CHAPTER – 4

AIMS AND OBJECTIVES

4.1 AIM OF THE STUDY

To evaluate the effectiveness of Yogā Prāṇāyāma intervention and Vedic Maths intervention compared to regular conventional classroom teaching, in the management of Math Anxiety, Cognitive flexibility, Working Memory, Mindfulness, Non Physical Aggressive Behaviour, Emotions, and Self-defeating and Self-enhancing cognitions associated with test anxiety and performance in school children.

4.2 OBJECTIVES OF THE STUDY

1. To evaluate the efficacy of Vedic Maths methods in the management of Math Anxiety in school children.

2. To assess pre-post changes following two separate interventions Prāṇāyāma and Vedic Maths in: Cognitive Flexibility, Working Memory, Mindfulness, Positive and Negative Emotions, Non-Physical Aggressive Behaviour, and Self-defeating and Self-enhancing Cognitions associated with test anxiety and performance.

3. To assess correlations between Math Anxiety and Cognitive Skills.

4. To compare efficacy of two interventions Prāṇāyāma and Vedic Maths in management of Math Anxiety and associated compromise of Cognitive Skills.

5. To report the changes in Pre-University Examination results of the students who took training in Prāṇāyāma and Vedic Maths along with regular classroom teaching, comparing with results of students taking only conventional classroom training.

4.3 HYPOTHESES

1. Yogā Prāṇāyāma practices and Vedic Maths methods reduce Math Anxiety.

2. Yogā Prāṇāyāma practices and Vedic Maths methods reduce aggression.

3. Yogā Prāṇāyāma practices and Vedic Maths methods improve development of Self-enhancing cognitions.

4. Yogā Prāṇāyāma practices and Vedic Maths methods impact positively on Working Memory.

5. Yogā Prāṇāyāma practices and Vedic Maths methods enhance Cognitive flexibility,

6. Yogā Prāṇāyāma practices and Vedic Maths methods increase Mindfulness.

7. Yogā Prāṇāyāma practices and Vedic Maths methods stabilize Emotion Regulation.

4.4 NULL HYPOTHESES

1. Yogā Prāṇāyāma practices and Vedic Maths methods do not reduce Math Anxiety and aggression.

2. Yogā Prāṇāyāma practices and Vedic Maths methods do not improve development Self-enhancing cognitions.

3. None of the specific hypotheses for each variable are true.

4.5 RATIONALE OF USING VEDIC MATHS AND YOGĀ PRĀṆĀYĀMA AS INTERVENTONS

The study compares two methods of reducing Math Anxiety and improving cognitive skills: Vedic Maths, a system offering student's choice of ways to carry out calculations, and Yogā Prāṇāyāma, a well-researched means of anxiety reduction and benchmark for doing so.

.

CHAPTER – 5

METHODS

5.0 METHODS

5.1 PARTICIPANTS

5.1.1 Sample Size

Study 1: (Pilot Study) 40

Study 2: 168

Study 3: 243

5.1.2 Location, Source and Selection of Participants

All the studies were performed at Sri Sai Angels Institution Chikkamagaluru, Karnataka, India. The institution is 25 years old, well-equipped with a good academic reputation. It is located at Sirgapura 8 km from the heart of the city of Chikkamagaluru. The author had been invited to take the position of mathematics teacher at the college in 2012. Possibilities to conduct Yogā research work were many since the management was supportive. When the design of the study was explained to the college management, they were enthusiastic to begin the Prāṇāyāma and Vedic Maths workshops. A clean, well arranged hall was used for the Prāṇāyāma classes, with students sitting on the floor in Sukhāsana (cross-legged) for practice. Vedic Maths classes were arranged in a regular classroom, where board, projector, and desk facilities were available.

The pilot study was conducted for Sri Sai Angels School boarding students in the 8th, 9th, and 10th standards where hall and classrooms were available. In the two main studies, all participants were in 12th standard, and available at one place, in the Pre-University College. It was a homogeneous sample. Students attended their regular classes from 09.15 to 17.00 hrs. In all the studies, workshop timings were carefully selected: the first hour of the day from 09.15 to 10.15 was used for the intervention, so that the students would be fresh and bright (Plate 1). .

PLATE 1: INTERVENTIONS

Pranayama session intervention

Vedic Maths intervention

5.1.3 Inclusion Criteria: School children with normal vision studying Mathematics

5.1.4 Exclusion Criteria: any child undergoing psychiatric treatment, with a neurological disorder, colour blindness, auditory deficits, or physically challenged (none were actually excluded).

5.1.5 Informed Consent and Ethical Considerations

The study designs were explained to parents and signed informed consent obtained for all students. Approval from the S-VYASA Institutional Ethics Committee was obtained for all the studies.

5.2 DESIGN OF THE STUDY (A common flow-chart for the 3 studies is given in Figure 2)

5.2.1 Demographics:

Pilot study: All 40 males studying in class 10^{th} of Sri Sai Angels School, Chikmagaluru, aged 15±1 years. Most of the students belonged to middle to high socio-economic status. All student stayed in the hostel of the school during the period of study.

Main studies (2 & 3): All the students studying in class 12^{th} of the Sri Sai Angels Pre-University College, Chikmagaluru, aged 17±1 years. Most students belonged to middle to high socio-economic status. In studies 2 and 3, a total of 417 students participated, 191 males and 226 females. Of these, 6 dropped out from the study. As the success of each study became apparent, subsequent studies increased in size.

