HYPOTHESIS

# Assessing Anxiety and Attitudes Towards Arithmetic and Algebra

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**ABSTRACT**

The study aimed at assessing the anxiety levels and attitudes of 68 students of Grades 11 and 12 studying the International Baccalaureate Diploma Program towards the math components of arithmetic and algebra by using a quantitative correlational study. Two survey instruments were used where the first section consisted of an achievement test for each branch of arithmetic and algebra. The second section consisted of an eighteen-item five-point Likert. scale where the anxiety levels and attitudes of the students were assessed. The results showed that a negative correlation existed between anxiety levels and performance for both, arithmetic and algebra and a weak positive correlation existed between attitudes and performance. Additionally, significant differences existed in anxiety levels and attitudes between high and low performers for each component. Thus, although arithmetic and algebra were components that students had high familiarity with, the anxiety levels and attitudes towards them were different.

**Key Words:** *Algebra; Arithmetic; Hypotheses; Cronbach's alpha.*

## INTRODUCTION

Math is an important aspect of STEM education and over the years, a decline in the number of students opting for the subject has been observed. One of the possible reasons for this is the increasing anxiety levels associated with the subject [1]. The rising anxiety levels lead to lowering the confidence levels finally leading to its complete avoidance [2,3]. Furthermore, an increase in anxiety levels negatively impact performance [3,4]. Hence, many students prefer dropping the subject altogether. The attitudes that students develop towards the subject guide the behavior of individuals [5]. Positive attitudes lead to better performance where individuals have a better liking for the subject and work harder to achieve better grades [6].

Math, however, consists of many components such as arithmetic, algebra, geometry, and trigonometry where each component holds its relevance [7]. For example, arithmetic is required for basic calculations and is widely used in everyday life. Algebra uses slightly more abstract concepts called variables where expressions are created using both variables and constants. In terms of conceptual understanding, students are initially introduced to basic operations of arithmetic using simpler numbers, followed by increasing the level of complexity using fractions, decimals, and so on. Algebra, on the other hand, is introduced to students in the form of basic concepts of patterns and then extending it to slightly more abstract concepts of variables. Both are components that students are introduced to at a young age. However, depending on personal experiences and differences in understanding, students could have probably developed different perceptions of the components (Figure 1).

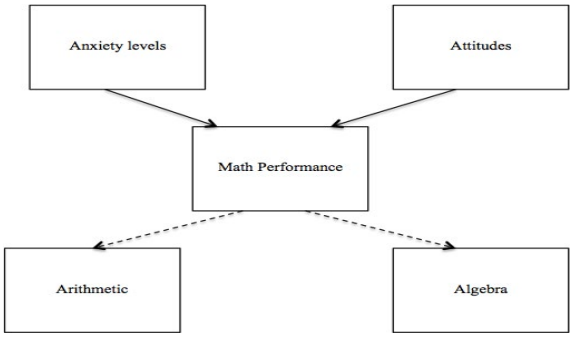


**Figure 1)** *The Theoretical Model*

The anxiety levels that students experience towards a component impact student learning and affect their performance [8]. Similarly, the attitudes students develop towards each component may affect their performance. Since math consists of many components, each that requires a different form of handling, students may or may not have the same perceptions towards them. Experienced teachers may know about the difference in student anxiety levels and attitudes based on the math component, however, new teachers may be unaware of how to pace the syllabus or handle the differences. Understanding student anxiety levels and attitudes towards individual math components can help educators provide the necessary support for the respective components. Additionally, an understanding of student perceptions can be used to modify the pace and design the syllabus accordingly. Many studies in the past have been conducted where anxiety levels or attitudes have been assessed with basic math performance or the general nature of math [9-11]. Limited studies were conducted on individual math components [12]. Hence, the study aimed to understand the anxiety levels and attitudes of students towards arithmetic and algebra, independently.

The theoretical framework guiding the study is as follows:

The set of hypotheses that guide the study are:

Null Hypothesis (H0): There is no difference in the anxiety levels and attitudes between arithmetic and algebra.

Alternate Hypothesis (H1): There is a significant difference in the anxiety levels and attitudes between arithmetic and algebra.

The research questions that guide the study are:

Research Question 1.1: What is the correlation between anxiety levels, attitudes, and performance in arithmetic?

Research Question 1.2: What is the correlation between anxiety levels, attitudes, and performance in algebra?

Research Question 2: Is there a significant difference in the anxiety levels, attitudes, and performance of the students between arithmetic and algebra?

Research Question 3: Is there a significant difference in the anxiety levels and attitudes towards arithmetic and algebra based on the branch of math?

Research Question 4: Is there a significant difference in the anxiety levels and attitudes towards arithmetic and algebra based on gender?

Research Question 5.1: Is there a significant difference in the anxiety

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levels and attitudes towards arithmetic based on the level of achievement? Research Question 5.2: Is there a significant difference in the anxiety levels and attitudes towards algebra based on the level of achievement? Research Question 6: Is there a significant difference in the anxiety levels and attitudes towards arithmetic and algebra based on the grade level?

## LITERATURE REVIEW

### Math anxiety

Math anxiety can be described as a "feeling of tension, apprehension, or fear that interferes with math performance" [13]. Anxiety is characterized by negative psychological reactions related to math situations [14]. The anxiety levels that students have negatively affect their performance [15,4]. Higher anxiety levels affect the confidence levels of the students, which eventually leads to avoidance [2]. In recent years, there has been a decline in the number of students graduating from the STEM field of education and one of the possible reasons for that is the rising anxiety levels [1]. Poor math skills lead to lower confidence levels, leading to higher anxiety levels, subsequently resulting in avoidance and underperformance in the STEM domains [16,17].

Math anxiety is a predictor of math skills in school children and adults [18]. Anxiety affects the well-being of an individual [19]. Past studies have been conducted to assess the anxiety levels towards the general nature of math. Research by Cargnelutti et al. (2017) was done to longitudinally investigate the relation between math performance, math-specific anxiety, and general anxiety. Reali et al. (2016) examined the link between math anxiety and performance in a group of 296 Colombian students. Gunderson et al. (2018) performed a longitudinal study to examine the anxiety levels and achievement of 634 first and second graders. Pappas et al. (2019) studied the relationship between working memory, attention, and math anxiety with math achievement for Grades 2 and 3. Szczygiel(2020) conducted two studies to measure general and test anxiety with math and Polish language self- esteem and math achievement for primary children. Dagaylo-an and Tancinco (2016) studied the relationship between math performance and anxiety. Wang (2020) proposed a model to show the relationship between gender, spatial ability, math anxiety, and math achievement. A study by Mutlu (2019) was done to understand the math anxiety levels in students with and without learning difficulties. Gand Sarmany-Schuller (2018) examined the relations between math anxiety, trait anxiety, and perceived problem-solving ability for 128 university students.

