher than the percentage of males (82%) that contradicts previous studies indicating that female self confidence in their math abilities tend to fall significantly below males', creating a confidence gap that tends to persist through high school and into college (Campbell & Beaudry, 1998).

Table 8: Sex of Participant * I feel confidence with using concepts from science in my life

		I feel confidence with using concepts from science in my life					Total
		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	
Sex of Participant	Female	8	6	21	14	10	59
	Male	1	8	8	13	4	34
Total		9	14	29	27	14	93

Enjoyment Subscale

Middleton and Spanias (1999) stated that American children enjoy learning mathematics in the primary grades but as they grow older, they start to consider mathematics as a subject for the smart kids and they lose interest towards it. The enjoyment subscale included six survey items listed in Table E. Means were between 2.9 and 3.65 on five point scale. Standard deviation varied between 0.972 and 1.600. All responses were negatively skewed except the one related with solving Sudoku puzzles. About half of the study participants (58% female and 50% male) agreed to the statement that solving math problems makes them feel good (Table 9).

Table 9: Sex of Participant * Solving math problems make me feel good

		Solving math problems make me feel good					Total
		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	
Sex of Participant	Female	5	5	15	21	13	59
	Male	1	6	10	12	5	34
Total		6	11	25	33	18	93

Table E: Enjoyment Subscale Descriptive Statistics

	N	Mean	Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
Solving math problems make me feel good	94	3.50	1.124	-.534	.249	-.334	.493
Solving science problems make me feel good	82	3.49	.972	-.296	.266	.106	.526
I enjoy going to science museums	94	3.21	1.294	-.316	.249	-.880	.493
I like doing laboratory experiments	94	3.65	1.161	-.665	.249	-.263	.493
I enjoy solving Sudoku puzzles	94	2.90	1.600	.095	.249	-1.589	.493
I like to work with numbers.	94	3.53	1.152	-.381	.249	-.612	.493
Valid N (listwise)	82						

Less than half (48% for both male and female) of the study participants agreed to the statement that solving science problems makes them feel good (Table 10). Slightly more females (63%) than males (59%) expressed enjoyment in doing laboratory experiments, and 44% of all participants agreed that they enjoy visiting science museums.

Table 10: Sex of Participant * Solving science problems make me feel good

		Solving science problems make me feel good					Total
		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	
Sex of Participant	Female	3	4	21	14	11	53
	Male	0	2	13	12	2	29
Total		3	6	34	26	13	82

More females (46%) enjoyed solving Sudoku puzzles compared with males (38%). Meanwhile, more males (62%) than females (47%) agreed that they liked working with numbers (Table 11). The majority of students who liked working with numbers took two or more math courses, which may indicate that taking more math courses may positively influence student attitudes. Students who like working with numbers are more likely to choose careers in banking, actuarial sciences, financial engineering, insurance sales, and other fields related with numerical skills.

Table 11: Sex of Participant * I like to work with numbers.

		I like to work with numbers.					
		Strongly disagree	Disagree	Neutral	Agree	Strongly agree	Total
Sex of Participant	Female	2	9	20	16	12	59
	Male	3	3	7	10	11	34
Total		5	12	27	26	23	93

3. Inferential Data Analysis

Nonparametric Correlations

The Spearman's rank-order correlation coefficient ρ was used to identify the strength and direction of relationship between different sets of student responses measured on ordinal scale. Table 12 and Table 13 represent values obtained for Spearman's ρ corresponding to strong positive correlations between student responses to selected survey items.

Statistically significant relationships were obtained between student agreements on the following two statements: “I like to work with numbers” and “I would consider career in math.”The corresponding Spearman's rank-order correlation coefficient was
$\rho = 0.646, p = 0.000$

Strong positive correlations were also obtained between student agreements on the following two statements “I feel confidence with using concepts from science/math in my life ($\rho = 0.625$) and “I imagine myself using science/math in my career”($\rho = 0.435$) at p=0.000.

Moderately strong positive correlations were found between the beliefs that math/science majors get better jobs and considering career in mathematics/sciences. Calculated Spearman's correlation coefficients were 0.443 and 0.363 correspondingly.