5.2.2 Study 1: (Pilot study) Randomized Controlled Trial

Participants: 40 school children randomized by random number generator (Psychic Science, n.d.) into three groups:

Vedic Maths (VM) (14), Yogā Prāṇāyāma (YP) (13), and Jogging (JG) (Controls) (13)

Intervention: seven days workshops, 30 mins each day for VM and YP groups

5.2.3 Study 2: (Main Study 1) Randomized Controlled Trial

Participants: 168 school children randomized by software into three groups - Vedic Maths (59), Yogā Prāṇāyāma (59), and Conventional Maths Class Controls (50) The difference in numbers was due to attrition in the control group.

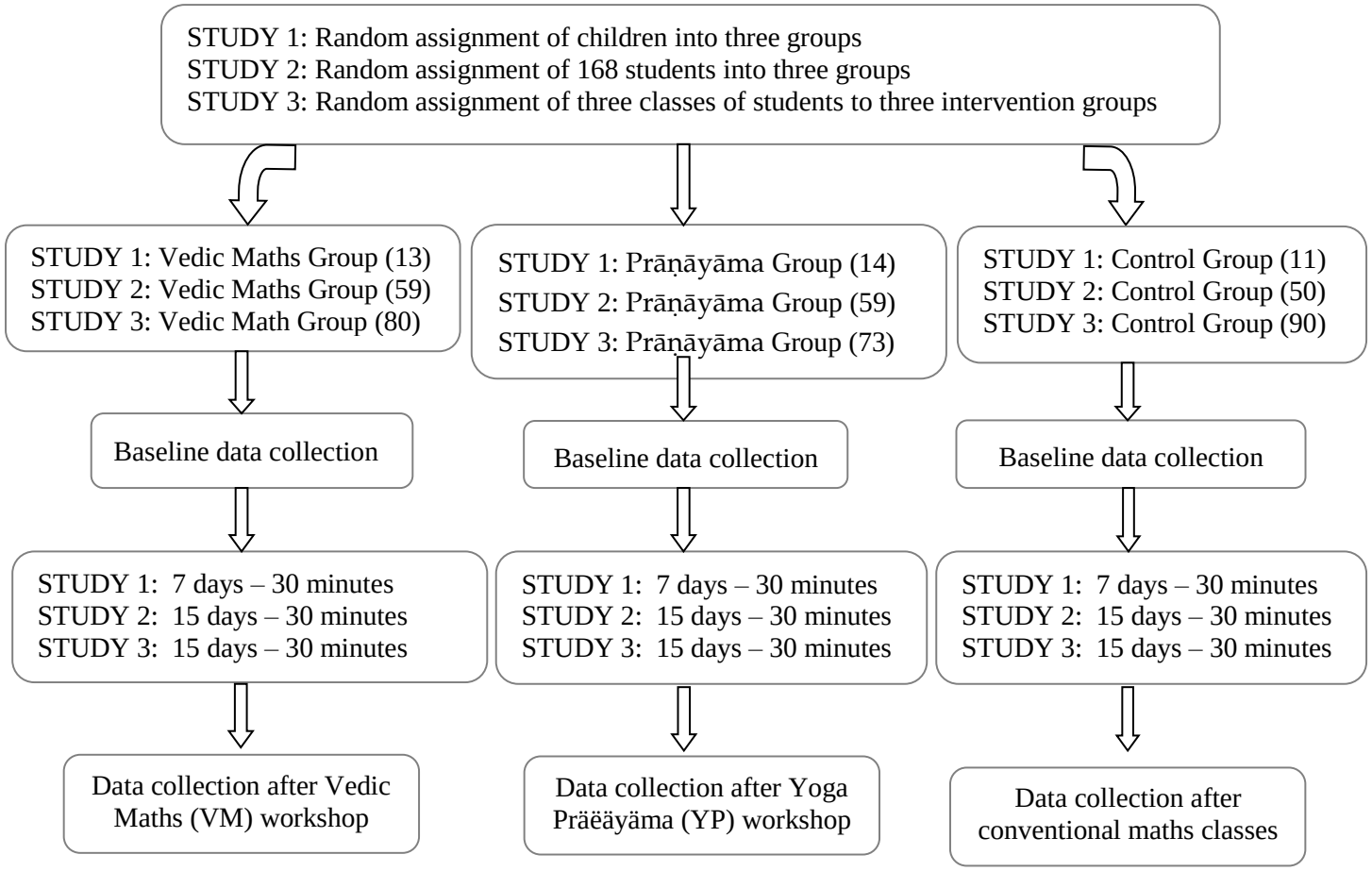
Intervention: 15 days workshops, 30 mins each day for VM and YP group

5.2.4 Study 3: (Main Study 2) Randomized Controlled Trial

Participants: (243 students) consisted of three classes randomly assigned to different groups, Vedic Maths (73), Yogā Prāṇāyāma (80), and Conventional Maths Class Controls (90).

