

## **CHAPTER – 6**

### **RESULTS**

<b>6.0</b>	<b>RESULTS</b>	<b>91-112</b>
<b>6.1</b>	<b>STUDY 1 PILOT STUDY</b>	<b>91-96</b>
6.1.1	Math Anxiety Rating Scale - Revised	91
6.1.2	STROOP test	93
6.1.3	Children’s Cognitive Assessment Questionnaire	94
6.1.4	Digit Span test	96
<b>6.2</b>	<b>FIRST MAIN STUDY</b>	<b>97-100</b>
6.2.1	Math Anxiety Rating Scale - Revised	97
6.2.2	Children’s Cognitive Assessment Questionnaire	98
<b>6.3</b>	<b>SECOND MAIN STUDY – MINDFULNESS, AGGRESSION AND EMOTION REGULATION</b>	<b>100-104</b>
<b>6.4</b>	<b>COMPARISON BETWEEN STUDY 2 AND 3</b>	<b>104-109</b>
6.4.1	Results of MARS-R	104
6.4.2	Results of CCAQ	106
<b>6.5</b>	<b>FINAL EXAM RESULT ANALYSIS</b>	<b>109-112</b>

## **6.0 RESULTS**

### **6.1 STUDY 1: PILOT STUDY**

Results for the three groups, Yogā Prāṇāyāma (YP), Vedic Maths (VM) and Jogging (JG) were as follows:

#### **6.1.1 Math-anxiety rating scale - Revised**

VM group showed significant pre-post differences in TMA (pre  $57.85 \pm 14.43$ ; post  $46.08 \pm 14.38$ ;  $p < 0.01$ ), LMA (pre  $34.69 \pm 8$ ; post  $29 \pm 9.23$ ;  $p < 0.05$ ) and EMA (pre  $23.15 \pm 7.8$ ; post  $17.08 \pm 6.22$ ;  $p < 0.01$ ) (Table 3).

YP group showed significant differences in MARS-R in pre-post measures. Of the two subsets, EMA was significantly different between pre-post measures (pre  $20.85 \pm 7.35$ ; post  $17.15 \pm 4.38$ ,  $p < 0.05$ ), but not LMA; TMA was still significantly lowered (pre  $51 \pm 14.3$ ; post  $46.92 \pm 12.63$ ,  $p < 0.05$ ) (Table 3).

JG: showed no significant differences between pre-post measures (Table 3).

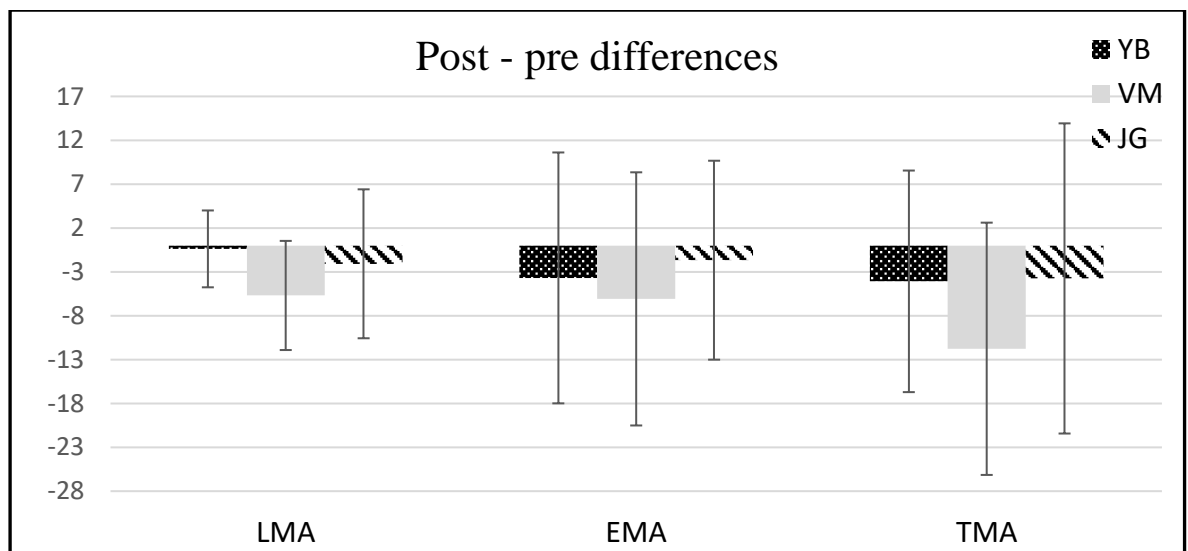
Comparisons of Pre-post differences between the three groups: LMA and TMA differences between YP and VM groups were significant ( $p < 0.05$ ) (Table 3; Figure 5); this could have been due to lower pre values in YP. In contrast the JG was not significantly different in any of the three parameters from either of the other groups (Table 3).

**TABLE 3: MATHEMATICS ANXIETY RATING SCALE - MARS-R: MEAN  $\pm$  SD**

	YP	YP (pre-post Difference)	VM	VM (pre-post Difference)	JG	JG (pre-post Difference)
<b>LMA (pre)</b>	30.15 $\pm$ 8.28	<b>-0.38 <math>\pm</math> 3.04*</b>	<b>34.69 <math>\pm</math> 8</b>	<b>-5.69 <math>\pm</math> 7.08*</b>	34.75 $\pm$ 8.41	<b>-2.08 <math>\pm</math> 10.83</b>
<b>LMA (post)</b>	29.77 $\pm$ 8.53		<b>29 <math>\pm</math> 9.23*</b>		32.67 $\pm$ 9.88	
<b>MEA (pre)</b>	<b>20.85 <math>\pm</math> 7.35</b>	<b>-3.69 <math>\pm</math> 5.36</b>	<b>23.15 <math>\pm</math> 7.8</b>	<b>-6.08 <math>\pm</math> 6.24</b>	22.5 $\pm$ 6.27	<b>-1.67 <math>\pm</math> 8.86</b>
<b>MEA (post)</b>	<b>17.15 <math>\pm</math> 4.38*</b>		<b>17.08 <math>\pm</math> 6.22**</b>		20.83 $\pm$ 8.49	
<b>TMA (pre)</b>	<b>51 <math>\pm</math> 14.3</b>	<b>-4.08 <math>\pm</math> 4.99*</b>	<b>57.85 <math>\pm</math> 14.43</b>	<b>-11.77 <math>\pm</math> 10.47*</b>	57.25 $\pm$ 11.34	<b>-3.75 <math>\pm</math> 16.94</b>
<b>TMA (post)</b>	<b>46.92 <math>\pm</math> 12.63*</b>		<b>46.08 <math>\pm</math> 14.38**</b>		53.5 $\pm$ 17.68	

**Caption:** Table 3 shows the pre and post mean  $\pm$  SD of Yogā (YB), Vedic Maths (VM) and Jogging (JG) groups on Mathematics Anxiety Rating Scale- Revised (MARS-R). The Table also gives the pre-post differences of the three groups. Significant differences are shown by \* and \*\*, where \* $<$ 0.05 and \*\* $<$ 0.01.

**FIGURE 5: COMPARISON OF MATH-ANXIETY PRE-POST DIFFERENCES BETWEEN YB, VM AND JG GROUPS**



**Caption figure 5:** Figure 5 shows pre-post differences of all three math-anxiety score: Learning math-anxiety, Evaluation math-anxiety and total math-anxiety, between all three groups i.e., YB, VM and JG. VM group showed greater reduction in math-anxiety, followed by YB group. Standard deviations are shown by error bars.

### 6.1.2 STROOP test

VM group showed significant difference in Color score (pre 61.23±7.44; post 66.85±10.64; p<0.05) and Color Word (pre 34.15±7.45; post 43.92±9.06; p< 0.001).

Pre-post differences in means of Color Word were not significant (Table 4).

YP showed significant difference in color Word test of the STROOP test (pre 35.46±5.98; post 40.85±7.89; p< 0.005) (Table 4).

In JG group significance were observed in Word score (pre 86.58±13.27; post 93.5±12.38; p<0.05) and Color Word (pre 31.33±6.4; post 39.92±9.03; p< 0.05) (Table 4).