These aforementioned studies were done towards the general nature of math. Some studies were conducted to assess anxiety using basic math skills or arithmetic. Klados et al. (2015) conducted a study with 32 university students to assess anxiety levels using basic arithmetic problems. Kucian et al. (2018) performed a study to determine the anxiety levels and changes in the brain structure using basic arithmetic problems, number line recognition, and so on. Pappas et al. (2019) assessed anxiety levels with specific math operations like division, pattern recognition, and number line estimation. Sorvo et al. (2019) examined the anxiety levels for arithmetic computations in math for students of Grades 2- 4.

### Attitudes

Attitude towards math is described as the liking or disliking of math, which determines the tendency to engage in the subject, and a belief regarding the utility of the subject. Attitude towards math is an important predictor of performance. A better attitude leads to a better performance where the interest and readiness toward the subject also increase [6]. Attitude and anxiety are also correlated, where better attitudes reduce the anxiety levels associated with a subject, and thereby improve the performance of a subject.

In a study by Fullerton and Kendrick (2013), the findings revealed that overall, students had a more positive than negative attitude to statistics. Katranc and Ş engul (2019) measured the attitudes toward math problem-solving revealing that students had an overall positive attitude to problem-solving. Mirza and Hussain (2018) determined the attitudes of middle school students to find that there were no significant differences in attitudes between the students. However, the study revealed a positive relationship between math achievement and attitudes and a difference in the attitudes between the target achievers and non-achievers. Al-Mutawah and Fateel (2018) determined that levels of grit and attitude were positively correlated with achievements in math and science. Mokgwathi et al. (2019) revealed that students with a cheerful outlook toward math were moreonfident and displayed better results compared to those with negative attitudes. Capuno et al. (2019) determined that students had a positive attitude towards the value of math and a neutral attitude related to confidence levels, enjoyment, and motivation in math. Performance and math attitudes had a negligible positive correlation. Dowker et al. (2019) assessed the attitudes of English and Chinese primary children, where the attitudes of the children in the English group showed significant relations to their math performance as compared to the Chinese group. Overall, the attitudes toward math were found to be significant predictors of performance. Mazana et al. (2018) discovered that initially, students had a positive attitude to math. However, the math attitudes decreased as the grade levels increased. Albelbisi and Yusop (2018) aimed to discover factors influencing attitudes to discover that performance expectancy influenced attitudes to a greater extent than effort expectancy. The aforementioned studies determined the attitudes of students towards math.

Most studies have been conducted to assess anxiety levels and attitudes towards the general nature of math. Fewer studies have assessed anxiety levels using more specific math components. Hunt et al., (2019) assessed the anxiety levels towards specific math domains of abstract math anxiety, statistics probability anxiety, statistics calculation anxiety, and numerical calculation anxiety. Catapano (2014) assessed anxiety levels and attitudes towards algebra. Condron et al. (2018), conducted a study to understand the anxiety levels of social science students taking statistics courses. Higher confidence levels led to lower anxiety and the previous knowledge impacted the confidence and attitudes towards the course. Since math has many branches, understanding anxiety levels and attitudes for each component will help educators deliver the syllabus in a manner that can probably help students combat the anxiety levels for each component. Hence, for this study, the researcher aimed to assess anxiety levels and attitudes towards specific math components of arithmetic and algebra.

## METHODOLOGY

The study utilized a quantitative correlational methodology and design to assess the anxiety levels and attitudes towards arithmetic and algebra. Due to the familiarity with the maths syllabus of the International Baccalaureate Diploma Program, students of Grades 11 and 12 were considered for participation. Consent was first obtained from the organizations, after which IRB approval was sought. A pilot study was first conducted, before proceeding with the actual data collection. Google Forms were used for parental and students' consent. After gaining consent, the researcher proceeded with data collection. Google Forms were sent to the students and they were supervised while answering the tests. In some cases, the researcher collected the data from the participants, and in some cases, the schoolteachers helped with data collection. The schools decided on the process for data collection, as the survey instruments were similar to regular class achievement tests.

### Sample studied

A total of 72 students participated in the study of which, the data was analyzed for 68 students (19.9%). The students were expected to sit for two achievement tests and only the students who attempted both the tests were considered for analysis. There were 23 students from Grade 11 (33.8%) and a total of 24 males (35.5%). Math in the IB is offered at two levels, the Standard Level (SL) and the Higher Level (HL). There are two broad options for math, Math Application and Interpretation (MAI) and Math Analysis and Approaches (MAA). Each one is offered at both levels, resulting in four options (MAI HL, MAA HL, MAI SL, MAA SL). When the students were classified based on the math option, a total of 9 students (13.2%) were from MAI SL, 7 students (10.3%) were from MAA SL and MAI HL each, and 45 students (66.2%) were from MAA HL. A total of 16 students (23.5%) were from the SL.

The students were also classified based on their performance level in the achievement test of 15 marks. Students with a performance of 12 or higher were classified as high performance, 6 or less were poor, and the rest were classified as moderate. In arithmetic, there were 6 high performers, 33 moderate performers, and 29 low performers. In algebra, there were 18 high performers, 22 moderate performers, and 28 low performers.

### Design of study

A quantitative correlational methodology was adopted for this study, which would enable an understanding of the relationships between the variables [20-22]. The study aimed to determine the anxiety levels and attitudes of students towards arithmetic and algebra, identify correlations, and compare the values to identify differences in individual perceptions. The independent variables were the performances in arithmetic and algebra, and the dependent variables were the anxiety levels and attitudes in each component.

**Data collection instrument**

Individual data collection instruments were created for arithmetic and algebra each. Each instrument consisted of three sections. The first section consisted of basic details including the student identification number, grade, and level of chosen math. The second section consisted of an achievement test, specific to each component, where 15 mark achievement tests were specially created. The questions were based on the type of questions asked in the diploma IB curriculum and consisted of multiple-choice questions.