Intervention: 15 days workshops, 30 mins each day for VM and YP group

FIGURE 2: FLOW CHART FOR STUDIES 1 TO 3



5.3 INTERVENTIONS

5.3.1 Yogā Prāṇāyāma (YP)

The YP group practiced Kapālabhāti, Bhastrikā, Sectional Breathing, Sūrya Anuloma, Candra Viloma, Nāḍī Śuddhi and Bhrāmarī in sequence over a 30-minute time period, allowing 5 minutes time for each, as listed in the left column of Table 2. The first two (Kapālabhāti and Bhastrikā) are Yogā Kriyās, cleansing techniques, the third is deep breathing technique, while the last four are forms of Prāṇāyāma practice. Each group received personal instruction from professionally trained Yogā instructors (the first author and his wife).

Initially, each technique was first demonstrated; the class then imitated the demonstrator, each member being carefully corrected for mistakes. After mastery of the first technique, instruction moved to the second technique etc., until all were confident in performing the techniques in sequence. In each subsequent workshop, verbal instructions were given to start each technique and assistance give to students with difficulties. After each allotted 5 minute time period, the group was instructed to start performing the next technique. Each workshop ended with Bhrāmarī Prāṇāyāma, the 7^{th} technique listed in Table 2 (left column).

5.3.2 Vedic Maths (VM)

In all three studies, the VM groups were instructed in use of selected VM Sūtras described in Chapter 2, and shown how to apply them to Speed Multiplication, Squaring and Cubing Numbers, Multiplication of Algebraic Expressions, Solving Specific Algebraic Equations, Solving Simultaneous Equations, Solving Quadratic Equations, HCF of Equations, Partial Fractions, Differential and Integral Calculus, Conics, Straight Lines, Determinants, and Binomial Expressions. After learning VM Sūtra techniques in the first 30 minutes, participants applied them to solve problems during the last 30 minutes. In study 1, examples were selected for the standards of the students in the study, i.e. 8, 9, or 10.

In studies 2 and 3, the Vedic Maths intervention comprised instruction in 12^{th} standard mathematics, taught by standard procedures for Vedic Maths instruction. Examples are given in Table 2, with details of three explained below the table, e.g. solutions to simultaneous equations were demonstrated using Vedic Maths Sūtras, ‘vertically and crosswise’, ‘transpose and apply’, and ‘addition and subtraction’, offering alternative strategies to solve equations related to specific examples. Example 1 solves two

simultaneous equations using ‘vertically and crosswise’. Example 2 uses ‘transpose and apply’ to simplify integration of the reciprocal of a factorizable quadratic function. With VM techniques, both problems cause less gifted students conceptual problems, time loss and errors. Example 3 presents a multiple choice question on integration of non-factorizable quadratic functions, the most difficult problems in Indian pre-university maths, and requiring understanding functions less familiar to the student (here the author’s proposal to short cut the solution using differential and discriminant of the quadratic function are crucially important).

These examples demonstrate how VM methods significantly simplify and shorten 12th grade maths calculations used in Algebra, Trigonometry, Coordinate Geometry, 3D Geometry, Vectors and Differential and Integral Calculus. These topics were taught to all three groups participating in the Studies 2 and 3, but only the VM group learned to solve problems using VM procedures.

5.3.3 Details of the Yogā Prāṇāyāma Interventions

Instructions given by teacher as described in SVYASA modules were as follows.

1. Kapālabhāti – Kriyā

Sit comfortably in sukhāsana with spine erect placing hands on knees in chin mudra. Close eyes and collapse shoulders. Take deep breath. Practice rapid breathing with active and forceful exhalation and passive inhalation. During each exhalation, blast out the air by vigorous flapping movements of the abdomen in quick succession. Repeat the exhalation as quickly as possible at the rate of 60 strokes per minute. At the end of one minute, stop the practice. Now observe an automatic suspension of breath. Simultaneously the mind may experience a deep state of silence.

2. Bhastrikā – Kriyā

Sit comfortably in sukhāsana with the hands on the knees and the eyes closed. Take a slow deep breath in, breath out quickly and forcefully through the nose, but do not strain, and immediately afterwards breathe in with the same force. When one breathes out the abdomen comes in and the diaphragm contracts. When you breathe in the diaphragm relaxes and the abdomen moves out. These movements should be slightly exaggerated. Continue to breathe in this manner counting ten breaths. At the end of ten breaths, take a deep breath in and out slowly. This is one round.

Normally three to five rounds practice fit into a five-minute period.

As the practitioner become accustomed to this style of breathing, the speed may be gradually increased, but breathing must be kept rhythmical: inhalation and exhalation must be equal.

3. Sectional Breathing (A normal preparatory exercise for Prāṇāyāma practices)

    a. Abdominal Breathing

        Place the hands resting on the thighs in Cina Mudrā. Inhale deeply, slowly and continuously, the abdomen bulges out. Exhale, the abdomen is drawn inwards continuously and slowly. Repeat this breathing cycle three times. There should be no jerks in the whole process. It should be smooth, continuous and relaxing.

    b. Thoracic Breathing

        Place the hands resting on the thighs in Cinmayī Mudrā. While inhaling, expand the chest cage forwards, outwards and upwards. While exhaling relax the chest wall and return to resting position. Repeat this breathing cycle three times.

c. Upper Lobar Breathing

Place the hands resting on the thighs in Ādi Mudrā. While inhaling raise the collar bones and shoulders upwards and backwards. While exhaling drop down the shoulders to the resting position. Repeat this breathing cycle three times.