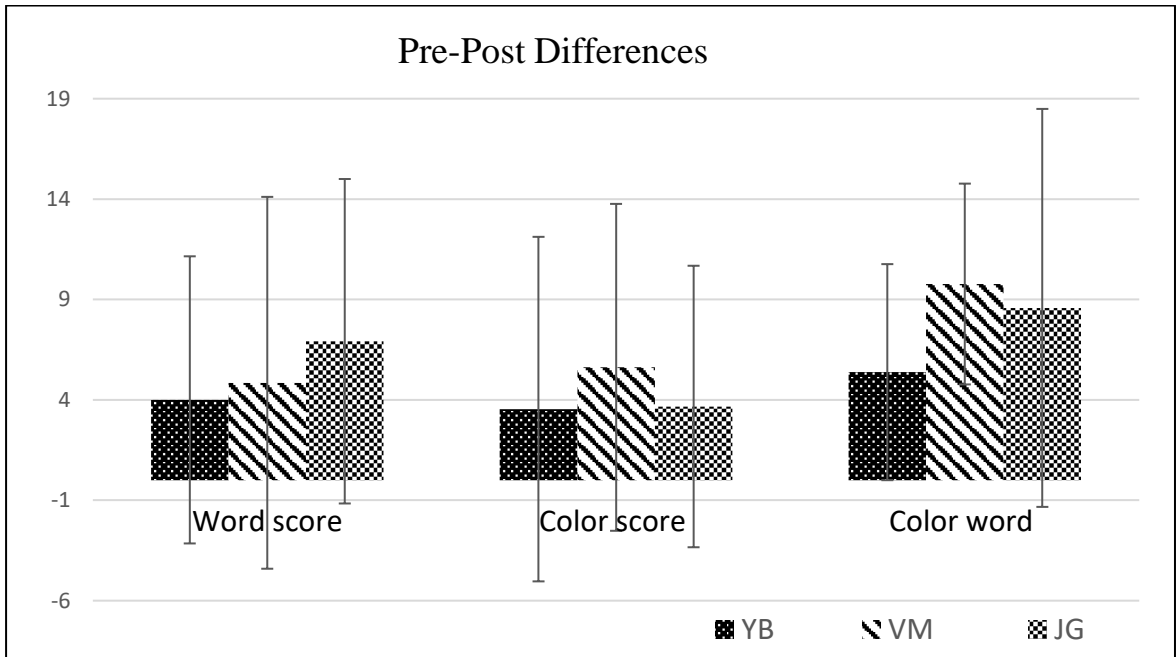
No significant difference was observed between three groups on the STROOP test (Figure 6).

**TABLE 4: STROOP TEST: MEAN ± SD**

	YP	YP (pre-post Difference)	VM	VM (pre-post Difference)	JG	JG (pre-post Difference)
<b>Word score (pre)</b>	95.15 ± 11.26	4.00 ± 7.15	97.85 ± 16.34	4.85 ± 9.26	<b>86.58 ± 13.27</b>	6.92 ± 8.08
<b>Word score (post)</b>	99.15 ± 15.57		102.69 ± 15.23		<b>93.5 ± 12.38*</b>	
<b>Color score (pre)</b>	61.69 ± 8.44	3.54 ± 8.58	<b>61.23 ± 7.44</b>	5.62 ± 8.14	61.17 ± 6.69	3.67 ± 7.01
<b>Color score(post)</b>	65.23 ± 11.1		<b>66.85 ± 10.64*</b>		64.83 ± 12.09	
<b>Color word (pre)</b>	<b>35.46 ± 5.98</b>	5.38 ± 5.38	<b>34.15 ± 7.45</b>	9.77 ± 5.00	<b>31.33 ± 6.4</b>	8.58 ± 9.91
<b>Color word (post)</b>	<b>40.85 ± 7.89**</b>		<b>43.92 ± 9.06***</b>		<b>39.92 ± 9.03*</b>	

**Caption:** Table 4 shows the pre and post mean ± SD of Yogā (YP), Vedic Maths (VM) and jogging (JG) groups on STROOP test. Table also provides the pre-post differences of the three groups as well. Significant differences are shown by \*; where \*<0.05, \*\*<0.01 and \*\*\*<0.001

**FIGURE 6: COMPARISON OF STROOP PRE-POST DIFFERENCES SCORES BETWEEN YB, VM AND JG GROUPS**



**Caption figure 6:** Figure 6 shows comparison of pre-post differences of all three parameters of stroop test score: Word score, Color score and Color word score, between all the three groups i.e., YP, VM and JG. VM group showed greater increase in color and color word scores. JG group showed maximum increase in word score. Standard deviations are shown by error bars.

### 6.1.3 Children’s Cognitive Assessment Questionnaire- CCAQ

VM group showed highly significant difference in pre-post values of OFFT (pre:  $6.08 \pm 1.61$ ; post:  $2.62 \pm 2.66$ ;  $p < 0.001$ ) (Table 5).

YB Group: showed significant improvement in lowering NSE (pre:  $2.77 \pm 2.01$ ; post:  $1 \pm 1$ ;  $p < 0.01$ ) and OFFT (pre:  $5.54 \pm 2.57$ ; post:  $3.38 \pm 2.36$ ;  $p < 0.01$ ) (Table 5).

JG group also showed significant difference in pre-post values of OFFT (pre:  $7.42 \pm 2.91$ ; post:  $5.92 \pm 2.35$ ;  $p < 0.05$ ) (Table 5).

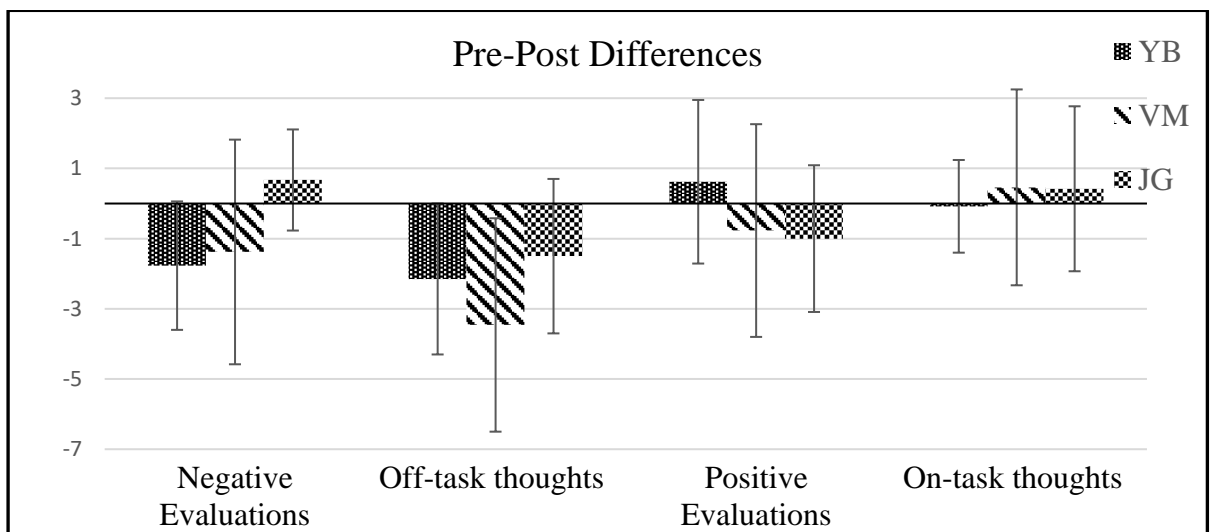
Pre-post differences analyses between the three groups suggest that YB and JG were significantly different in NSE (YB:  $-1.77 \pm 1.83$ ; JG:  $0.67 \pm 1.44$ ;  $p < 0.05$ ) (Table 5).