The enjoyment of solving math problems and along with the enjoyment of solving Sudoku puzzles were positively correlated with career choices in mathematics as well.

Nonparametric correlations on Table 12 demonstrated that when student confidence level with using concepts from math/science in their lives increases they are more likely to consider careers in math/science. Students who read articles on science, liked doing laboratory experiments, and enjoyed solving science problems were more likely to consider career in sciences. Spearman's correlation coefficients were 0.510, 453, and 429 correspondingly and indicated significant correlations at the 0.01 level (2 tailed).

Table 12: Spearman's Rank-Order Correlations: Motivation Subscale

			I would consider a career in science	I feel confidence with using concepts from science in my life
Spearman's rho	I would consider a career in science	Correlation Coefficient	1.000	.563**
		Sig. (2-tailed)	.	.000
		N	94	94
	I feel confidence with using concepts from science in my life	Correlation Coefficient	.563**	1.000
		Sig. (2-tailed)	.000	.
		N	94	94
			I feel confidence with using concepts from math in my life	I would consider a career in math
Spearman's rho	I feel confidence with using concepts from math in my life	Correlation Coefficient	1.000	.435**
		Sig. (2-tailed)	.	.000
		N	94	94
	I would consider a career in math	Correlation Coefficient	.435**	1.000
		Sig. (2-tailed)	.000	.
		N	94	94

Table 13: Spearman's Rank-Order Correlations: Usefulness Subscale

			Math has practical applications	I imagine myself using math in my career
Spearman's rho	Math has practical applications	Correlation Coefficient	1.000	.284**
		Sig. (2-tailed)	.	.006
		N	94	94
	I imagine myself using math in my career	Correlation Coefficient	.284**	1.000
		Sig. (2-tailed)	.006	.
		N	94	94
			Science has practical applications	I imagine myself using science in my career
Spearman's rho	Science has practical applications	Correlation Coefficient	1.000	.404**
		Sig. (2-tailed)	.	.000
		N	94	94
	I imagine myself using science in my career	Correlation Coefficient	.404**	1.000
		Sig. (2-tailed)	.000	.
		N	94	94

Moderate positive correlations were observed among thinking critically about problems, enjoying visiting science museums and career choices in science. Table 13 represents moderate positive correlations between student's beliefs in practical applications of math/sciences and imagining themselves using math/sciences in their careers. Positive correlations were observed between students' positive attitudes towards mathematics and sciences and their career choices in these fields.

Chi-Square Test: Investigating Gender Gaps

Chi-Square test was performed to compare male and female students' attitudes measured on all four subscales.

Confidence subscale

Chi-square test was performed to test hypothesis about the existence of gender gaps in students' confidence levels with using concepts from math in their lives. Null and alternative hypotheses were formed as follows:

H0: Male and female students are equally confident with using concepts from math in their lives
HA:Male and female students are not equally confident with using concepts from math in their lives

Calculated $\chi^2 = 42.915$ and p=0.000 which allows to reject the null hypothesis.

Table 14a: Chi-Square Test: Confidence Subscale (Math).

I feel confidence with using concepts from math in my life

	Observed N	Expected N	Residual
Strongly Disagree	4	18.8	-14.8
Disagree	10	18.8	-8.8
Neutral	33	18.8	14.2
Agree	35	18.8	16.2
Strongly Agree	12	18.8	-6.8
Total	94		

Test Statistics

	Sex of Participant	I feel confidence with using concepts from math in my life
Chi-Square	7.191[a]	42.915[b]
df	1	4
Asymp. Sig.	.007	.000

Corresponding null and alternative hypothesis for testing students attitudes towards sciences were:

H0: Male and female students are equally confident with using concepts from science in their lives
HA: Male and female students are not equally confident with concepts from math in their lives

The null hypothesis was rejected again with $\chi^2 = 17.595$ and p=0.001. Differences between male and female students' confidence with using math science concepts in their lives were statistically significant.

Table 14b: Chi-Square: Confidence Subscale (Science).

