

CHAPTER – 8

APPRAISAL

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8.0 APPRAISAL

This chapter summarizes the results obtained in the studies recounted in this thesis and appraises their significance from scientific and social perspectives.

8.1 SUMMARY OF THE FINDINGS

Yogā Prāṇāyāma methods consisting of two Kriyās, Sectional Breathing, Nāḍī Śodhana, Sūrya Anuloma and Candra Viloma, and Bhrāmari improve mindfulness and reduce stress levels. Yogā Prāṇāyāma practices including repetitive chanting of A, U, M, OM, and generating a humming sound in Śāmbhavī Mudrā, have been observed to stimulate the brain, eventually yielding stronger pattern recognition (Subbalakshmi et al., 2004). They also stimulate the dopamine and endorphin system (Mohandas, 2008). Improved cognitive flexibility, reaction to cognitive stress, and reduced math-anxiety result.

Yogā Prāṇāyāma brought greater improvements in CCAQ than Vedic Maths or normal maths classes, strengthened the impact of Yogā in decreasing stress, and improved self-concept and self-esteem (Raghuram et al., 2008), which may lead to greater self-confidence, and result in better performance (Feltz, 1988). These may also contribute to reduction in math-anxiety.

Vedic Maths offers new strategies of mental calculation in fewer steps, bringing a “feel-good factor” to solving problems. It promotes pattern recognition in maths (Kellman et al., 2010), motivates students to participate effectively in problem solving sessions, and introduces a fun element, possibly by stimulating ‘feel good’ neurotransmitters release

(dopamine, serotonin, and endorphins) (The Harvard Mahoney Neuroscience Institute, 2010). Reduction in math-anxiety and improvement in cognitive skills result.

The combined effect of these practices should therefore be considered of value in managing Math Anxiety and enhancing cognitive skills. The studies bring new understanding of Vedic Maths, introducing a new domain of application. They offer good reasons for including Vedic Maths and Yogā Prāṇāyāma, individually or together, in school curricula in India. In this context, it may be mentioned that the Maharishi School in Hosur, where students practice Transcendental Meditation, a Yogā-associated technique, morning and afternoon, is widely regarded as the best school in the district.

8.2 CONCLUSIONS FROM INDIVIDUAL ASSESSMENT TESTS

8.2.1 MARS-R

Overall results indicate that teaching mathematics using Vedic Maths methods is an effective way to reduce Math Anxiety in school students in all standards, 8 and above. The results were highly significant, $p < 0.0001$, and robust with $\beta = 0.19$ for Studies 2 and 3 combined. Further research showed that the improvements had objective correlates: results on final year examinations at Sai Angels PU College showed consistent improvements for all four years in which Vedic Maths methods have been employed.

8.2.2 CCAQ (Cognitive Skills)

The YP groups performed consistently best in improving CCAQ scores in all three studies, indicating that the Yogā Prāṇāyāma module represents a highly effective way to improve cognitive skills in high school students. However, the Vedic Maths interventions also improved CCAQ scores relative to controls in all three studies,

reaching significance in Studies 2 and 3. This result may be due to use of pattern recognition in Vedic Maths teaching, practice in which may have the effect of enhancing cognitive skills in general.

8.2.3 Digit Span Test

No significant improvements were seen on the Digit Span test in any of the three Studies. This result is of extreme interest, since the test is meant to assess working memory, and according to many studies, working memory plays a vitally important role in arithmetic calculations. While that may be true, the only conclusion to be drawn from the combination of failure to improve working memory, and observations of vastly improved performance on maths exams, is that another factor plays a more important role: the ability to think conceptually about each calculation required to solve a problem. This supports the concept that the mind functions by using ideas, as we experience rather than just being an algorithmic machine.

8.2.4 MAAS (Mindfulness)

The Yogā Prāṇāyāma module proved effective in improving scores on MAAS in Study 3, in contrast to the Vedic Maths group for which improvements in score did not reach significance. These results indicate that Yogā Prāṇāyāma techniques could prove useful in schools and pre-university colleges to produce more settled states of mind such as those associated with mindfulness.

8.2.5 Pittsburgh Aggression Scale

Again, the Yogā Prāṇāyāma module was found to reduce symptoms of aggression, while the Vedic Maths group did not improve. Examination pressures during 12th grade

seem to make such stressors peak, so this offers an additional reason to introduce such modules widely in high school education.

8.3 IMPLICATIONS OF THE STUDY

8.3.1 Study 1 (Pilot study)

The pilot study established the feasibility of the proposed program of research. It also provided a G power analysis from which to determine the number of subjects needed in the two main studies. Both proposed interventions, Vedic Maths, and the Yogā Prāṇāyāma module, were found to decrease Math Anxiety and self-defeating thoughts, and improve cognitive flexibility and self-enhancing thoughts in school children in standards 8, 9 and 10. It concluded that increasing sample size and intervention time would generate stronger conclusions, justifying the implementation of the two larger studies. It provided grounds for implementing both Vedic Maths and Yogā Prāṇāyāma in school curricula.

Observed improvements in working memory, math-anxiety, and focused attention, resulting from learning Vedic Maths were new, as were Math Anxiety reductions from practising Yogā Prāṇāyāma. The one-week intervention was not enough to make these provocative results conclusive, so further studies with larger group sizes were called for, and investigation of mechanisms behind observed changes.