**TABLE 5: CHILDREN’S COGNITIVE ASSESSMENT QUESTIONNAIRE – CCAQ: MEAN ± SD**

	YP	YP (pre-post Difference)	VM	VM (pre-post Difference)	JG	JG (pre-post Difference)
Negative Evaluations (pre)	2.77 ± 2.01	-1.77 ± 1.83*	3.08 ± 3.25	-1.38 ± 3.2	2.83 ± 1.99	0.67 ± 1.44*
Negative Evaluations (post)	1 ± 1**		1.69 ± 2.75		3.5 ± 2.58	
Off-task thoughts (pre)	5.54 ± 2.57	-2.15 ± 2.15	6.08 ± 1.61	-3.46 ± 3.04	7.42 ± 2.91	-1.5 ± 2.2
Off-task thoughts (post)	3.38 ± 2.36**		2.62 ± 2.66***		5.92 ± 2.35*	
Positive Evaluations (pre)	7.77 ± 1.92	0.62 ± 2.33	7.15 ± 2.64	-0.77 ± 3.03	8 ± 2.22	-1 ± 2.09
Positive Evaluations (post)	8.38 ± 1.94		6.38 ± 3.31		7 ± 2.89	
On-task thoughts (pre)	8.15 ± 1.52	-0.08 ± 1.32	6.85 ± 3.05	0.46 ± 2.79	7.5 ± 1.68	0.42 ± 2.35
On-task thoughts (post)	8.08 ± 1.98		7.31 ± 3.07		7.92 ± 1.83	

**Caption:** Table 5T shows the pre and post mean ± SD of YP, VM and JG groups on Children’s Cognitive Assessment Questionnaire (CCAQ). Table also provides the pre-post differences of the three groups as well. Significant differences are shown by \*; where \*<0.05, \*\*<0.01 and \*\*\*<0.001.

**FIGURE 7: COMPARISON OF CCAQ PRE-POST DIFFERENCES SCORES BETWEEN YP, VM AND JG GROUPS**



**Caption:** Figure 7 compares the pre-post differences of all four parameters of CCAQ, between all the three groups i.e., YP, VM and JG. VM group showed greater reduction in Off-task thoughts, followed by YP group. YP was observed to have greater reduction in negative

evaluation and maximum increase in positive evaluations. Standard deviations are shown by error bars.

#### 6.1.4 Digit Span test:

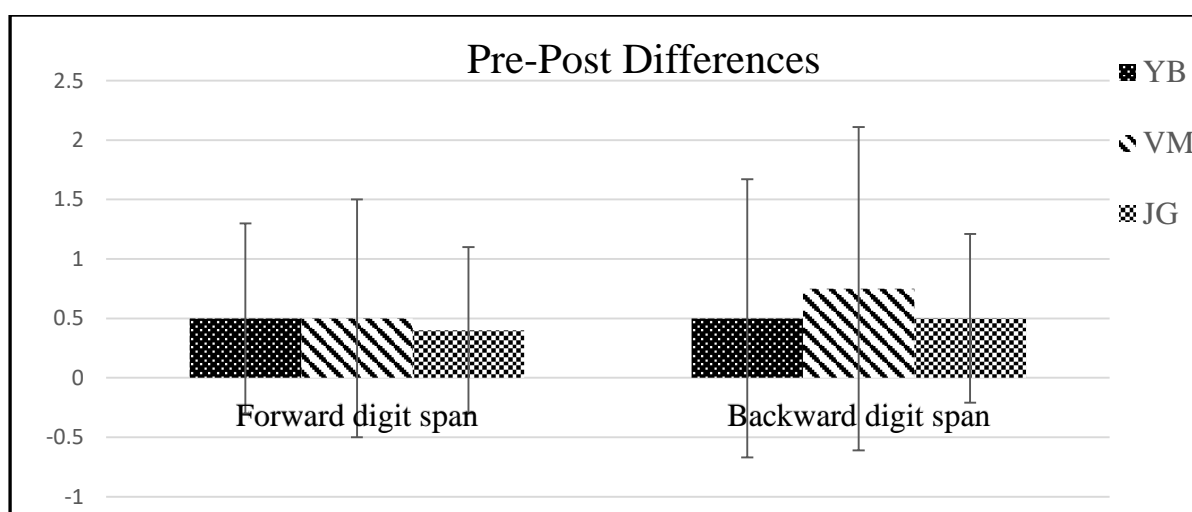
All the three groups performed equally in forward and backward digit span tests (Table 6). None of the digit span parameter showed significant difference. VM group showed greater improvement in the forward and backward digit span as compared to YB and control groups (Table 6, figure 8).

**TABLE 6: DIGIT SPAN TEST: MEAN  $\pm$  SD**

	YP	YP (pre-post Difference)	VM	VM (pre-post Difference)	JG	JG (pre-post Difference)
<b>Forward digit span (pre)</b>	6.17 $\pm$ 0.58	0.50 $\pm$ 0.80	6.75 $\pm$ 0.87	0.50 $\pm$ 1.00	6.00 $\pm$ 0.82	0.40 $\pm$ 0.70
<b>Forward digit span (post)</b>	6.67 $\pm$ 0.65		7.25 $\pm$ 1.22		6.40 $\pm$ 0.70	
<b>Backward digit span (pre)</b>	6.75 $\pm$ 0.87	0.50 $\pm$ 1.17	6.50 $\pm$ 1.51	0.75 $\pm$ 1.36	6.10 $\pm$ 0.88	0.50 $\pm$ 0.71
<b>Backward digit span (post)</b>	7.25 $\pm$ 0.75		7.25 $\pm$ 0.87		6.60 $\pm$ 0.70	

**Caption:** Table 6 shows pre and post mean  $\pm$  SD of the Yogā (YB), Vedic Maths (VM) and jogging (JG) groups on Digit span test- forward and backward digit span. Table also provides the pre-post differences of the three groups as well.

**FIGURE 8: COMPARISON OF DIGIT SPAN PRE-POST DIFFERENCES SCORES BETWEEN YB, VM AND JG GROUPS**



**Caption:** Figure 8 shows comparison of digit span pre-post differences: forward and backward span, between all the three groups i.e., YB, VM and JG. Standard deviations are shown by error bars.

## 6.2 STUDY 2: FIRST MAIN STUDY

Data is given for 54 students in VM, 53 in YP group and 50 controls, as presented in Tables 8 to 11.

8 students in the YP group and 7 in VM group failed to give post intervention data, and were listed as drop outs. Data was therefore analyzed for the remaining 51 students in YP, 52 in VM group and 50 in controls. Baseline demographic data was not significantly different between the three groups.

### 6.2.1 Math Anxiety Rating Scale – Revised

Test results are presented in Tables 7 and 8 and Figure 9. Table 7 presents means and standard deviations of the scores on MARS-R for the three groups, pre- and post- the interventions, while Table 8 summarizes pre-post differences, giving statistical significances of differences between experimental and control groups. The YP and VM groups showed consistent improvements on both LMA and EMA subscales,  $p < 0.001$ . Controls showed no change in scores.

**TABLE 7: MATHEMATICS ANXIETY RATING SCALE – MARS-R - STUDY 2**

	Yogā Prāṇāyāma		Vedic Maths		Control	
	Pre	Post	Pre	Post	Pre	Post
<b>LMA</b>	32.74 ± 9.88	29.26 ± 9.01***	33.46 ± 9.64	29.40 ± 10.33***	34.92 ± 10.16	36.08 ± 10.33
<b>EMA</b>	20.60 ± 6.78	17.57 ± 6.2***	22.84 ± 7.28	17.57 ± 7.35***	20.90 ± 6.2	20.60 ± 6.42
<b>TMA</b>	53.33 ± 15.83	46.83 ± 14.1***	56.30 ± 15.74	46.97 ± 16.89***	55.82 ± 15.26	56.68 ± 15.32