The third section was used to assess the perceptions of the students. For measuring the anxiety levels, nine statements were adopted from the Modified Abbreviated Math Anxiety Scale [20-22]. For arithmetic, the statements were modified to assess anxiety levels to arithmetic. For example, "I get anxious to complete an arithmetic worksheet by myself" [14]. From the pilot study, the Cronbach's alpha value for these nine items for the arithmetic test was found to be .94, indicating high reliability. For algebra, the statement was modified to gain perceptions of algebra. For example "I get anxious to complete an algebra worksheet by myself" [14]. From the pilot study, the Cronbach's alpha value for the algebra test was found to be .96, indicating high reliability. A five-point Likert-type scale ranging from "Strongly Agree" corresponding to a value of '5' to "Strongly Disagree" corresponding to a value of '1' was used. Google Forms were used to collect the data.

For measuring attitudes, nine statements from the Attitude Toward Mathematics Inventory were used [23]. A five-point Likert-type scale with options varying from "Strongly Agree" which corresponded to a value of '5' to "Strongly Disagree" which corresponded to the value of '1' was used to assess the perceptions. For arithmetic, the statements were modified to gauge the attitudes toward arithmetic. An example of a statement includes "Arithmetic is one of the most important subjects for people to study" [23]. A pilot study was conducted to assess the reliability of the instrument. The Cronbach's alpha value for the nine items selected for measuring attitudes towards arithmetic was found to be .93, indicating high reliability. For algebra, the statements were modified to assess attitudes towards algebra. An example of a statement includes "Algebra is one of the most important subjects for people to study" [23]. From the pilot study, the Cronbach's alpha value for the nine items selected to measure attitudes towards algebra was found to be .93, indicating high reliability once again [24].

## RESULTS

The data were analyzed using SPSS (Version 28) as follows:

RQ 1.1: What is the correlation between anxiety levels, attitudes, and performance in arithmetic?

A Pearson's correlation was used to understand the correlation between performance, anxiety levels, and attitudes toward arithmetic. A weak correlation was observed between anxiety levels and performance and a weak positive correlation was observed between attitudes and performance. Table 1.1 displays the results of the correlations of performance, anxiety levels, and attitudes in arithmetic. Figures 2.1 and 2.2 show the relations between performance in arithmetic and the corresponding anxiety levels and attitudes [25].

**TABLE 1. 1**

**Correlations between arithmetic and student perceptions**

| | | Arithmetic Performance | Arithmetic Anxiety | Arithmetic Attitude |
|---|---|---|---|---|
| Arithmetic Performance | Pearson Correlation | 1 | -.425** | .261* |
| | Sig. (2-tailed) | | <.001 | 0.031 |
| | N | 68 | 68 | 68 |
| Arithmetic Anxiety | Pearson Correlation | -.425** | 1 | -.327** |
| | Sig. (2-tailed) | <.001 | | 0.007 |
| | N | 68 | 68 | 68 |
| Arithmetic Attitude | Pearson Correlation | .261* | -.327** | 1 |
| | Sig. (2-tailed) | 0.031 | 0.007 | |
| | N | 68 | 68 | 68 |

*** Correlation is significant at the 0.01 level (2-tailed), *Correlation is significant at the 0.05 level (2-tailed).*

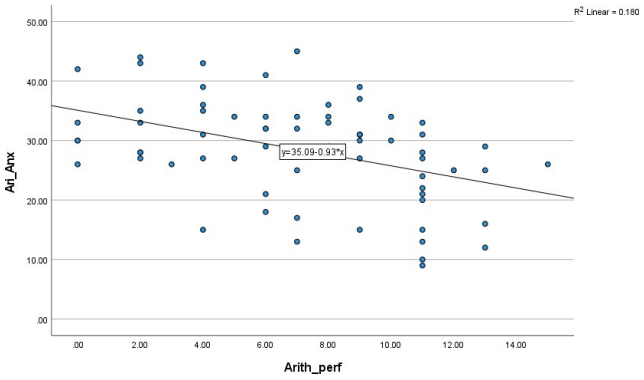


**Figure 2.1)** *Scatter plot for performance versus anxiety levels in arithmetic*

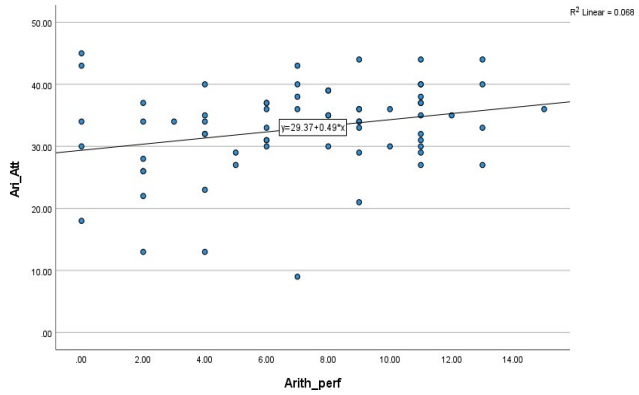


**Figure 2.2)** *Scatter plot for performance versus attitudes towards arithmetic*

RQ 1.2: What is the correlation between anxiety levels, attitudes, and performance in algebra?

A Pearson's correlation was used to understand the correlation between performance, anxiety levels, and attitudes toward algebra. A negative correlation was observed between anxiety levels and performance and a weak positive correlation was observed between attitudes and performance. Table 1.2 displays the results of the correlations of performance, anxiety levels, and attitudes in algebra. Figures 3.1 and 3.2 show the relations between performance in algebra and the corresponding anxiety levels and attitudes [26-28].

**TABLE 1. 2**

**Correlations between algebra and student perceptions**

| | | Arithmetic Performance | Arithmetic Anxiety | Arithmetic Attitude |
|---|---|---|---|---|
| Arithmetic Performance | Pearson Correlation | 1 | -0.468 | .374** |
| | Sig. (2-tailed) | | <.001 | 0.002 |
| | N | 68 | 68 | 68 |
| Arithmetic Anxiety | Pearson Correlation | -0.468 | 1 | -0.302 |
| | Sig. (2-tailed) | <.001 | | 0.012 |
| | N | 68 | 68 | 68 |
| Arithmetic Attitude | Pearson Correlation | .374** | -0.302 | 1 |
| | Sig. (2-tailed) | 0.002 | 0.012 | |
| | N | 68 | 68 | 68 |