4. Sūrya Anuloma and Candra Viloma Prāṇāyāmas

Adopt Nāsikā Mudrā with your right hand. Close the left nostril. Inhale through right nostril. Close the right nostril. Exhale through left nostril. Practice three rounds.

Now close the right nostril. Inhale through left nostril. Close the left nostril. Exhale through right nostril. Practice three rounds.

5. Nāḍī Śuddhi (Anuloma Viloma - Alternate Nostril breathing)- Prāṇāyāma

Sit comfortably in sukhāsana. Adopt Nāsikā Mudrā. Close the right nostril with the right thumb and exhale completely through the left nostril. Close the left nostril with the ring and little finger of the Nāsikā Mudrā, release the right nostril. Now exhale slowly and completely through right nostril. Inhale deeply through the same (right) nostril. Then close the right nostril and exhale through the left nostril. Normally five rounds will take 5 minutes.

6. Bhrāmarī (Humming Sound) – Prāṇāyāma

Adopt Śāmbhavī Mudrā. Place your index finger on eyebrows, middle finger on eyes, ring finger below the nostril little finger on chin and thumb inside the ear. Hands parallel to the ground. Inhale deeply. Chant M- kāra or humming sound. Repeat 11 rounds.

TABLE 2: INTERVENTIONS

Yogā Prāṇāyāma Methods	**Some of the topics taught using Vedic Maths Sūtras**
1. Kapālabhāti – Kriyā	1. Simultaneous Equations, Determinants, Multiplication, Coordinate Geometry Sūtras used: Vertically and Crosswise, Addition and Subtraction, Transpose and Apply
2. Bhastrikā - Kriyā	2. Partial Fractions, Conics, Integrals Sūtra Used: Transpose and Apply
3. Sectional Breathing Abdominal breathing, Thoracic breathing, Upper lobar breathing, Full yogic breathing	3. Quadratic Equation, Integration, Sūtra used: Differential Calculus
4. Sūrya Anuloma, Candra Viloma (single nostril) – Prāṇāyāmas (2 ½ mins each)	4. Squaring, Cubing Sūtra used: One more than one before
5. Nāḍī Śuddhi (Anuloma Viloma - Alternate Nostril breathing)- Prāṇāyāma	5. Factorization Sūtras used: Proportionately, By alternate elimination and retention, The first by the first and last by the last
6.Bhrāmarī (Humming Sound) - Prāṇāyāma	6.Highest common factors Sūtras used: Addition and subtraction, The first by the first and last by the last By alternate elimination and retention

5.3.4 Details of the Vedic Maths Interventions

Example 1 solves two simultaneous equations using ‘vertically and crosswise’. Example 2 demonstrates use of ‘transpose and apply’ to simplify integration of the reciprocal of a factorizable quadratic function. Both problems cause less gifted students conceptual problems, time loss and errors. Example 3 presents a multiple choice question on integration of non-

factorizable quadratic functions, the most difficult problem in Indian pre-university maths, and requiring understanding functions less familiar to the student.

Example 1: Simultaneous Equations. Students often have to solve simultaneous equations in problems in 'Coordinate Geometry', 'Algebra', 'Calculus' and other parts of maths and physics. Conventional methods take more time finding values of x and y than the time saving methods of VM using patterns.

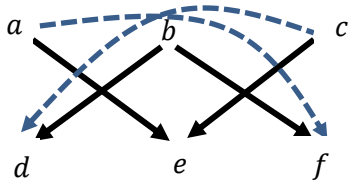
Find values of x and y if $3x + 5y = 13$ and $4x + 7y = 18$

$3x + 5y = 13$

$4x + 7y = 18$

VM method: $x = \frac{5.18-13.7}{5.4-7.3} = 1, \quad y = \frac{13.4-18.3}{5.4-7.3} = 2,$

Multiplication Pattern shown using the Vedic math procedure, Vertically & Crosswise.



$ax + by = c$

$dx + ey = f$

$\boldsymbol{x = \frac{bf-ce}{bd-ae}, \quad y = \frac{cd-af}{bd-ae}}$

The Vedic Maths procedure enables students to find either x *or* y mentally, depending on which looks easier, and then substitute it to find the other value. The conventional method of finding their values is:

$3x + 5y = 13$ ------ (1a)

$4x + 7y = 18$ ------ (2a)

Multiplying (1a) by 4 and (2a) by 3 we obtain

$12x + 20y = 52$ ------ (1b)

$12x + 21y = 54$ ------ (2b)

Subtracting (1b) from (2b) gives y = 2 and substituting this in either equation yields x=1. Note the labor-saving advantages of the Vedic Maths approach.

Example 2. $\int \frac{1}{x^2+5x+6}dx = \int \frac{1}{(x+2)(x+3)}dx = \int \frac{A}{(x+2)}dx + \int \frac{B}{(x+3)}dx$

Vedic Maths suggests an application of the procedure, 'Transpose and Apply', as follows.

First let $x = -2$ ($\because\ x + 2 = 0$) in LHS of the equation, giving $\frac{1}{-2+3} = 1$ which is A.

Next let $x = -3$ ($\because\ x + 3 = 0$) in LHS of the equation, giving $\frac{1}{-3+2} = -1$ for B.