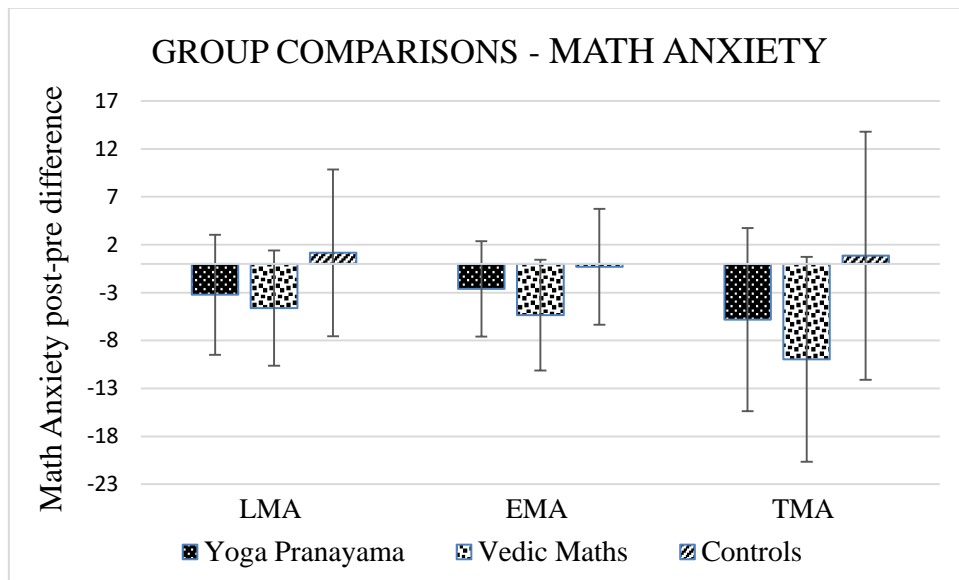
**Caption:** Table 7 shows the pre and post mean ± standard deviation of YP, VM and Control groups on Mathematics Anxiety Rating Scale - revised (MARS-R). Differences for experimental groups were highly significant,  $p < .001$ , while controls showed essentially no change. *Note:* \*\*\* =  $p < .001$ .

**TABLE 8: COMPARISON OF PRE-POST DIFFERENCES BETWEEN EXPERIMENTAL GROUPS AND CONTROL GROUP -- STUDY 2**

	Prāṇāyāma (YP)	Vedic Maths (VM)	Control (CG)
<b>LMA</b>	-3.22 ± 6.26**	-4.62 ± 6.01***	1.16 ± 8.71
<b>EMA</b>	-2.61 ± 4.98**	-5.35 ± 5.77***	-0.30 ± 6.06
<b>TMA</b>	-5.82 ± 9.56**	-9.96 ± 10.68***	0.86 ± 12.95

**Caption:** Table 8 shows between group differences. Controls were unchanged, while experimental groups improved significantly, with VM having greater effects than YP. \*\*=  $p < .01$ , \*\*\*=  $p < .001$ .

**FIGURE 9: MATH ANXIETY POST-PRE MEAN SCORE COMPARISONS FOR YP, VM AND CONTROLS – STUDY 1**



**Caption:** Figure 9 shows Math Anxiety post-pre difference comparisons for the three study groups from Math Anxiety Rating Scale-Revised. Decrease in Math Anxiety for YP and VM is significant as compared to controls;  $p < 0.01$  and  $p < 0.001$ , respectively. All bars and attached error lines represent means ± standard deviations

### 6.2.2 Children's Cognitive Assessment Questionnaire

For CCAQ results, Table 9 presents pre-post values of means and standard deviations for the three groups, pre and post the intervention period. As hypothesized, both experimental groups showed significant pre-post differences,  $p < 0.001$ . Significance was less for the On Task subscale, where the YP group attained  $p < 0.05$ , while the differences for the VM group was only  $p = 0.06$  only showing a trend; interestingly, values for controls improved on every scale, but did not reach significance on any.

Table 9 and Figure 10 compares the groups' pre-post differences showing that relative improvements between controls and the YP group were significant for the first three subscales, reaching  $p < 0.01$  for the Off Task subscale and  $p < 0.05$  for Negative and Positive Evaluation subscales, but not for the fourth subscale, On Task. Pre-post differences were significantly different for Positive Evaluation between VM and control groups ( $p < 0.05$ ) (Table 10).

**TABLE 9: CHILDREN'S COGNITIVE ASSESSMENT QUESTIONNAIRE – STUDY 2**

	Yogā Prāṇāyāma		Vedic Maths		Control	
	Pre	Post	Pre	Post	Pre	Post
<b>Negative Evaluation</b>	3.60 ± 2.53	1.93 ± 1.76***	3.02 ± 2.0	2.06 ± 1.76***	3.02 ± 2.16	2.64 ± 2.38
<b>Off Task</b>	4.51 ± 1.91	2.93 ± 1.50***	4.88 ± 2.58	3.58 ± 2.53***	4.92 ± 2.25	4.44 ± 2.27
<b>Positive Evaluation</b>	6.88 ± 2.34	8.00 ± 1.86***	7.43 ± 1.91	8.42 ± 1.69***	7.00 ± 2.21	7.36 ± 2.04
<b>On Task</b>	7.77 ± 1.54	8.27 ± 1.43*	7.67 ± 1.73	8.36 ± 1.74	7.68 ± 1.8	7.92 ± 1.75

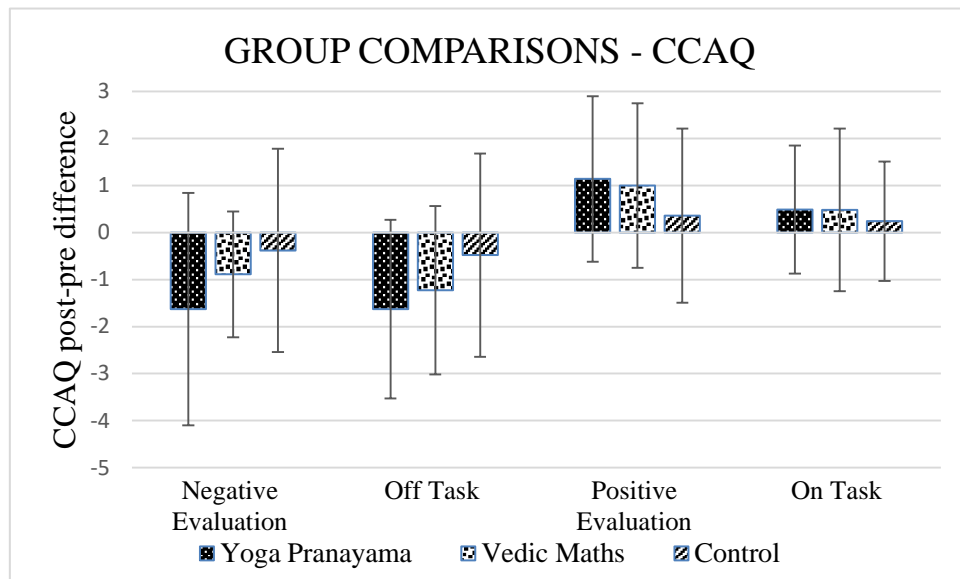
**Caption:** Table 9 shows differences for both experimental groups were highly significant,  $p < .001$ , except for the On Task subscale, where only YP reached  $p < .05$ ; controls showed no significant difference on any subscale, as expected. *Note:* \*=  $p < .05$ , \*\*\*=  $p < .001$ .

**TABLE 10: GROUP COMPARISON - CHILDREN'S COGNITIVE ASSESSMENT QUESTIONNAIRE – STUDY 2**

	Yogā Prāṇāyāma	Vedic Maths	Control
<b>Negative Evaluation</b>	-1.63±2.47*	-0.88±1.34 *	-0.38±2.16
<b>Off Task</b>	-1.63±1.9**	-1.23±1.79 **	-0.48±2.16
<b>Positive Evaluation</b>	1.14±1.76*	1.00 ±1.75 *	0.36±1.85
<b>On Task</b>	0.49±1.36	0.48±1.73	0.24±1.27

**Caption:** Table 10 shows Pre-Post differences (as mean ± standard deviation) for the three groups. As expected controls were not significantly changed, while both experimental groups improved significantly compared to controls, YP having greater effects than Vedic Maths. *Note:* \*=  $p < .05$ , \*\*=  $p < .01$ .