*** Correlation is significant at the 0.01 level (2-tailed), *Correlation is significant at the 0.05 level (2-tailed).*

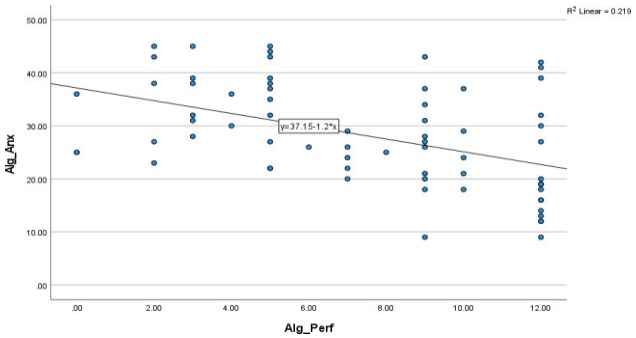


**Figure 3.1)** *Scatter plot for Performance versus Anxiety Levels in Algebra*

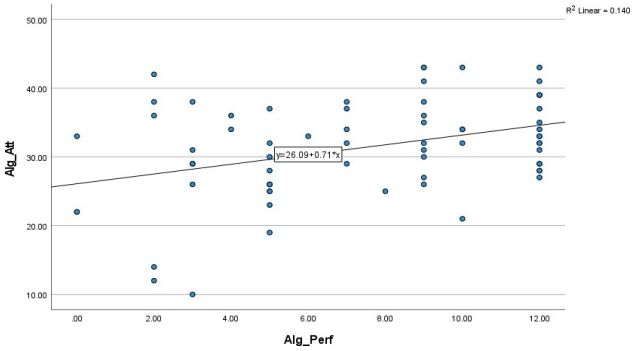


**Figure 3.2)** *Scatter plot for performance versus attitudes towards algebra*

Research Question 2: Is there a significant difference in the anxiety levels, attitudes, and performance of the students between arithmetic and algebra?

Table 2.1 shows the descriptive statistics for the performances in arithmetic and algebra, as well as student perceptions of anxiety and attitudes towards each math component. Table 2.2 shows the independent t-sample test results to examine the differences in performance, anxiety, and attitudes in each component of arithmetic and algebra. No significant differences were observed [29-32].

**TABLE 2. 1**

**Performances and perceptions for both math components**

| | Groups | N | Mean | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|---|
| Both Performances | 1 | 68 | 7.0882 | 3.8507 | 0.46697 |
| | 2 | 68 | 7.4265 | 3.78258 | 0.45871 |
| Both Anxiety Levels | 1 | 68 | 28.4706 | 8.47027 | 1.02717 |
| | 2 | 68 | 28.2059 | 9.72696 | 1.17957 |
| Both Attitudes | 1 | 68 | 32.8676 | 7.26658 | 0.8812 |
| | 2 | 68 | 31.3529 | 7.15868 | 0.86812 |

Research Question 3: Is there a significant difference in the anxiety levels and attitudes towards arithmetic and algebra based on the branch of math?

A one-way ANOVA was used to understand the differences in perceptions of students towards arithmetic and algebra based on the math option chosen. Since there were four math options, the aim was to understand whether significant differences in perceptions existed based on the math option selected by students. Table 3.1 shows the results of the ANOVA. No significant differences in perceptions were observed [33-35].

The data was further analyzed based on the level of math chosen i.e. higher and lower level math. An independent two-sample t-test was done to check for differences in perceptions between the SL and HL students. A significant difference was observed between HL and SL in the performance of students in the arithmetic test where the HL students had performed better [36].

Table 3.2 gives the descriptive statistics and Table 3.3 gives the results of the independent t-test for the HL and SL students.

Research Question 4: Is there a significant difference in the anxiety levels and attitudes towards arithmetic and algebra based on gender?

An independent two-sample t-test was done to understand differences based on gender. Table 4.1 shows the values of the descriptive statistics. Table 4.2 shows the results of the t-test. Significant differences were observed in arithmetic based on gender [37].

**TABLE 2.2**

**Two-sample t-test for performances and perceptions towards math components**

| | | Levene's Test for Equality of Variances | | t-test for Equality of Means | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Significance | | | | 95% Confidence Interval of the Difference | |
| | | | | | | One- Sided | Two- Sided | | | | |
| | | F | Sig. | t | df | p | p | Mean Difference | Std. Error Difference | Lower | Upper |
| Performances in Arithmetic and Algebra | Equal variances assumed | 0.125 | 0.724 | -0.517 | 134 | 0.303 | 0.606 | -0.33824 | 0.65458 | -1.63287 | 0.9564 |
| | Equal variances not assumed | | | -0.517 | 133.957 | 0.303 | 0.606 | -0.33824 | 0.65458 | -1.63287 | 0.9564 |
| Both Anxiety levels | Equal variances assumed | 3.036 | 0.084 | 0.169 | 134 | 0.433 | 0.866 | 0.26471 | 1.56412 | -2.82884 | 3.35825 |
| | Equal variances not assumed | | | 0.169 | 131.515 | 0.433 | 0.866 | 0.26471 | 1.56412 | -2.82937 | 3.35879 |
| Both Attitudes | Equal variances assumed | 0.057 | 0.812 | 1.225 | 134 | 0.111 | 0.223 | 1.51471 | 1.23699 | -0.93184 | 3.96126 |
| | Equal variances not assumed | | | 1.225 | 133.97 | 0.111 | 0.223 | 1.51471 | 1.23699 | -0.93185 | 3.96126 |

**TABLE 3.1**

**Comparison of components based on math option**

| Sum of Squares | | | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| Arithmetic Performance | Between Groups | 68.036 | 3 | 22.679 | 1.568 | 0.206 |
| | Within Groups | 925.435 | 64 | 14.46 | | |
| | Total | 993.471 | 67 | | | |
| Arithmetic Anxiety | Between Groups | 205.767 | 3 | 68.589 | 0.954 | 0.42 |
| | Within Groups | 4601.175 | 64 | 71.893 | | |
| | Total | 4806.941 | 67 | | | |
| Arithmetic Attitude | Between Groups | 211.199 | 3 | 70.4 | 1.354 | 0.265 |
| | Within Groups | 3326.61 | 64 | 51.978 | | |
| | Total | 3537.809 | 67 | | | |
| Algebra Performance | Between Groups | 88.067 | 3 | 29.356 | 2.158 | 0.102 |
| | Within Groups | 870.565 | 64 | 13.603 | | |
| | Total | 958.632 | 67 | | | |
| Algebra Anxiety | Between Groups | 310.172 | 3 | 103.391 | 1.098 | 0.357 |
| | Within Groups | 6028.946 | 64 | 94.202 | | |
| | Total | 6339.118 | 67 | | | |
| Algebra Attitude | Between Groups | 349.536 | 3 | 116.512 | 2.418 | 0.074 |
| | Within Groups | 3083.994 | 64 | 48.187 | | |
| | Total | 3433.529 | 67 | | | |