Finally integrate obtaining, $I = \log(x + 2) - \log(x + 3) + C$. Note how using this procedure converts the solution to the problem into a one line mental calculation.

The laborious conventional method requires multiplying out the polynomial fraction:

$\int \frac{1}{(x+2)(x+3)} = \int \frac{A}{(x+2)} + \int \frac{B}{(x+3)}$

Consider $\frac{1}{(x+2)(x+3)} = \frac{A}{(x+2)} + \frac{B}{(x+3)}$

$\Rightarrow \frac{1}{(x+2)(x+3)} = \frac{A(x+3)+B(x+2)}{(x+2)(x+3)}$

$\Rightarrow 1 = A(x + 3) + B(x + 2)$

$\Rightarrow 1 = Ax + 3A + Bx + 2B$

By equating coefficients of x and constant terms

$0 = A + B$ and $1 = 3A + 2B$ and solving them we get $A = 1\ and\ B = -1$.

Now substitute values of A and B and finally integrate to get

$I = \log(x + 2) - \log(x + 3) + C$.

Example 3. Choose the correct option for the integral $\int \frac{\boldsymbol{dx}}{\boldsymbol{9x^2-12x+8}} =$

(a) $\frac{1}{6}\tan^{-1}\frac{3x+2}{2}$ (b) $\frac{1}{6}\log\frac{3x-2}{3x+2}$ (c) $\frac{1}{6}\sin^{-1}\frac{3x+2}{2}$ (d) $\frac{1}{6}\tan^{-1}\frac{3x-2}{2}$

The procedure that the author evolved from VM methods for this kind of problem is as follows: First observe the sign of the discriminant $= 144 - 288 = -144 < 0$, negative; next the sign of the coefficient of the square term, $a = 9 > 0$, positive; last write down the derivative $f'(x) = 18x - 12$, all of which are easily done mentally and part of students' earlier training in quadratic equations.

The final answer, $\int \frac{dx}{9x^2-12x+8} = \frac{2}{\sqrt{144}}\tan^{-1}\frac{18x-12}{12} = \frac{1}{6}\tan^{-1}\frac{3x-2}{2}$.

is obtained by using the rule $I = \int \frac{dx}{ax^2+bx+c} = \begin{cases} \frac{1}{\sqrt{D}}\log\left[\frac{f'-\sqrt{D}}{f'+\sqrt{D}}\right], & a>0, D>0 \\ \frac{1}{\sqrt{D}}\log\left[\frac{\sqrt{D}-f'}{\sqrt{D}+f'}\right], & a<0, D>0 \\ \frac{2}{\sqrt{|D|}}\tan^{-1}\left(\frac{f'}{\sqrt{|D|}}\right), & a>0, D<0 \\ \frac{2}{f'}, & D=0 \end{cases}$

In this case $I = \frac{2}{\sqrt{|D|}}\tan^{-1}\left(\frac{f'}{\sqrt{|D|}}\right) because\ a>0, D<0$

Students trained to observe the signs of the discriminant and the coefficient of x^2 simply pick the correct answer from among the four options, not bothering with detailed calculations, but performing a quick mental calculation. Answering such a multiple choice question quickly is fun, especially as it obviates the need for laborious algebraic paper and pencil work of the conventional maths method illustrated below.

$I = \int \frac{dx}{9x^2-12x+8}$

$= \int \frac{dx}{9\{x^2-\frac{12}{9}x+\frac{8}{9}\}}$

$= \frac{1}{9}\int \frac{dx}{\{x^2-\frac{4}{3}x+\frac{8}{9}\}}$

$= \frac{1}{9}\int \frac{dx}{\{x^2-2\left(\frac{2}{3}\right)x+\frac{4}{9}-\frac{4}{9}+\frac{8}{9}\}}$

$= \frac{1}{9}\int \frac{dx}{\left(x-\frac{2}{3}\right)^2+\left(\frac{2}{3}\right)^2}$

Next students trained the conventional way have to choose one of the forms

1) $\int \frac{1}{x^2-a^2}dx = \frac{1}{2a}log\left|\frac{x-a}{x+a}\right| + c$ 2) $\int \frac{1}{a^2-x^2}dx = \frac{1}{2a}log\left|\frac{a+x}{a-x}\right| + c$

3) $\int \frac{1}{a^2+x^2}dx = \frac{1}{a}tan^{-1}\left(\frac{x}{a}\right) + c$ which are standard formulae to be memorized.

So $I = \frac{1}{9}\frac{1}{\left(\frac{2}{3}\right)}\tan^{-1}\frac{x-\frac{2}{3}}{\frac{2}{3}}$

$= \frac{1}{6}\tan^{-1}\frac{3x-2}{2}$

Note that VM associated rules are slightly modified forms of the above rules, obtained using the derivative $f'(x) = \pm\sqrt{D}$ discussed in the Shankaracharya's original Vedic Maths text. Here

the rule named ‘Differential Calculus’ has been applied to choose the right pattern related to quadratic equations.

5.3.5 Control Group

Subjects in Study 1 Control Group went for jogging during pilot study.

Subjects in Control Groups in Studies 2 and 3 attended their regular conventional maths classes.