**FIGURE 10: CCAQ POST-PRE MEAN SCORE COMPARISONS FOR YP, VM AND CONTROLS – STUDY 2**



**Caption:** Figure 10 compares CCAQ’s post-pre differences among the three groups. YP shows significant reduction in negative evaluation ( $p < 0.05$ ) and Off Task thoughts ( $p < 0.01$ ) as compared to controls. YP and VM groups improved significantly in positive evaluation ( $p < 0.05$ ) as compared to controls. All bars and attached error lines represent means  $\pm$  standard deviations

### 6.3 STUDY 3: SECOND MAIN STUDY – MINDFULNESS, AGGRESSION AND EMOTION REGULATION

Demographic variables and age, were not significantly different for the three groups. The RM ANOVAs were statistically significant for the tests of Mindfulness,  $F(2, 240) = 19.88, p < 0.001$ , and Aggression,  $F(2, 240) = 14.49, p < 0.001$ , but not for either positive or negative ERQ scales. Experimental results are set out in Tables 11 and 13. Table 11 presents pre- and post- intervention values of the three groups on the four different scales, giving statistical significance of within group pre-post differences. Table 12 sets out between group comparisons of Table 11’s within group differences, i.e. group-time interaction effects, giving their significances, as explained in the Table 12 Caption. Table 11 shows that Mindfulness, Aggression and Negative Emotion Regulation changed significantly for the YP group ( $p \leq 0.001$  for Mindfulness and

Aggression;  $p \leq 0.028$  for Negative emotion regulation), while for the VM group only Mindfulness improved significantly,  $p \leq 0.001$  (Table 11, Figure 11), though changes in Aggression may have showed a weak trend towards improvement ( $p = 0.15$ ). No group changed significantly on Positive Emotion Regulation. Controls seemed to improve on Aggression,  $p \leq 0.030$  (paired sample t test) (Table 11, Figure 12). Effect sizes (Cohen's d) were for the YP group, 0.93 (Mindfulness), 0.78 (Aggression), and for the VM group, 0.29 (Mindfulness).

Table 12 shows Group-Time interaction differences and significances. Mindfulness and Aggression changed significantly more for the YP group than for VM and Control groups,  $p \leq 0.001$  (Figure 13a and Figure 13b), but within group changes on Positive and Negative Emotion Regulation scores were not significantly different between the three groups.

**TABLE 11: MINDFULNESS, AGGRESSION, AND EMOTION REGULATION: MEAN  $\pm$  SD; PRE AND POST DATA – STUDY 3**

GROUP →	Yogā Prāṇāyāma (73)		Vedic Maths (80)		Controls (90)	
	Pre	Post	Pre	Post	Pre	Post
TEST ↓						
<b>Mindfulness</b>	57.85± 9.45	67.75± 11.52***	56.50± 11.72	60.19± 13.56***	60.39± 10.96	61.53± 11.87
<b>Aggression</b>	11.64± 4.31	8.4± 4.03***	11.53± 4.34	11.01± 4.55	11.18± 3.96	10.39± 4.3*
<b>Emotion Regulation +ve</b>	27.18± 5.77	26.48± 6.59	29.53± 5.67	28.73± 6.10	27.64± 5.67	27.23± 5.37
<b>Emotion Regulation -ve</b>	18.77± 4.5	17.51± 4.88*	20.25± 4.60	19.84± 4.58	18.53± 5.28	18.39± 5.34

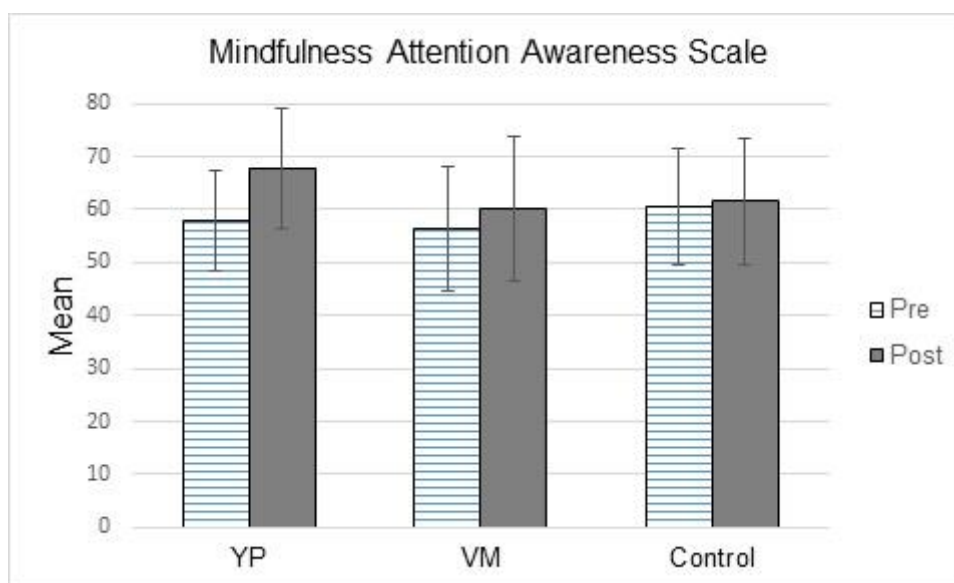
**Caption:** Table 11 presents means, SDs and significances of within group changes for each group. Significance values as before. Mindfulness, Aggression and Negative Emotion Regulation changed significantly for the YP group while Mindfulness alone improved significantly for the VM group. No group changed significantly on Positive Emotion Regulation. Controls seemed to improve on aggression.

**TABLE 12: WITHIN GROUP DIFFERENCES AND SIGNIFICANCES OF BETWEEN GROUP COMPARISONS – STUDY 3**

TEST ↓ GROUP →	Yogā Prāṇāyāma	Vedic Maths	Control
<b>Mindfulness</b>	9.88±9.77***(***)	3.69±8.40***	1.14±8.82(***)
<b>Aggression</b>	-3.28±3.82***(***)	-0.51±3.16***	-0.79±3.39(***)
<b>Emotion Regulation (+ve)</b>	-0.44±6.7	-0.8±6.56	-0.41±6.42
<b>Emotion Regulation (-ve)</b>	-1.26±4.79	-0.41±4.62	-0.14±4.6

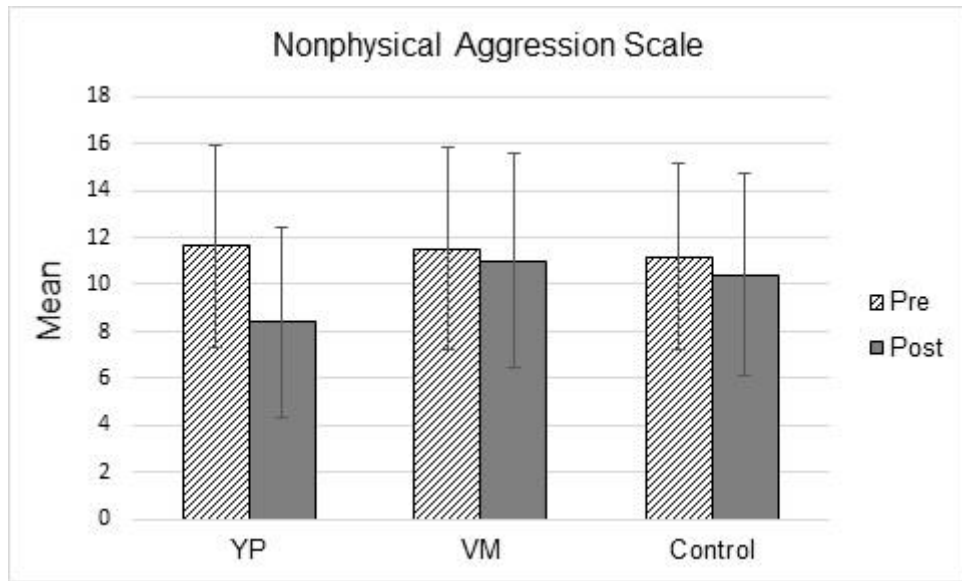
**Caption:** \*\*\* =  $p \leq 0.001$ , \*\* =  $p \leq 0.01$ , \* =  $p \leq 0.05$ . Those under Vedic Maths are significance of differences with the Yogā Prāṇāyāma group while those under controls are also significances with the Yogā Prāṇāyāma group.