**TABLE 3.2**

**Descriptive statistics for standard and higher level students**

| Level | N | | Mean | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|---|
| Arithmetic Performance | 1 | 16 | 5.3125 | 3.21908 | 0.80477 |
| | 2 | 52 | 7.6346 | 3.89081 | 0.53956 |
| Arithmetic Anxiety | 1 | 16 | 30.875 | 6.58154 | 1.64538 |
| | 2 | 52 | 27.7308 | 8.89617 | 1.23368 |
| Arithmetic Attitude | 1 | 16 | 30.25 | 6.63827 | 1.65957 |
| | 2 | 52 | 33.6731 | 7.32099 | 1.01524 |
| Algebra Performance | 1 | 16 | 6.25 | 3.92428 | 0.98107 |
| | 2 | 52 | 7.7885 | 3.70128 | 0.51328 |
| Algebra Anxiety | 1 | 16 | 31.0625 | 8.19324 | 2.04831 |
| | 2 | 52 | 27.3269 | 10.06006 | 1.39508 |
| Algebra Attitude | 1 | 16 | 29.25 | 7.28011 | 1.82003 |
| | 2 | 52 | 32 | 7.06552 | 0.97981 |

**TABLE 3.3**

**Two samples t-test for standard and higher level students**

| | | Levene's Test for Equality of Variances | | t-test for Equality of Means | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Significance | | | | 95% Confidence Interval of the Difference | |
| | | | | | | One- Sided | Two- Sided | | | | |
| | | F | Sig. | t | df | p | p | Mean Difference | Std. Error Difference | Lower | Upper |
| Arithmetic Performance | Equal variances assumed | 1.307 | 0.257 | -2.16 | 66 | 0.017 | 0.034 | -2.32212 | 1.07171 | -4.4618 | -0.18238 |
| | Equal variances not assumed | | | -2.39 | 29.748 | 0.012 | 0.023 | -2.32212 | 0.96891 | -4.3015 | -0.34264 |
| Arithmetic Anxiety | Equal variances assumed | 1.543 | 0.219 | 1.305 | 66 | 0.098 | 0.196 | 3.14423 | 2.40891 | -1.6653 | 7.95378 |
| | Equal variances not assumed | | | 1.529 | 33.492 | 0.068 | 0.136 | 3.14423 | 2.05651 | -1.0374 | 7.3259 |
| Arithmetic Attitude | Equal variances assumed | 0.03 | 0.863 | -1.67 | 66 | 0.05 | 0.1 | -3.42308 | 2.05024 | -7.5165 | 0.67036 |
| | Equal variances not assumed | | | -1.76 | 27.207 | 0.045 | 0.09 | -3.42308 | 1.94548 | -7.4134 | 0.56729 |
| Algebra Performance | Equal variances assumed | 0.048 | 0.827 | -1.43 | 66 | 0.078 | 0.156 | -1.53846 | 1.07297 | -3.6807 | 0.60378 |
| | Equal variances not assumed | | | -1.38 | 23.811 | 0.089 | 0.178 | -1.53846 | 1.10723 | -3.8246 | 0.7477 |
| Algebra Anxiety | Equal variances assumed | 0.972 | 0.328 | 1.352 | 66 | 0.091 | 0.181 | 3.73558 | 2.7638 | -1.7825 | 9.25368 |
| | Equal variances not assumed | | | 1.507 | 30.231 | 0.071 | 0.142 | 3.73558 | 2.47827 | -1.3241 | 8.79526 |
| Algebra Attitude | Equal variances assumed | 0 | 0.997 | -1.35 | 66 | 0.09 | 0.181 | -2.75 | 2.03404 | -6.811 | 1.31109 |
| | Equal variances not assumed | | | -1.33 | 24.353 | 0.098 | 0.196 | -2.75 | 2.06701 | -7.0128 | 1.51283 |

**TABLE 4.1**

**Description of values based on gender**

| | Gender | N | Mean | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|---|
| Arithmetic Performance | Male | 24 | 6.8333 | 3.82971 | 0.78174 |
| | Female | 44 | 7.2273 | 3.8991 | 0.58781 |
| Arithmetic Anxiety | Male | 24 | 25.25 | 10.03147 | 2.04767 |
| | Female | 44 | 30.2273 | 7.00121 | 1.05547 |
| Arithmetic Attitude | Male | 24 | 35.5 | 5.64146 | 1.15156 |
| | Female | 44 | 31.4318 | 7.69898 | 1.16067 |
| Algebra Performance | Male | 24 | 8.375 | 3.7857 | 0.77275 |
| | Female | 44 | 6.9091 | 3.72183 | 0.56109 |
| Algebra Anxiety | Male | 24 | 26.2917 | 11.11786 | 2.26942 |
| | Female | 44 | 29.25 | 8.83999 | 1.33268 |
| Algebra Attitude | Male | 24 | 33.25 | 5.68943 | 1.16135 |
| | Female | 44 | 30.3182 | 7.70917 | 1.1622 |

**TABLE 4.2**

**Two samples t-test for omparing values based on gender**

| | | Levene's Test for Equality of Variances | | t-test for Equality of Means | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Significance | | | | 95% Confidence Interval of the Difference | |
| | | | | | | One- Sided | Two- Sided | | | | |
| | | F | Sig. | t | df | p | p | Mean Difference | Std. Error Difference | Lower | Upper |
| Arithmetic Performance | Equal variances assumed | 0.093 | 0.761 | -0.401 | 66 | 0.345 | 0.69 | -0.39394 | 0.98333 | -2.35723 | 1.56935 |
| | Equal variances not assumed | | | -0.403 | 48.131 | 0.344 | 0.689 | -0.39394 | 0.97808 | -2.36035 | 1.57248 |
| Arithmetic Anxiety | Equal variances assumed | 6.353 | 0.014 | -2.39 | 66 | 0.01 | 0.019 | -4.97727 | 2.07717 | -9.12447 | -0.83008 |
| | Equal variances not assumed | | | -2.16 | 35.505 | 0.019 | 0.038 | -4.97727 | 2.30368 | -9.65162 | -0.30292 |
| Arithmetic Attitude | Equal variances assumed | 2.29 | 0.135 | 2.274 | 66 | 0.013 | 0.026 | 4.06818 | 1.78912 | 0.49608 | 7.64028 |
| | Equal variances not assumed | | | 2.488 | 60.223 | 0.008 | 0.016 | 4.06818 | 1.635 | 0.79794 | 7.33842 |
| Algebra Performance | Equal variances assumed | 0.012 | 0.915 | 1.543 | 66 | 0.064 | 0.128 | 1.46591 | 0.95013 | -0.43109 | 3.3629 |
| | Equal variances notassumed | | | 1.535 | 46.701 | 0.066 | 0.132 | 1.46591 | 0.95497 | -0.45556 | 3.38738 |
| Algebra Anxiety | Equal variances assumed | 1.565 | 0.215 | -1.2 | 66 | 0.117 | 0.233 | -2.95833 | 2.46013 | -7.87015 | 1.95348 |
| | Equal variances not assumed | | | -1.12 | 39.11 | 0.134 | 0.268 | -2.95833 | 2.63179 | -8.28115 | 2.36448 |
| Algebra Attitude | Equal variances assumed | 2.17 | 0.145 | 1.634 | 66 | 0.054 | 0.107 | 2.93182 | 1.79436 | -0.65074 | 6.51438 |
| | Equal variances not assumed | | | 1.784 | 59.966 | 0.04 | 0.079 | 2.93182 | 1.643 | -0.35471 | 6.21834 |