I feel confidence with using concepts from science in my life

	Observed N	Expected N	Residual
Strongly Disagree	9	18.8	-9.8
Disagree	14	18.8	-4.8
Neutral	29	18.8	10.2
Agree	28	18.8	9.2
Strongly Agree	14	18.8	-4.8
Total	94		

Test Statistics

	Sex of Participant	I feel confidence with using concepts from science in my life
Chi-Square	7.191[a]	17.596[b]
df	1	4
Asymp. Sig.	.007	.001

Enjoyment Subscale

Chi-square test was performed to identify gender gaps in student attitudes measured on enjoyment subscale (Table 15). Statistically significant differences at 95% confidence level were observed in male and female students' attitudes measured on the enjoyment subscale.

Table 15: Chi-Square Test: Enjoyment Subscale.

	Sex of Participant	I enjoy solving Sudoku puzzles	I enjoy going to science museums	I like doing laboratory experiments	Solving math problems make me feel good	Solving science problems make me feel good	I like to work with numbers.
Chi-Square	7.191[a]	10.362[b]	10.255[b]	25.681[b]	26.319[b]	48.979[b]	20.787[b]
df	1	4	4	4	4	4	4
Asymp. Sig.	.007	.035	.036	.000	.000	.000	.000

Motivation and Usefulness Subscales

Chi-square test was performed to identify gender gaps in student attitudes measured on the motivation and usefulness subscales (Table 16 and Table 17). Statistically significant differences were observed in male and female students' attitudes measured on both subscales.

Table 16: Chi-Square Test Statistics: Motivation subscale

	Sex of Participant	I am interested in understanding how things work	I read articles on math	I read articles on science	I would consider a career in math	I imagine myself using math in my career
Chi-Square	7.191[a]	24.213[b]	61.851[b]	17.809[b]	11.000[b]	13.979[b]
df	1	3	4	4	4	4
Asymp. Sig.	.007	.000	.000	.001	.027	.007

Table 17: Chi-Square Test Statistics: Usefulness Subscale

	Sex of Participant	I use math in my everyday life	I check discount rates when I shop	Math has practical applications	Science has practical applications
Chi-Square	7.191[a]	23.702[b]	19.085[b]	99.511[b]	61.638[b]
df	1	3	4	4	4
Asymp. Sig.	.007	.000	.001	.000	.000

Kruscal-Wallis Test: Grouping by Age of Participants

Kruscal-Wallis test was performed to investigate differences in students' attitudes by age. Five independent age groups were analyzed. Student attitudes were measured and compared on all four subscales

Confidence Subscale

The following non-directional hypothesis was tested to identify age related differences in student confidence levels with using concepts from math in their lives.

H0: Students in different age groups are equally confident with using concepts from math in their lives
HA: Students in different age groups are not equally confident with concepts from math in their lives

Table 18a: Kruskal- Wallis Test: Grouping Variable: Age of Participant (Math).

Ranks			
	Age of Participant	N	Mean Rank
I feel confidence with using concepts from math in my life	14	46	48.62
	15	15	41.40
	16	10	37.45
	17	18	54.22
	18	5	51.40
	Total	94	

Test Statistics[a,b]	
	I feel confidence with using concepts from math in my life
Chi-Square	3.748
df	4
Asymp. Sig.	.441

As Table 18a demonstrates, there is no statistically significant difference in confidence levels between the different age groups (H = 3.784, p = 0.441) with a mean rank of 48.62 for age 14, 41.40 for age 15, 37.46 for age 16, 54.22 for age 17 and 51.40 for age 18.

The following non-directional hypothesis was tested to identify age related differences in student confidence levels with using concepts from science in their lives:

H0: Students in different age groups are equally confident with using concepts from science in their lives
HA: Students in different age groups are not equally confident with using concepts from Science in their lives

Table 18b: Kruskal -Wallis Test: Grouping Variable: Age of Participant (Science)

Ranks			
	Age of Participant	N	Mean Rank
feel confidence with using concepts from science in my life	14	46	48.68
	15	15	55.67
	16	10	33.50
	17	18	48.89
	18	5	35.10
	Total	94	

Test Statistics[a,b]	
	I feel confidence with using concepts from science in my life
Chi-Square	5.492
df	4
Asymp. Sig.	.240

According to Table 18b, there is no statistically significant difference in confidence levels between the different age groups (H = 5.492, p = 0.240) with a mean rank of 48.68 for age 14, 55.67 for age 15, 33.50 for age 16, 48.89 for age 17 and 35.10 for age 18. Consequently, no statistically significant differences by age were found in student s' attitudes in terms of their confidence in using math and science concepts in their life.