**FIGURE 11: MINDFULNESS ATTENTION AWARENESS SCALE PRE-POST MEAN SCORES – STUDY 3**



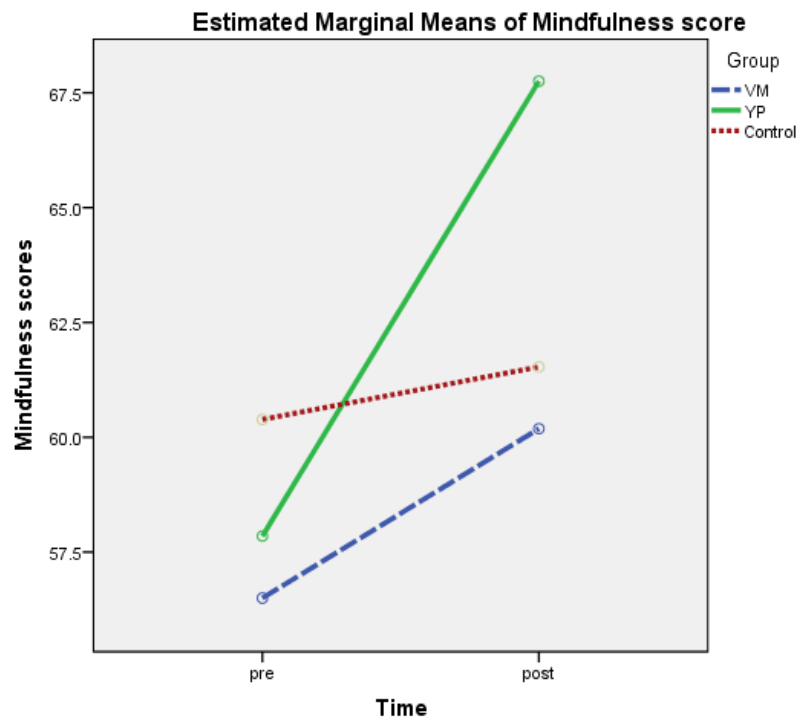
**Caption:** Figure 11 Shows Mindfulness Attention Awareness Scale pre-post mean scores with a significant increase in Yoga Pranayama and Vedic Mathematics ( $P = 0.001$ ) groups. All bars and attached error lines represent means ± standard deviations

**FIGURE 12: NONPHYSICAL AGGRESSION SCALE SCALE PRE-POST MEAN SCORES – STUDY 3**



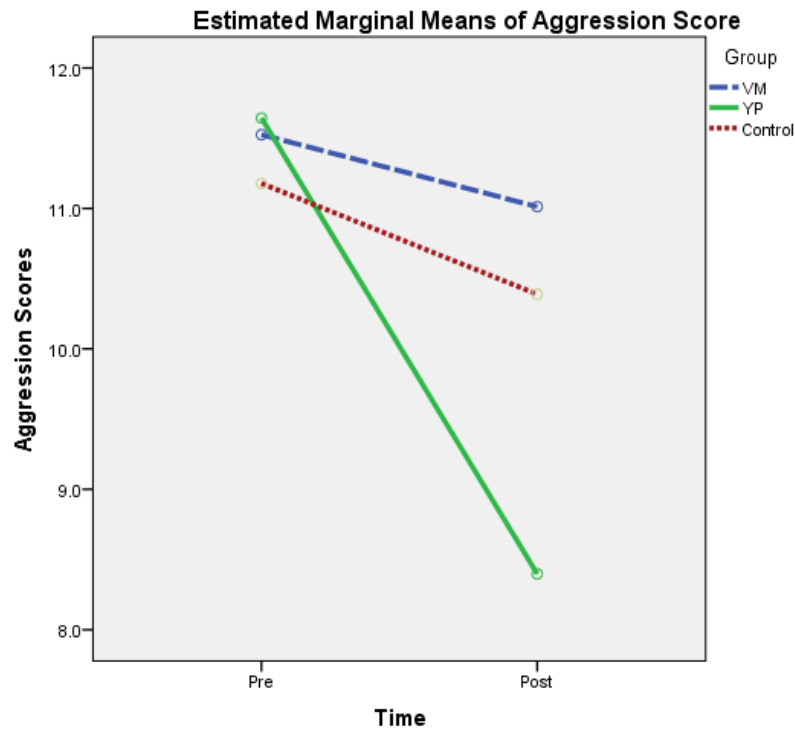
**Caption:** Figure 12 depicts pre- and post-mean scores of the three study groups on the Nonphysical Aggression Scale from Pittsburgh Youth Study. All bars and attached error lines represent means  $\pm$  standard deviations. Decreases for Yoga Pranayama (-3.25,  $P = 0.001$ ) and Control (-0.79,  $P = 0.030$ ) groups attained reportable significance,  $P = 0.05$

**FIGURE 13A: GROUP-TIME INTERACTION EFFECTS ON MINDFULNESS**



**Caption:** Figure 13A shows group-time interaction for mindfulness scores. At time 1 i.e., pre, all the three groups are not significantly different from each other. At time 2 i.e., post, YP group is significantly different from VM ( $p=0.001$ ) and Control ( $p=0.005$ ).

**FIGURE 13B: GROUP-TIME INTERACTION ON AGGRESSION**



**Caption:** Figure 13B shows Group-time interaction effects on Aggression; Figure 4b Caption: Fig. 4b shows group-time interaction effects for Non Physical Aggression scale. At time 1 i.e., pre, all the three groups are not significantly different from each other on mean aggression scores. At time 2 i.e., post, YP group's mean aggression score is significantly lower from VM ( $p=0.001$ ) and Control ( $p=0.011$ ) groups.

## 6.4 COMPARISONS BETWEEN STUDY 2 AND STUDY 3

### 6.4.1 Results of MARS-R

Table 13 shows the comparison between MARS-R parameters between study 2 and study 3. Panayama and Vedic Maths group showed significant difference ( $p<0.001$ ) between pre and post data in both the studies, in all the three parameters i.e., LMA, EMA and TMA whereas in controls no significant change is observed in all the three parameters of study 2 and study 3.

**TABLE 13: MATHEMATICS ANXIETY RATING SCALE– MARS-R:  
MEAN±SD – COMPARISION STUDY 2 AND STUDY 3**

Parameter	Dataset	YP		VM		Control (CG)	
		Pre	Post	Pre	Pre	Post	Pre
LMA	Study 2	32.74 ± 9.88	29.26 ± 9.01***	33.46 ± 9.64	29.40 ± 10.33***	34.92 ± 10.16	36.08 ± 10.33
	Study 3	38.58 ± 10.61	31.74 ± 11.86***	39.58 ± 12.25	34.65 ± 10.74***	36.98 ± 11.42	39.3 ± 12.60
	Combined	35.93 ± 10.63	30.69 ± 10.77***	37.03 ± 11.60	32.44 ± 10.85***	37.55 ± 11.13	38.15 ± 11.9
EMA	Study 2	20.60 ± 6.78	17.57 ± 6.2***	22.84 ± 7.28	17.57 ± 7.35***	20.90 ± 6.2	20.60 ± 6.42
	Study 3	28.71 ± 17.59	21.1 ± 7.97***	24.26 ± 8.72	21.63 ± 8.25***	24.99 ± 7.48	23.99 ± 7.37
	Combined	25.26 ± 14.57	19.59 ± 7.45***	23.67 ± 8.16	19.91 ± 8.11***	23.55 ± 7.30	22.78 ± 7.2
TMA	Study 2	53.33 ± 15.83	46.83 ± 14.1***	56.30 ± 15.74	46.97 ± 16.89***	55.82 ± 15.26	56.68 ± 15.32
	Study 3	67 ± 21.56	51.83 ± 19***	63.84 ± 18.49	56.01 ± 17.34***	63.28 ± 17.77	63.29 ± 18.73
	Combined	61.19 ± 20.36	50.12 ± 16.71***	60.7 ± 17.74	52.21 ± 17.67***	60.67 ± 17.25	60.93 ± 17.82

**Caption:** Table 13 shows the pre and post mean ± standard deviation of YP, VM, and Control groups on Mathematics Anxiety Rating Scale - revised (MARS-R). Differences for experimental groups were highly significant,  $p < .001$ , while controls showed essentially no change. Study 2 and study 3 shows same pattern of change in pre and post data. *Note:* \*\*\* =  $p < .001$ .

Comparison between pre-post difference between experimental groups and control group showed significant differences in both the studies (Table 14). In study 2, LMA decrease better in Vedic Maths group as compared to control group ( $p < 0.001$ ) where

in study 3, LMA showed similar decrease in both Vedic Maths as well as Yogā Prāṇāyāma groups as compared to controls ( $p < 0.01$ ).