Research Question 5.1: Is there a significant difference in the anxiety levels and attitudes towards arithmetic based on level of achievement?

A one-way ANOVA was conducted to understand the differences in perceptions towards arithmetic based on the level of achievement. Table 5.1 displays these results. Significant differences were observed in the arithmetic anxiety levels. An independent two-sample t-test was done to check for differences between the high and low performers. Tables 5.2 and 5.3 give the values of the descriptive statistics and t-tests respectively.

Research Question 5.2: Is there a significant difference in the anxiety levels and attitudes towards algebra based on the level of achievement?

A one-way ANOVA was conducted to understand the differences in perceptions towards algebra based on the level of achievement. Table 5.4 displays these results. Significant differences were observed in the anxiety levels and attitudes towards algebra. An independent two-sample t-test was done to check for differences between the high and low performers. Tables 5.5 and 5.6 give the values of the descriptive statistics and t-tests respectively.

Research Question 6: Is there a significant difference in the anxiety levels and attitudes towards arithmetic and algebra based on the grade level?

An independent two-sample t-test was done to check for differences based on grade level. Table 6.1 gives the values of the descriptive statistics and Table 6.2 gives the values of the independent t-test.

**TABLE 5.1**

**Comparison of perceptions based on arithmetic achievement level**

| | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| Arithmetic Anxiety | Between Groups | 632.386 | 2 | 316.193 | 4.923 | 0.01 |
| | Within Groups | 4174.555 | 65 | 64.224 | | |
| | Total | 4806.941 | 67 | | | |
| Arithmetic Attitude | Between Groups | 252.708 | 2 | 126.354 | 2.5 | 0.09 |
| | Within Groups | 3285.101 | 65 | 50.54 | | |
| | Total | 3537.809 | 67 | | | |

**TABLE 5.2**

**Descriptive statistics of perceptions based on arithmetic achievement level**

| Category | Arithmetic | N | Mean | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|---|
| Arithmetic Anxiety | 1 | 29 | 31.6897 | 7.22151 | 1.341 |
| | 3 | 6 | 22.1667 | 6.61564 | 2.70082 |
| Arithmetic Attitude | 1 | 29 | 30.6897 | 7.68163 | 1.42644 |
| | 3 | 6 | 35.8333 | 5.84523 | 2.3863 |

**TABLE 5.3**

**Comparison of perceptions based on arithmetic achievement level**

| Levene's Test for Equality of Variances | | | | t-test for Equality of Means | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Significance | | | | 95% Confidence Interval of the Difference | |
| | | | | | | One- Sided | Two- Sided | | | | |
| | | F | Sig. | t | df | p | p | Mean Difference | Std. Error Difference | Lower | Upper |
| Arithmetic Anxiety | Equal variances assumed | 0.004 | 0.951 | 2.977 | 33 | 0.003 | 0.005 | 9.52299 | 3.19914 | 3.01429 | 16.03168 |
| | Equal variances not assumed | | | 3.158 | 7.686 | 0.007 | 0.014 | 9.52299 | 3.01542 | 2.51963 | 16.52635 |
| Arithmetic Attitude | Equal variances assumed | 0.535 | 0.47 | -1.54 | 33 | 0.066 | 0.132 | -5.14368 | 3.3335 | -11.925 | 1.63838 |
| | Equal variances not assumed | | | -1.85 | 9.006 | 0.049 | 0.097 | -5.14368 | 2.78014 | -11.432 | 1.14477 |

**TABLE 5.4**

**Comparison of perceptions based on algebra achievement level**

| | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| Algebra Anxiety | Between Groups | 1717.785 | 2 | 858.892 | 12.08 | <.001 |
| | Within Groups | 4621.333 | 65 | 71.097 | | |
| | Total | 6339.118 | 67 | | | |
| Algebra Attitude | Between Groups | 558.4 | 2 | 279.2 | 6.312 | 0.003 |
| | Within Groups | 2875.13 | 65 | 44.233 | | |
| | Total | 3433.529 | 67 | | | |

**TABLE 5.5**

**Descriptive statistics of perceptions based on algebra achievement level**

| Category | Algebra | N | Mean | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|---|
| Algebra Anxiety | 1 | 28 | 33.9643 | 7.55955 | 1.42862 |
| | 3 | 18 | 22.1111 | 10.49307 | 2.47324 |
| Algebra Attitude | 1 | 28 | 27.9286 | 7.95789 | 1.5039 |
| | 3 | 18 | 33.8333 | 4.87792 | 1.14974 |

**TABLE 5.6**

**Comparison of perceptions based on algebra achievement level**

| | | Levene's Test for Equality of Variances | | t-test for Equality of Means | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Significance | | | | 95% Confidence Interval of the Difference | |
| | | | | | | One- Sided | Two- Sided | | | | |
| | | F | Sig. | t | df | p | p | Mean Difference | Std. Error Difference | Lower | Upper |
| Algebra Anxiety | Equal variances assumed | 2.646 | 0.111 | 4.454 | 44 | <.001 | <.001 | 11.85317 | 2.66144 | 6.4894 | 17.21695 |
| | Equal variances not assumed | | | 4.15 | 28.256 | <.001 | <.001 | 11.85317 | 2.8562 | 6.0049 | 17.70145 |
| Algebra Attitude | Equal variances assumed | 3.111 | 0.085 | -2.82 | 44 | 0.004 | 0.007 | -5.90476 | 2.09424 | -10.125 | -1.6841 |
| | Equal variances not assumed | | | -3.12 | 43.943 | 0.002 | 0.003 | -5.90476 | 1.89304 | -9.7201 | -2.08945 |