5.4 ASSESSMENT INSTRUMENTS

5.4.1 Mathematics Anxiety Rating Scale Revised - MARS-R: (Plake et al., 1982)

MARS-R was used in all three studies. Its 24-items measure Learning Math Anxiety (LMA) and Evaluation Math Anxiety (EMA). Total Math Anxiety equals LMA score plus EMA score.

Scoring: Students rate each item on a 5-point scale from “low anxiety”, 1, to “high anxiety”, 5. Scores are the sum of item ratings; overall scores for LMA and EMA range from 24 to 120.

5.4.2 Children’s Cognitive Assessment Questionnaire – CCAQ: (Zatz et al., 1983)

All studies used CCAQ, which measures self-defeating and self-enhancing cognitions associated with performance and anxiety when faced by a test. CCAQ subscales are negative and positive self-evaluations (NSE & PSE), self-distracting, off-task, and on-task thoughts, (OFFT & ONT).

Scoring: Each item is answered true or false. Scores on each subscale are the number of items answered “true”, and range from 0 to 10. Higher scores on the first two

subscales reflect more test-anxiety, while higher scores on the last two subscales reflect less test anxiety.

5.4.3 STROOP: (Gualtieri et al., 2006**)**

Computerized STROOP 2011 version (Draine, 1998) was used in all three studies. It includes three subtasks, which measure cognitive flexibility, creativity, and reaction to cognitive stress. Participants are presented words in colors red, green, blue or black, and are asked to state the color by pressing keys: ‘s’, ‘d’, ‘j’, and ‘k’. Three kinds of trial are presented: 1. Congruent: colour name and colour presented match. 2. Incongruent: colour name and color presented differ. 3. Control: colored rectangles. Latency of response and errors in each trial are recorded.

5.4.4 Digit Span Test: Forward and Backward

The Digit Span Test computerized version (Draine, 1998) measuring visual working memory was used in all three studies. Participants are given 14 trials observing a sequence of digits (starting with 3 digits – level 3), with each digit presented for one second, after which they are asked to recall the digit sequence and type the answer into a textbox. Correct responses move participants to the next level. Incorrect responses mean that the same level is presented a second time. Consecutive errors move participants back to the next lower level. The test continues for 14 trials. The first time a participant makes consecutive errors, the score is the last correctly recalled number of digits (e.g. two incorrect answers at level 8, sets the Digit Span score at 7).

5.4.5 Mindfulness Attention Awareness Scale (MAAS):

The MAAS instrument (Brown et al., 2003) used only in Study 3 is a single-factor 15-item questionnaire on a six-point scale, 1 = almost always to 6 = almost never. Total

scores range from 15 to 90; normal scale score is the average over all 15 items. Higher scores reflect higher levels of dispositional mindfulness. The instrument was validated in college, community adults, and cancer patient populations in different studies (Carlson et al., 2005). 'Mindfulness' as measured by MAAS connects consciousness to emotional regulation, behaviour regulation, and well-being.

5.4.6 Nonphysical Aggression Scale from Pittsburgh Youth Study

The Nonphysical Aggression Scale from the Pittsburgh Youth Study (Loeber et al., 1998) used in Study 3, is a 16 item scale measuring nonphysical aggressive behaviours: arguing, attention seeking, bragging, disobeying parents or teachers, not getting on with others, swearing, and sulking. Internal Consistency is .85 from samples of 6, 9, and 12 year old males followed into adulthood. Its 3=point scale ranges from 0 = Not True to 2 = Very True; total scores range from 0 to 32.

5.4.7 Emotion Regulation Questionnaire (ERQ)

The Emotion Regulation Questionnaire (Gross et al., 2003) was only used in Study 3. It consists of 10 items, each with a 7 point scale (1 = Strongly Disagree to 7 = Strongly Agree). It measures two important aspects of emotion, emotional experience and emotional expression, both concerning management of emotion. Statements assess cognitive reappraisal, and suppression of expression of positive and negative emotions. Each contains 5 items concerned with each.

5.4.8 An additional Assessment: Exam Result Analysis

A retrospective study was carried out on two independent cohorts at Sai Angels PU College. The first comprised 340 subjects, who had taken final exams in years 2010 to 2013, while the second comprised 312 who had taken final exams in 2014 and 2015.

The study assessed their final year, 12th Standard, exam results in Maths, Physics and Chemistry over the six year period 2010-2015, obtained from college records, which were then tabulated by percentage and percent ranges.

5.4.8 A Conventional Mathematics Teaching

Conventional Mathematics Teaching refers to the traditional chalk and board method used at the school from 2010 to 2013, during which time no special teaching methods were employed. Problems were solved after explaining the mathematical concepts on the board. Students wrote the details of the problems and answers after listening to instructions given by teachers. Similarly, any graph or illustrative pictures used in teaching were drawn on the board.

5.4.8 B Vedic Maths Teaching

Two tools, Vedic Maths and Geogebra with Presentation Slides, were used in teachers' explanation for classes graduating in 2014 and 2015. Two examples, one from Geogebra and one from Presentation Slides are shown in Figure 3 and Figure 4 to provide glimpses of their visual based teaching methods.

Concepts taught and respective visuals employed are listed below. These were implemented throughout each year, not during Vedic Maths teaching or Yogā Prāṇāyāma interventions. These were used in the entire 2014 and 2015 academic years after the 15 days of Main Study 3.