8.3.2 Study 2

The Vedic Maths and Yogā Prāṇāyāma workshop interventions were definitively shown to decrease Math Anxiety and self-defeating thoughts, and improve cognitive flexibility and self-enhancing thoughts in school children. Study results fulfilled

expectations from the Pilot Study, Study 1, and justified performing the further study, Study 3, in order to provide good grounds for widely implementing both techniques of improving student performance in school curricula.

8.3.3 Study 3

Teaching 12th grade mathematics using the methods of Vedic Maths was again shown to reduce Math Anxiety highly significantly, and to increase student enjoyment of maths classes, as discussed in the previous chapter. The Yogā Prāṇāyāma intervention proved more effective than Vedic Maths on improving mindfulness, aggression and emotional regulation variables. Both Vedic Maths and Yogā Prāṇāyāma techniques may therefore be useful in pre-university colleges and schools to improve student enjoyment and performance. Yogā Prāṇāyāma produces settled states of mind like those associated with mindfulness. It can also reduce aggression symptoms resulting from examination pressures in 12th grade when such stressors peak.

8.3.4 Final Exam Results in Mathematics

The remarkable results obtained in 12th grade final exams are the ultimate justification for introducing the techniques described here in schools throughout India. Substantially increasing the numbers of students scoring full marks, 100%, gaining distinctions, over 85%, and bringing the average score up to the 85% distinction level, demonstrates that the combination of methods used to enhance mathematics teaching, Vedic Maths including its further developments over the past 40 years, together with Geogebra and Presentation Slides, offer invaluable ways to improve the mathematics achievements of the population.

8.4 APPLICATION OF THE STUDY

Vedic Maths methods can therefore play major roles in increasing students career choices. They improve chances of securing places on most courses by which students can become IAS officer, Forest officer, Management head, Hotel Manager, Bank Manager, Army officer, Engineer, Teacher etc. Using Vedic Maths has merit in any competitive exam where quantitative aptitudes, mathematical reasoning and high school mathematics are key requirements.

The possibility of scaling up these results must definitely be taken forward. The ease of training successful teachers in Vedic Maths methods should also be studied: do those initially using Vedic Maths methods obtain similar results from their classes? At the International Conference on Ancient Indian Languages in Ahmedabad in September, 2017, sponsored by IGNOU, the Distance Learning Methods in which IGNOU has long experience, were deemed suitable to teach Vedic Maths more widely, and to train teachers in Vedic Maths methods. Such scaling would significantly increase numbers of school graduates qualified to study for degrees in Science and Technology; and for other courses requiring maths competency. Such increases should increase the rate at which India can transform into a knowledge-based society, as envisaged by the National Knowledge Commission instituted by the then President Abdul Kalam.

8.5 STRENGTHS OF STUDIES

STUDY 1: Observed improvements in working memory, math-anxiety, and focused attention, resulting from learning Vedic Maths are new, as are the observed reductions of Math Anxiety produced by practising the Yogā Prāṇāyāma module.

STUDY 2: The study was a randomized control trial with 59 in Vedic Maths, 59 in Yogā Prāṇāyāma and 50 controls after attrition. It obtained significant results on all tests except CCAQ's fourth subscale.

STUDY 3: The strengths of the study include the number of participants for pre-post within group changes and intergroup comparisons. Also it specifically supports the idea that Yogā Prāṇāyāma can improve participants' quality of Mindfulness (Brown et al., 2009) and help in students' management of aggression issues (Deshpande et al., 2009).

Results of the study were sufficiently promising to encourage further research, particularly in light of the measurements on Math Anxiety and other variables. It is hoped that funds for larger, fully randomized studies will be forthcoming.

Strengths of the Final exam result analysis: the first four years data established baseline statistics of the percentages obtained in mathematics without visual aid and Vedic Maths teaching methods. Moreover the statistical analysis indicated that the evidence is robust, $\alpha < 0.0001$ and $\beta = 0.000002$.

8.6 LIMITATIONS OF THE STUDIES

STUDY 1: A pilot study: the sample size was too small to draw strong conclusions.

STUDY 2: Being an enthusiastic proponent of Vedic Maths, and experienced Yogā teacher, means that reported results may depend on the personal qualities of the teacher.

STUDY 3: Main weakness was assignment by arbitrary choice of class to each group. Each class was heterogeneous, but with similar demographic characteristics at baseline. Full randomization would have improved study quality, but no reason exists for believing that that would have changed overall findings.

Weaknesses of the Final exam result analysis: Only two years data on examination results for students educated in Vedic Maths and Visual based teaching was available, and the total number of 652 students may seem relatively small for studies of maths education. To offset this, however, and as stated under ‘Strengths’, results were consistent; statistics obtained had excellent significance, alpha, and high power, beta.

8.7 SUGGESTIONS FOR FUTURE RESEARCH

Future Research: As is usual in scientific research, first results, however favourable, require follow-up to attempt to identify any drawbacks or problems. Further studies of the impact of teaching through Geogebra, animated slides and Vedic Maths teaching should extend this study to different groups of students in more kinds of school, and to students from more varied demographic backgrounds. They should also explore possible predispositions to these approaches. The present analysis will be expanded as new data becomes available.

Effects of Vedic Maths have not been previously studied like this. Results need verification. Further studies should add more variables. Such studies will be carried out in the future.