**TABLE 6.1**

**Description of values based on grade level**

| | Grade | N | Mean | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|---|
| Arithmetic Performance | Grade 11 | 23 | 6.5652 | 3.87094 | 0.80715 |
| | Grade 12 | 45 | 7.3556 | 3.85626 | 0.57486 |
| Arithmetic Anxiety | Grade 11 | 23 | 28.5217 | 8.89775 | 1.85531 |
| | Grade 12 | 45 | 28.4444 | 8.34635 | 1.2442 |
| Arithmetic Attitude | Grade 11 | 23 | 31.7826 | 7.42206 | 1.54761 |
| | Grade 12 | 45 | 33.4222 | 7.20634 | 1.07426 |
| Algebra Performance | Grade 11 | 23 | 7.4348 | 3.6906 | 0.76954 |
| | Grade 12 | 45 | 7.4222 | 3.86998 | 0.5769 |
| Algebra Anxiety | Grade 11 | 23 | 28.6522 | 9.49932 | 1.98075 |
| | Grade 12 | 45 | 27.9778 | 9.93956 | 1.4817 |
| Algebra Attitude | Grade 11 | 23 | 30.9565 | 7.48014 | 1.55972 |
| | Grade 12 | 45 | 31.5556 | 7.06642 | 1.0534 |

**TABLE 6.2**

**Two samples t-test for comparison based on grade level**

| | | Levene's Test for Equality of Variances | | t-test for Equality of Means | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Significance | | | | 95% Confidence Interval of the Difference | |
| | | | | | | One-Sided | Two-Sided | | | | |
| | | F | Sig. | t | df | p | p | Mean Difference | Std. Error Difference | Lower | Upper |
| Arithmetic Performance | Equal variances assumed | 0.112 | 0.739 | -0.79 | 66 | 0.214 | 0.427 | -0.79034 | 0.9897 | -2.766 | 1.18565 |
| | Equal variances not assumed | | | -0.79 | 44.282 | 0.215 | 0.429 | -0.79034 | 0.99093 | -2.787 | 1.2064 |
| Arithmetic Anxiety | Equal variances assumed | 0.358 | 0.551 | 0.035 | 66 | 0.486 | 0.972 | 0.07729 | 2.18747 | -4.29 | 4.44472 |
| | Equal variances not assumed | | | 0.035 | 41.991 | 0.486 | 0.973 | 0.07729 | 2.23388 | -4.431 | 4.58547 |
| Arithmetic Attitude | Equal variances assumed | 0.256 | 0.614 | -0.88 | 66 | 0.191 | 0.383 | -1.63961 | 1.86575 | -5.365 | 2.08548 |
| | Equal variances not assumed | | | -0.87 | 43.284 | 0.194 | 0.389 | -1.63961 | 1.88391 | -5.438 | 2.15893 |
| Algebra Performance | Equal variances assumed | 0.349 | 0.557 | 0.013 | 66 | 0.495 | 0.99 | 0.01256 | 0.97687 | -1.938 | 1.96295 |
| | Equal variances not assumed | | | 0.013 | 46.356 | 0.495 | 0.99 | 0.01256 | 0.96178 | -1.923 | 1.94812 |
| Algebra Anxiety | Equal variances assumed | 0.049 | 0.826 | 0.269 | 66 | 0.395 | 0.789 | 0.6744 | 2.51067 | -4.338 | 5.68711 |
| | Equal variances not assumed | | | 0.273 | 46.267 | 0.393 | 0.786 | 0.6744 | 2.47362 | -4.304 | 5.65276 |
| Algebra Attitude | Equal variances assumed | 0.047 | 0.829 | -0.32 | 66 | 0.373 | 0.747 | -0.59903 | 1.8473 | -4.287 | 3.08922 |
| | Equal variances not assumed | | | -0.32 | 42.252 | 0.376 | 0.752 | -0.59903 | 1.88212 | -4.397 | 3.19857 |

Research Question 5.1: Is there a significant difference in the anxiety levels and attitudes towards arithmetic based on level of achievement?

A one-way ANOVA was conducted to understand the differences in perceptions towards arithmetic based on the level of achievement. Table 5.1 displays these results. Significant differences were observed in the arithmetic anxiety levels. An independent two-sample t-test was done to check for differences between the high and low performers. Tables 5.2 and 5.3 give the values of the descriptive statistics and t-tests respectively.

Research Question 5.2: Is there a significant difference in the anxiety levels and attitudes towards algebra based on the level of achievement?

A one-way ANOVA was conducted to understand the differences in perceptions towards algebra based on the level of achievement. Table 5.4 displays these results. Significant differences were observed in the anxiety levels and attitudes towards algebra. An independent two-sample t-test was done to check for differences between the high and low performers. Tables 5.5 and 5.6 give the values of the descriptive statistics and t-tests respectively.

Research Question 6: Is there a significant difference in the anxiety levels and attitudes towards arithmetic and algebra based on the grade level?

An independent two-sample t-test was done to check for differences based on grade level. Table 6.1 gives the values of the descriptive statistics and Table 6.2 gives the values of the independent t-test.

The results for each research question are analyzed in the next section.

## DISCUSSION OF RESULTS

Research Question 1.1: What is the correlation between anxiety levels, attitudes, and performance in arithmetic?

A moderate negative correlation was observed between anxiety levels and performance in arithmetic. A weak positive correlation was observed between attitude and performance. This was consistent with previous literature where anxiety was found to negatively impact performance and better attitudes were found to positively impact performance. Thus, for arithmetic, the findings were consistent with previous literature.

Research Question 1.2: What is the correlation between anxiety levels, attitudes, and performance in algebra?

For algebra, a moderate negative correlation was observed between anxiety levels and performance in algebra. A weak positive correlation was observed between attitude and performance. These results for algebra were consistent with previous literature.

Research Question 2: Is there a significant difference in the anxiety levels, attitudes, and performance of the students between arithmetic and algebra?

The results of the independent two-sample t-test showed that there were no significant differences in the anxiety levels, attitudes, and performances of students in arithmetic and algebra. This was indicative of the fact that perceptions of both components were similar. This could be because arithmetic and algebra are both components with which students have a relatively high amount of familiarity and hence, there is no significant difference in the perceptions.