EMA for study 2 is found to better in Vedic Maths groups as compared to controls ( $p < 0.001$ ) whereas in study 3, EMA reduced better in Yogā Prāṇāyāma group compared to controls ( $p < 0.01$ ).

Similar results were obtained in TMA in both the studies (Table 14).

**TABLE 14: COMPARISON OF PRE-POST DIFFERENCES BETWEEN EXPERIMENTAL GROUPS AND CONTROL GROUP – COMPARISON STUDY 2 AND STUDY 3**

Parameter	Dataset	YP	VM	Control
LMA	Study 2	-3.22±6.26(**)	-4.62±6.01***	1.16±8.71*** (**)
	Study 3	-6.08±11.54(**)	-4.7±9.55**	0.13±9.92** (**)
	Combined	-4.89±9.78 (***)	-4.66±8.27***	0.50±9.49*** (***)
EMA	Study 2	-2.61±4.98(**)	-5.35±5.77***	-0.30±6.06***(**)
	Study 3	-7.44±19.74(**)	-2.43±6.73	-1.06±6.98(**)
	Combined	-5.44±15.58 (***)	-3.62±6.49***	-0.79±6.66*** (***)
TMA	Study 2	-5.82±9.56(**)	-9.96±10.68***	0.86±12.95***(**)
	Study 3	-13.53±25.29(***)	-9.96±13.78**	0.13±9.92**(***)
	Combined	-10.33±20.6 (***)	-8.28±12.65***	-2.54±13.48*** (***)

**Caption:** It shows between group differences. Controls were unchanged, while experimental groups improved significantly. ‘\*’ in bracket show significant difference between YP and controls while those without bracket show difference between VM and controls. \*\*=  $p < .01$ , \*\*\*=  $p < .001$ .

#### 6.4.2 Results of CCAQ

**Study 1:** The YP and VM group showed hypothesized pre-post changes for all CCAQ subscales, on task thoughts were  $p < 0.05$  for YP and no significant change for VM, the

rest  $p < 0.001$  (Table 15). Controls showed no significant pre-post changes. Between group comparisons also found that the YP and VM groups performed significantly better than the control group on all CCAQ subscales ( $p < 0.05$ ), except on-task thoughts (Table 16).

**Study 2:** Here all the groups showed highly significant differences between pre-post results on all subscales of CCAQ, except on task thoughts (Table 15) where changes for the YP and VM groups attained significance, but those for the Control group did not. Between group comparisons also found that the YP group performed significantly better than the control group on all CCAQ subscales ( $p < 0.05$  for Off task and Positive evaluation and  $p < 0.01$  for on task thoughts), except for negative evaluation scale (Table 16). VM performed significantly better only in off task thought as compared to controls ( $p < 0.05$ ).

**TABLE 15: CHILDREN’S COGNITIVE ASSESSMENT QUESTIONNAIRE –  
CCAQ: MEAN ± SD – COMPARISION STUDY 2 AND STUDY 3**

		YP		VM		Control (CG)	
		Pre	Post	Pre	Post	Pre	Post
Negative Evaluation	Study 2	3.60 ± 2.53	1.93 ± 1.76***	3.02 ± 2.0	2.06 ± 1.76***	3.02 ± 2.16	2.64 ± 2.38
	Study 3	4.60 ± 2.21	2.90 ± 2.12***	4.79 ± 4.0	3.31 ± 2.64***	4.44 ± 2.82	3.00 ± 2.43***
	Combined	4.17 ± 2.39	2.48 ± 2.03***	4.04 ± 3.37	2.78 ± 2.39***	3.94 ± 2.69	2.87 ± 2.4***
Off task	Study 2	4.51 ± 1.91	2.93 ± 1.50***	4.88 ± 2.58	3.58 ± 2.53***	4.92 ± 2.25	4.44 ± 2.27
	Study 3	6.27 ± 1.73	4.36 ± 2.29***	5.89 ± 1.68	4.81 ± 2.23***	6.37 ± 1.80	5.26 ± 2.12***
	Combined	5.52 ± 2.01	3.74 ± 2.11***	5.46 ± 2.16	4.3 ± 2.43***	5.86 ± 2.08	4.96 ± 2.2***
Positive Evaluation	Study 2	6.88 ± 2.34	8.00 ± 1.86***	7.43 ± 1.91	8.42 ± 1.69***	7.00 ± 2.21	7.36 ± 2.04
	Study 3	5.97 ± 2.03	7.44 ± 2.11***	6.74 ± 2.22	7.56 ± 2.43***	7.48 ± 2.07	7.99 ± 2.20**
	Combined	6.36 ± 2.2	7.68 ± 2.02***	7.03 ± 2.12	7.91 ± 2.19***	7.31 ± 2.13	7.76 ± 2.1**
On task	Study 2	7.77 ± 1.54	8.27 ± 1.43*	7.67 ± 1.73	8.36 ± 1.74	7.68 ± 1.8	7.92 ± 1.75
	Study 3	6.13 ± 1.89	7.41 ± 1.94***	7.19 ± 2.18	7.72 ± 2.11**	7.31 ± 1.8	7.58 ± 2.12
	Combined	6.83 ± 1.92	7.78 ± 1.79***	7.51 ± 2.30	7.99 ± 1.98***	7.44 ± 1.80	7.7 ± 2*

**Caption:** \*= p < .05, \*\*\*= p < .001. Differences for both experimental groups were highly significant, p < .001, except for the On Task subscale, where only YP reached p < .05; controls showed no significant difference on any subscale, as expected.

**TABLE 16: GROUP COMPARISON - CHILDREN'S COGNITIVE ASSESSMENT QUESTIONNAIRE – COMPARISON STUDY 2 AND STUDY 3**

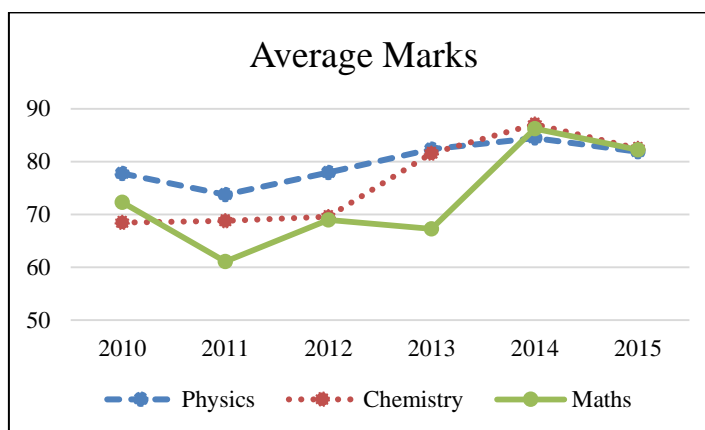
		Prāṇāyāma (YP)	Vedic Maths (VM)	Control (CG)
<b>Negative Evaluation</b>	<b>Study 2</b>	-1.63±2.47*	-0.88±1.34 (*)	-0.38±2.16 (*) *
	<b>Study 3</b>	-1.53±2.53	-1.58±3.79	-1.41±2.88
	<b>Combined</b>	1.57 ± 2.5	-1.3 ± 3.05	1.04 ± 2.68
<b>Off task</b>	<b>Study 2</b>	-1.63±1.9**	1.23±1.79 (**)	-0.48±2.16 (**) **
	<b>Study 3</b>	1.19±2.19 *	0.5±2.02 (*)	0.26±1.6 (*) *
	<b>Combined</b>	-1.8 ± 2.17*** (*)	-1.16 ± 1.79* (*)	-0.86 ± 1.99***
<b>Positive Evaluation</b>	<b>Study 2</b>	1.14±1.76*	1±1.75 (*)	0.36±1.85 (*) *
	<b>Study 3</b>	1.44±2.31*	0.88±1.88	0.5±2.14*
	<b>Combined</b>	1.32 ± 2.1**	0.93 ± 1.82 (*)	0.45 ± 2.04**(*)
<b>On task</b>	<b>Study 2</b>	0.49±1.36	0.48±1.73	0.24±1.27
	<b>Study 3</b>	1.19±2.19**	0.5±2.02	0.26±1.6**
	<b>Combined</b>	0.9 ± 1.91**	0.49 ± 1.9	0.25 ± 1.48**

**Caption:** Pre-Post differences (as mean ± standard deviation) for the three groups. As expected controls were not significantly changed, while both experimental groups improved significantly compared to controls, YP having greater effects than Vedic Maths. P -values in bracket for VM and control comparison. : \*= p < .05, \*\*= p < .01.