1. Relations and Functions – domain, range, graphs of functions, vertical line test to prove relation as function, horizontal line test for one-one functions, odd and even functions, continuity and differentiability of the function were explained using Geogebra animations.

2. Inverse Trigonometric Functions – all trigonometric functions, restricted domains of inverse functions, translation from trigonometric to inverse trigonometric functions were shown with colourful Geogebra graphical animations.

3. Continuity and differentiability – The physical and graphical meaning of differentiation was discussed using animated graphs of Geogebra files and presentation slides.

4. Applications of derivatives – 28 problems on "Derivative as a rate measure" given in the NCERT textbook were presented through slides with amusing step-by-step animations. First and second derivative tests, graphical meanings of Maxima, Minima and Points of Inflection, tangent and normal at points on various different curves, Mean Value Theorem and Rolle's Theorem were explained through visuals in presentation slides.

5. Application of Integrals – Integration as the area under a curve was illustrated by animations. Many problems were solved using power point presentations to show colourful graphs of conic sections, and other functions intersecting each other.

6. Vector Algebra – Scalar product, vector product, scalar triple product, vector triple product and the differences between them were presented using slides and Geogebra 3d animations.

7. 3D Geometry – Skew lines, the normal to a plane and other 3d concepts were similarly illustrated through slides and Geogebra animations (Figure 3).

FIGURE 3: INTEGRATION AS SUMMATION TO FIND THE AREA UNDER A CURVE

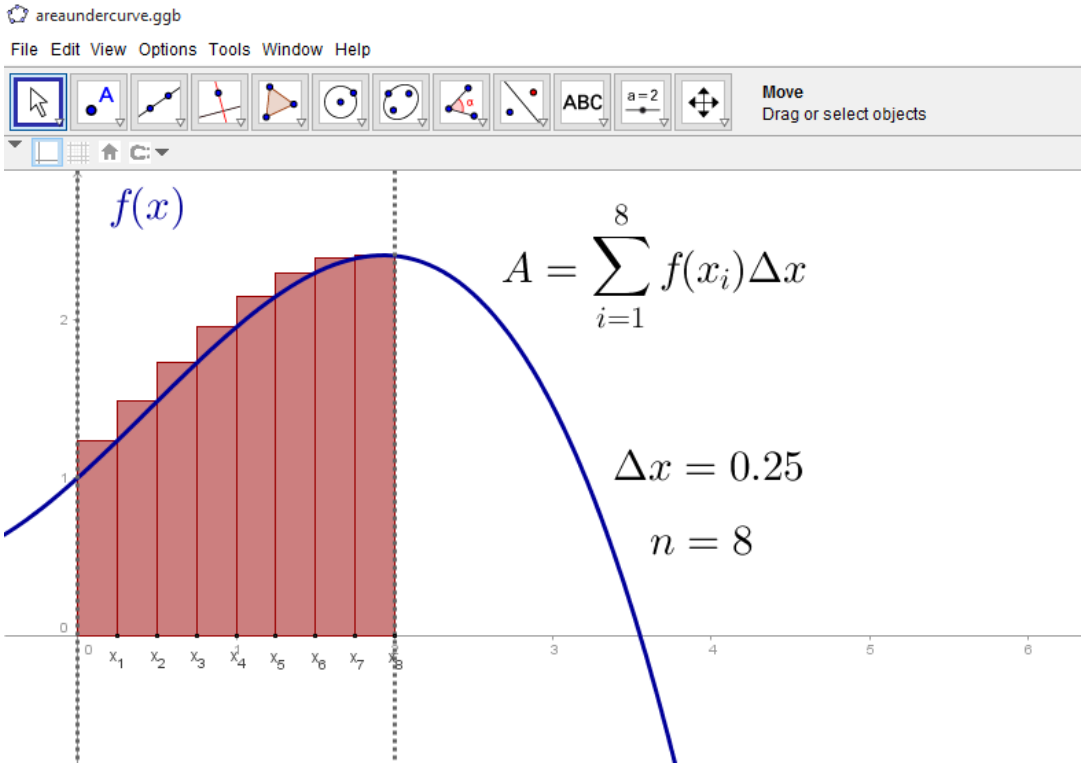


Figure 3 Caption: Integration as summation to find the area under a curve is explained using animation to keep increasing the number of rectangles and so improve approximations. Area under the curve is the sum of the areas of all rectangles with length $f(x_i)$ and breadth is Δx for any natural number n.