Usefulness subscale

The following non-directional hypothesis was tested to identify age related differences in student beliefs about practical applications of sciences.

H0: Students' beliefs about practical applications of sciences are equal in different age groups
HA: Students' beliefs about practical applications of sciences are not equal in different age groups

Table 19: Kruskal- Wallis Test: Grouping Variable: Age of Participant (Science)

Ranks			
	Age of Participant	N	Mean Rank
Science has practical applications	14	46	44.39
	15	15	49.20
	16	10	28.70
	17	18	64.00
	18	5	49.20
	Total	94	

Test Statistics[a,b]	
	Science has practical applications
Chi-Square	13.728
df	4
Asymp. Sig.	.008

According to Table 19, there is a statistically significant difference in students' beliefs regarding practical applications of sciences in the different age groups (H = 13.728, p = 0.008) with a mean rank of 44.39 for age 14, 49.20 for age 15, 28.70 for age 16, 64.00 for age 17 and 49.20 for age 18. No statistically significant differences by age were discovered in students' beliefs that math has practical applications, with corresponding values of H= 2.477 and p=0.649. No statistically significant differences by age were also observed in students' attitudes measured on the motivation and enjoyment subscales.

Kruscal-Wallis Test: Grouping by Number of Courses Taken

Kruscal-Wallis test was performed to analyze differences in students' attitudes by the number of math and science courses taken. Four independent groups were considered. Students' attitudes were measured and compared on all four subscales.

Confidence subscale

The following non-directional hypothesis was tested to investigate whether student confidence in using math concepts in their life depends on the number of math courses taken

H0: Students' confidence with using concepts from math in their lives does not depend on the number of math courses taken
HA: Students' confidence with using concepts from math in their lives depend on the number of math courses taken

Table 20a: Kruskal -Wallis Test: Grouping Variable: Number of Math Courses Taken

Ranks			
	Number of Math courses taken.	N	Mean Rank
I feel confidence with using concepts from math in my life	1	56	45.28
	2	3	41.67
	3	19	45.08
	4	12	48.17
	Total	90	

Test Statistics[a,b]	
	I feel confidence with using concepts from math in my life
Chi-Square	.220
df	3
Asymp. Sig.	.974

According to Table 20a, there is no statistically significant difference in students' confidence levels with using math concepts by number of math courses taken ($H = 0.220$, $p = 0.974$) with a mean rank of 45.28 for one math course taken, 41.67 for two math courses taken, 45.08 for three math courses taken, and 48.17 for four math courses taken.

Table 20b. Kruskal Wallis Test: Grouping Variable: Number of Science Courses Taken

Ranks			
	Number of Science courses taken.	N	Mean Rank
I feel confidence with using concepts from science in my life	1	56	49.10
	2	4	56.75
	3	30	39.23
	4	3	72.50
	Total	93	

Test Statistics[a,b]	
	I feel confidence with using concepts from science in my life
Chi-Square	6.422
df	3
Asymp. Sig.	.093

The following non-directional hypotheses was tested to investigate whether students' confidence in using science concepts in their lives depends on the number of science courses taken

H0: Students confidence with using concepts from science in their lives does not depend on the number of math courses taken
HA: Students confidence with using concepts from science in their lives depend on the number of math courses taken

According to Table 20b, there is no statistically significant difference in students' confidence levels with using science concepts by number of science courses taken (H = 6.420, p = 0.093) with a mean rank of 49.10 for one math course taken, 56.75 for two math courses taken, 39.23 for three math courses taken, and 72.50 for four math courses taken.

Statistically significant difference by number of math courses taken was observed in student ability to solve problems by themselves (Table 21).