## 6.5 FINAL EXAM RESULT ANALYSIS

Physics, Chemistry, and Mathematics marks displayed in Figure 14 from means and standard deviations given in Table 17 show that average marks stabilized and exceeded 80 for all subjects during the years 2014 and 2015. Considerable improvement is seen in Maths results of the 2014 and 2015 batches compare to the 2010-13 batches.

**FIGURE 14: AVERAGE MARKS FOR THE SIX BATCHES FROM 2010 TO 2015**



**Caption:** Figure 14 displays average marks in Physics, Chemistry and Mathematics for all batches from 2010 to 2015.

**TABLE 17: MEAN SCORES FOR COHORTS FOR YEARS 2010 TO 2015**

Subject → Year (No) ↓	Physics	Chemistry	Maths	Physics Theory Only	Chemistry Theory Only	Maths
<b>2010 (31)</b>	77.71 ± 16.67	68.45 ± 16.15	72.26 ± 19.20	0.75 ± 0.18	0.65± 0.18	0.72± 0.18
<b>2011 (69)</b>	73.72 ± 16.01	68.77 ± 17.30	61.09 ± 22.97	0.71 ± 0.18	0.65± 0.19	0.61± 0.23
<b>2012 (108)</b>	77.93 ± 16.73	69.56 ± 17.52	68.98 ± 22.25	0.76 ± 0.18	0.66± 0.19	0.69± 0.22
<b>2013 (132)</b>	82.36 ± 15.40	81.58 ± 15.24	67.26 ± 21.45	0.81± 0.17	0.80± 0.17	0.67± 0.21
<b>2014 (143)</b>	84.44 ± 12.31	87.06 ± 11.03	86.23 ± 15.89	0.80 ± 0.16	0.84± 0.14	0.86± 0.16
<b>2015 (169)</b>	81.83 ± 12.90	82.49 ± 10.780	82.22 ± 17.22	0.75± 0.18	0.76± 0.15	0.82± 0.17

**Caption:** Table 17 columns display Means and Standard Deviations of student marks in Physics, Chemistry and Mathematics for each year's batch. Fractional scores for theory alone without practical examination marks are displayed in the last columns to highlight improvement in Maths.

Table 18 displays the means and standard deviations of results in percentages (or fractions without practical examination marks) for the cohort from years 2010 to 2013 combined when Maths teaching did not employ Vedic Maths or Geogebra methods,

with the cohort comprising years 2014 and 2015 combined when those methods were in use. Improvements are shown including marks on practical examinations (left three columns) and without such marks (right three columns). Mean improvements on the latter were 0.00 in Physics, 0.08 in Chemistry, and 0.17 in Maths.

**TABLE 18: MEANS AND STANDARD DEVIATIONS FOR BATCHES WITH AND WITHOUT VEDIC MATHS**

Years (Nos.)	Physics	Chemistry	Maths	Physics Theory Only	Chemistry Theory Only	Maths
<b>2010-13 (340)</b>	78.78 ±16.33	73.97 ± 17.51	67.01 ± 21.99	0.77±0.18	0.71±0.19	0.67±0.22
<b>2014-15 (312)</b>	83.03 ± 12.68	84.58 ± 11.12	84.06 ± 16.72	0.77±0.17	0.79±0.15	0.84±0.17
<b>M-W 'Z'</b>	-2.749	-7.970	-10.749	-0.286	-5.389	-10.749
<b>Signif. p</b>	0.006	0.00012	0.000001	0.775	0.00001	0.000001

**Caption:** Table 18 presents mean and standard deviations for marks in Physics, Chemistry and Maths examinations for the totals of 340 students in years 2010 to 2013 and 312 students in years 2014 and 2015. Fractional scores only for theory without scores on practical examinations are displayed in the last three columns, to highlight improvement in Maths. The last two rows give statistics for non-parametric tests between 2010-2013 and 2014-2015 batches.

**TABLE 19: NUMBERS OF STUDENTS OBTAINING DISTINCTIONS AND FULL MARKS**

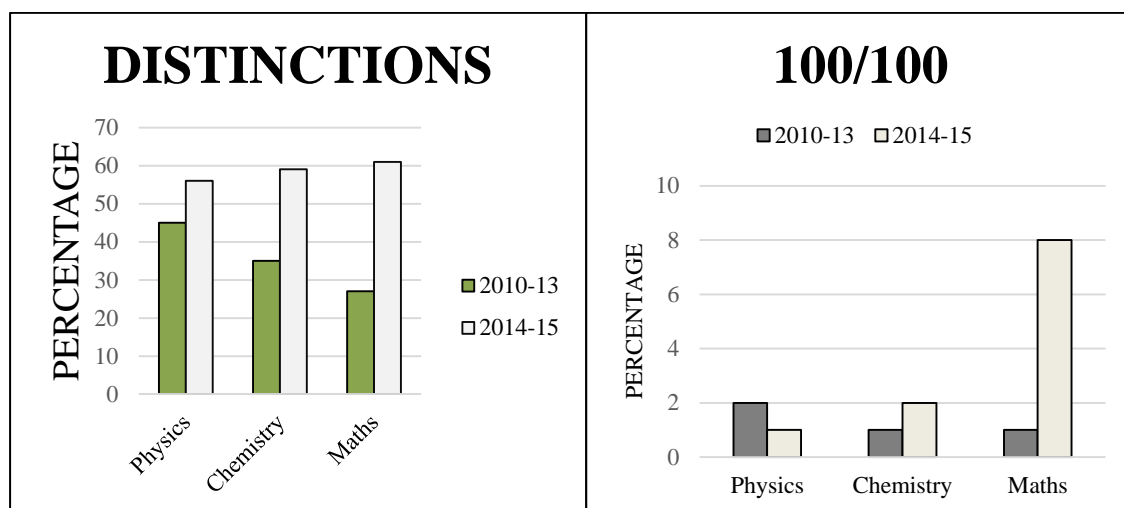
	Years	Physics	Chemistry	Maths
Distinctions	2010-13	153 (45%)	118 (35%)	91 (27%)
	2014-15	176 (56%)	183 (59%)	189 (61%)
100/100	2010-13	6 (2%)	2 (1%)	3 (1%)
	2014-15	3 (1%)	5 (2%)	24 (8%)

**Caption:** Table 19 presents the number of students in the 2010-2013 and 2014 & 2015 pair of cohorts obtaining distinctions (85% or more), or scoring 100%, for Physics, Chemistry or Maths. Corresponding percentages of the total number of students involved are also displayed.

Finally numbers of students obtaining distinctions and 100% scores are presented in Table 19 with corresponding bar graphs displayed in Figure 15. Most striking is relative improvement in Maths, with the percentage of distinctions increasing from 27% to

61%, and 100% full marks scores improving from 3 (one percent of students) to 24 (eight percent of students) (Table 20, Figure 15).

**FIGURE 15: NUMBERS OF STUDENTS OBTAINING DISTINCTIONS AND SCORING 100 OUT OF 100**



**Caption:** Figure 15 displays percentage marks in the three different subjects; dark and light columns depict scores of the 2010-13 batches and 2014-15 batches respectively. Improvements in Math scores compared to those in Physics and Chemistry are clear for all to see.

**TABLE 20 EFFECT SIZES AND SIGNIFICANCES OF DISTINCTIONS AND FULL MARKS DATA**

TOTALS	DISTINCTION ( $\geq 85\%$ )		FULL MARKS (100%)	
	No	Yes	No	Yes
340	249	91	337	3
312	123	189	288	24
	Odds Ratio 4.2	$p = 0.0000001$	Odds Ratio 9.36	$p = 0.0000001$
Odds Ratio = $(249 \times 189) / (123 \times 91) = 4.2$			= $(337 \times 24) / (288 \times 3) = 9.36$	

**Caption:** Table 20 displays numbers of distinctions and full mark scores for the two cohorts, 2010-2013 and 2014-2015, together with Odds Ratio effect sizes and significance values.