FIGURE 4: TEXT BOOK PROBLEM

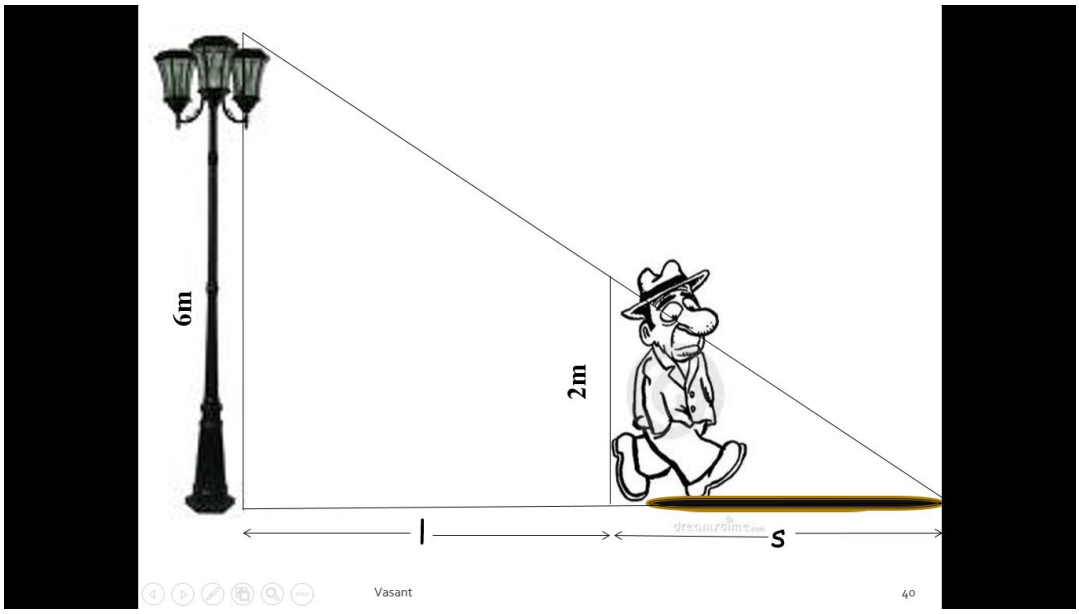


Figure 4 Caption: A man of height 2 metres walking at a uniform speed of 5 km/h away from a lamp post 6 metres high. Find the rate at which the length of his shadow increases. The problem solution uses an animated picture increasing the length of his shadow.

5.5 DATA EXTRACTION FROM EACH INSTRUMENT

This section summarizes the data extraction for each test in the three studies described in this thesis, and the subsequent analysis of 12th grade final exam results.

5.5.1 Mathematics Anxiety Rating Scale Revised - MARS-R:

Students rated each item ranging from 1 to 5. Name, College register number, Gender, Learning Math Anxiety (LMA), Evaluation Math Anxiety (EMA) and Total Math Anxiety (TMA) of the student were manually entered into Excel sheets from their written paper. Collected data was organized as pre-, post, pre-post differences and transferred to SPSS 19 for analysis.

5.5.2 Children's Cognitive Assessment Questionnaire – CCAQ

Students rated each item either as true or false. Name, College register number, Gender, Negative evaluations, Off-task, Positive Evaluations, On-task thoughts and Total CCAQ score were manually entered into Excel sheets from the written paper. Collected data was organized as pre-, post, pre-post differences and transferred to SPSS 19 for analysis.

5.5.3 STROOP:

Both computerized and non-computerized mode of testing were used. Non-Computerized Mode: Number of verbally recognized different colored rectangles printed in first page, number of verbally recognized colour names (Congruent and Incongruent trials) printed in second and 3rd pages were noted. These three numbers were manually entered to Excel sheets along with Name, College register number, and Student Gender. Data was arranged and transferred to SPSS 19 for analysis. This mode of testing was used only in Study 1 (pilot study).

Computerized Mode: STROOP 2011 version (Inquisit Software) was used to record student responses. Latency of response and errors of Congruent, Incongruent and Control trials were recorded. Information was then transferred to Excel sheets and arranged for SPSS analysis. Finally it was transferred to SPSS 19 for analysis. This computerized mode of testing was used in the two main studies, Studies 2 and 3.

5.5.4 Digit Span Test: Forward and Backward

Non-computerized version: Verbal working memory span scores are noted separately for forward and backward scores. These scores were manually entered to Excel sheets along with Name, College register number, and Student Gender. The Data was arranged and transferred to SPSS 19 for analysis. This mode of testing was used only in study 1 (pilot study).

Computer version (Inquisit software): The visual working memory Digit Span scores recorded by the Inquisit software was transferred to Excel sheets. Forward scores and backward scores were entered separately. Then the data was finally transferred to SPSS 19 for analysis.

5.5.5 Mindfulness Attention Awareness Scale (MAAS):

Students answered 15 items ranging from 1 to 6, which were entered manually into Excel sheets. Name, College register number, and Student Gender were also recorded. The Data was arranged and transferred to SPSS 19 for analysis.

5.5.6 Nonphysical Aggression Scale from Pittsburgh Youth Study

Students answered 16 items ranging in value from 0 to 2, which were entered manually into Excel sheets. Name, College register number, and Student Gender were also recorded. The Data was arranged and transferred to SPSS 19 for analysis.

5.5.7 Emotion Regulation Questionnaire (ERQ)

This test was used only in Study 3. Students answered 10 items ranging in value from 1 to 7, which were entered manually into Excel sheets. Name, College register number, and Student Gender were also recorded. The Data was arranged and transferred to SPSS 19 for analysis.

5.6 DATA ANALYSIS

IBM Statistical Package for Social Sciences (SPSS), Statistics for Windows, Version 19.0, marketed by IBM Corporation, Armonk, NY (IBM Corp, 2010) was used for data analysis. For all parametric data, group comparisons were performed using One Way ANNOVA tests, whereas pre-post analysis was performed using paired sample t-tests. For all nonparametric data, group comparisons were carried out using Kruskal Wallis tests with Bonferroni corrections, while within group pre-post analysis was done using Mann Whitney tests.