Tabel 21: Kruskal Wallis Test: Grouping Variable: Number of Math Courses Taken

Ranks			
	Number of Math courses taken.	N	Mean Rank
I like to solve problems by working them out myself	1	56	40.06
	2	3	49.50
	3	20	53.95
	4	13	62.08
	Total	92	

Test Statistics[a,b]	
	I like to solve problems by working them out myself
Chi-Square	10.667
df	3
Asymp. Sig.	.014

There is a statistically significant difference by number of math courses taken in students ability to solve problems by working them out themselves (H = 10.667, p = 0.014) with a mean rank of 40.06 for one math course taken, 49.50 for two math courses taken, 53.95 for three math courses taken, and 62.08 for four math courses taken.

Enjoyment Subscale

Statistically significant differences by number of math and science courses taken in students' attitudes measured on the enjoyment subscale are represented on Tables 21a and 21b.

Table 21a: Kruskal- Wallis Test: Grouping Variable: Number of Math Courses Taken

Ranks			
	Number of Math courses taken.	N	Mean Rank
I enjoy solving Sudoku puzzles	1	56	40.14
	2	3	70.50
	3	20	58.85
	4	13	49.35
	Total	92	

Test Statistics[a,b]	
	I enjoy solving Sudoku puzzles
Chi-Square	10.602
df	3
Asymp. Sig.	.014

Table 21b: Kruskal -Wallis Test: Grouping Variable: Number of Science Courses Taken

Ranks			
	Number of Science courses taken.	N	Mean Rank
I like doing laboratory experiments	1	56	53.16
	2	4	34.00
	3	30	35.70
	4	3	62.33
	Total	93	

Test Statistics[a,b]	
	I like doing laboratory experiments
Chi-Square	10.839
df	3
Asymp. Sig.	.013

According to Table 21a, there is a statistically significant difference by number of math courses taken and students' enjoyment for solving Sudoku puzzles (H = 10.602, p = 0.014) with a mean rank of 40.16 for one math course taken, 70.50 for two math courses taken, 58.85 for three math courses taken, and 49.35 for four math courses taken. Table 18b represents mean ranks for the statistically significant difference by the number of science courses taken in students enjoyment of doing laboratory experiments (H = 10.839, p = 0.013).

No statistically significant differences by number of courses taken were observed in students' attitudes measured on the motivation and usefulness subscales.

4. Conclusions

A quantitative descriptive design was used to explore different dimensions of high school students' attitudes towards mathematics and sciences and to identify statistically significant differences in students' attitudes by sex, age, and number of math and science courses taken. Chi-square test demonstrated statistically significant gender gaps in students' attitudes measured on the motivation, enjoyment, usefulness and self-confidence subscales. An overwhelming majority of female participants underestimated the value and usefulness of acquiring scientific and mathematical skills, did not enjoy either working with numbers or solving science and math problems, and did not express any intellectual curiosity towards the subject matter. Meanwhile, more female participants felt confident in using basic math in everyday life compared with males and more females seemed to check discount rates while shopping. No statistically significant differences by age and number of courses taken were discovered in students' confidence levels in using math and science concepts in their lives. Statistically significant differences by number of math courses taken were discovered in students' abilities to solve problems by working them out themselves and in students' enjoyment for solving Sudoku puzzles. Statistically significant differences by number of science courses taken were observed in students' enjoyment for doing laboratory experiments. No statistically significant differences by number of courses taken were observed in students' attitudes measured on the motivation and usefulness subscales.

Educating students about benefits of studying math and science and encouraging them to take more advanced courses may influence student attitudes positively and decrease gender gaps in math and science programs. Instructors should emphasize that studying mathematics develops problem solving, logical, analytical, and abstract thinking skills that are highly valued by all employers. Science curriculum should include more real life problem solving examples to increase student motivation and demonstrate how basic science skills such as making predictions, gathering evidence, weighting the evidence and drawing conclusions manifest in daily decision making and problem solving.

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Future Research Plans

To improve representativeness of the sample, 500 research subjects will be selected from five different New York City private high schools using random sampling. Students' attitudes toward mathematics and sciences will also be investigated at undergraduate level by surveying students from several private liberal arts colleges located in New York City. Exploring changes in students' attitudes as they progress from high school to college level may provide a valuable insight toward improving math and science programs.

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