Research Question 3: Is there a significant difference in the anxiety levels and attitudes towards arithmetic and algebra based on the branch of math?

While comparing the performances and perceptions for all four options, no significant differences were seen. This indicates that the students had relatively similar perceptions and the option of math selected did not impact their performance, anxiety levels, or attitudes. Thus, the math option selected by the students was not an indication of their perceptions of each component.

However, when the analysis was done based on the level of subject choice i.e. HL or SL, differences in values were seen. However, the only significant difference was in arithmetic performance, indicating that in the arithmetic test, the HL students had a better performance than the SL students. When the anxiety levels and attitudes were compared, no significant differences were observed indicating that both SL and HL students had similar anxiety levels and attitudes towards arithmetic. Students had a similar performance in the algebra test and the similar anxiety levels and attitudes also showed that both, HL and SL students experienced similar perceptions. This is an interesting finding, as one would assume that the HL students would perhaps have lower anxiety levels and better attitudes than the SL students. However, the findings revealed similar levels of anxiety and attitudes, and educators need to be sensitized to the existence of these perceptions.

Research Question 4: Is there a significant difference in the anxiety levels and attitudes towards arithmetic and algebra based on gender?

While comparing the perceptions based on gender, differences in values were seen.

However, for arithmetic, the difference in anxiety levels and attitudes was significant based on gender. This indicated that for arithmetic, the anxiety levels of the females were significantly more than the males. Additionally, the attitudes of males toward arithmetic were significantly higher than of females. There were no significant differences in performance in arithmetic and algebra based on gender. For algebra, however, no significant differences in perceptions were seen.

This indicated that arithmetic and algebra were math components in which students had similar performances. Although arithmetic and algebra were components that students had been exposed to for a fairly long period, there were differences in the anxiety levels and attitudes, where the differences in perceptions towards arithmetic were significant compared to differences in algebra. Educators need to sensitize themselves to the varying anxiety levels and attitudes based on gender and accordingly pace class depending on the type of students as well as the course content being delivered.

Research Question 5.1: Is there a significant difference in the anxiety levels and attitudes towards arithmetic based on the level of achievement?

While assessing the anxiety levels based on the performance levels, a significant difference was seen amongst the low, moderate, and high performers. While comparing the low and high performers, a significant difference was observed in the anxiety levels for arithmetic. However, no significant differences were observed in the attitudes. This indicated that the anxiety levels are dependent on the level of performance where lower performers have higher anxiety levels. This finding is of significance as in every class, one would have students of different caliber and the weaker students tend to get more anxious. Thus, even if a student is an HL student, but a low performer, high levels of anxiety exist, and educators need to be sensitive to such students. Students require either additional support, revision of old concepts, or perhaps even more time to reduce or cope with the anxiety. Teachers too need additional resources that can help them to differentiate and provide the necessary support for such students.

Research Question 5.2: Is there a significant difference in the anxiety levels and attitudes towards algebra based on the level of achievement?

While assessing the anxiety levels and attitudes based on the performance levels in algebra, a significant difference was seen amongst the low, moderate, and high performers. While comparing the low and high performers, a significant difference was observed in the anxiety levels and attitudes toward algebra. Thus, in algebra, the differences in perceptions were significant compared to arithmetic. In algebra, the weaker students had significantly poorer attitudes and higher anxiety levels. Arithmetic and algebra can be considered to be two basic components of math. Despite that, the perceptions towards each component were varied. Algebra consists of slightly more abstract concepts compared to arithmetic. Students with a weaker ability to grasp those concepts had significant differences in their perceptions of algebra than arithmetic. Educators need to be sensitized to the perceptions of weaker students. Additionally, educators need to work on improving the attitudes of the students, by creating better classroom environments, allowing mistakes to take place, increasing peer support, being more motivational, and creating a supportive work atmosphere. When the student feels more comfortable, the attitude is likely to increase, thereby having an impact on the performance. While the high performers may be intrinsically motivated, the low performers would perhaps need to understand the utility of a component to develop a better attitude. Thus, teachers need to work on improving the attitudes by making students understand the real-world application of a component.

Research Question 6: Is there a significant difference in the anxiety levels and attitudes towards arithmetic and algebra based on the grade level?

On comparing the anxiety levels and attitudes based on the grade, no significant differences were seen in the values. This indicates that neither the performances nor perceptions differ based on the grade level. Thus, a similar support system can be created for both grade levels.

## CONCLUSION

Overall, the findings of the study reveal that although arithmetic and algebra are math components that students are exposed to for a long period, students exhibit different levels of anxiety and attitudes toward the different components. For arithmetic, there were no major differences in anxiety based on the level of performance. However, for algebra, it was observed that a significant difference in anxiety existed between the high and low achievers. This reveals that although math is one subject, students do not perceive the individual components in the same way. While arithmetic caused less anxiety, algebra, another basic math component, showed more levels of anxiety among the students. Thus, a certain amount of differentiation occurs among students based on the component. Educators need to be made aware of the different perceptions so that differentiation can be incorporated not only based on the students but also based on the math component being taught. Differentiation can be done by providing additional support, more drill practice for concepts that students are more anxious about, and perhaps even using different forms of technology to help in better understanding. Additionally, teachers also need to be provided with more access to resources, and better resources need to be designed that would support teachers to provide students with differentiation. Teachers need to understand the weaker areas of students and provide targeted practice to them so that they focus on specific and not generic areas of math. Educators should also consciously work on improving the attitudes of students and focusing on the real-world application of the components.

## SUGGESTIONS FOR FUTURE RESEARCH

The current study has been conducted to assess anxiety levels and attitudes towards arithmetic and algebra. Math, however, is made up of several other components such as geometry, trigonometry, calculus, and so on. Perceptions towards these other components should also be assessed. The student population for this study consisted of Grades 11 and 12 studying the IB curriculum. The study should be extended to other boards as well as other grades to understand the different perceptions of the students. The study was conducted to assess the perceptions of students in Mumbai. The study can be repeated to assess student perceptions in different parts of the world. The limitations of the current study included a small sample size. Although the tests used were appropriate, the accuracy can be improved by acquiring the perceptions of more students. Hence, the study should be repeated using larger sample sizes to improve the accuracy of the results. Furthermore, the highly anxious students avoided the study. The research is recommended to be repeated but by doing this as a whole class event to gain the perceptions of all the students. Lastly, the students were assessed using web cameras as the data was collected using Google Forms. In future studies, actual monitoring of the students in school is recommended.

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