CHAPTER 3 - METHODOLOGY

The present chapter describes the research methodology adopted for the conduct of the study such as the various stages and processes involved in the planning and finalization of the study, collection, analysis and interpretation of the data.

3.1 RESEARCH DESIGN: A before-after experimental design with controls was adopted for the present study. The particular design was selected because the study involved a pre assessment of the dependant variables in two matched groups, an intervention for one of the groups and a post assessment of the same variables in both the groups. The dependant variables under study were:

- Marks obtained by children in the school exams
- Cognitive functions of the children
- Their behavior as rated by parents
- Their behavior as rated teachers

A computer-based cognitive enrichment programme was the independent variable and the impact of the intervention on the dependant variables formed the total study.

3.2 OBJECTIVES: The major objective of the study was to assess the effect of a computer-based cognitive enrichment programme on the scholastic performance of children.

The specific objectives were:

3.2.1. To identify children with average scholastic performance in classes 3, 4, 5
3.2.2. To assess the academic functioning of the identified children
3.2.3 To assess the cognitive functioning in the identified children.
3.2.4. To assess the behaviour of the identified children.
3.2.5. To study the effects of the training on cognitive functioning, everyday behaviour and academic performance of this group of children.
3.2.6. To study whether the effects of training on academic performance, persists after 3 months.

3.3 HYPOTHESES: The children who have undergone the computer-based cognitive enrichment programme will henceforth be referred to as group E while the children who have not undergone the enrichment programme will be referred to as group C.

1. Cognitive functioning will be better in group E as compared to group C.
2. Academic functioning will be better in group E as compared to group C.
3. Behavior problems will be decreased in group E when compared to group C.

3.4 DEFINITION OF CONCEPTS:

3.4.1 EFFECT is defined as result or consequence or outcome. In this study, effect is the difference before and after intervention, in the child, with respect to academic performance, intellectual functioning, and other behaviour.

3.4.2 COMPUTER-AIDED is defined as the presentation or delivery or administration of a programme using a computer.

3.4.3 COGNITIVE relates to thought processes. In this study it is defined as processes that involve neuropsychological functions such as attention, perception, memory and language, as measured on a standardised battery of intelligence tests for children, MISIC.

3.4.4 The meaning of ENRICHMENT is to enhance or improve. In this study, enrichment is defined as improving (cognitive) functions such as attention, perception, memory and language.

3.4.5 PROGRAMME refers to 20 sessions of individual training that children in the E group underwent.
3.4.6 SCHOLASTIC or academic performance is the performance of children on the evaluations of the schools they attend.

3.4.7 CHILDREN refers to the group of boys and girls studying in classes 3, 4, or 5 in CBSE schools in Ernakulum.

3.4.8 BEHAVIOUR refers to the social and emotional responses of the child as rated by teachers and parents on the Strengths and Difficulties Questionnaire.

3.5 LOCALE OF STUDY: This study was carried out in Ernakulum; the initial part was done in CBSE schools while the computer-based programme was conducted in the hospital (Amrita Institute of Medical Sciences, Ponekkara). Only schools that were affiliated to the Central Board for Secondary Education (CBSE) were included in the study.

3.6 SAMPLING UNIVERSE OF STUDY: The universe comprised children of classes 3, 4, and 5 in all the CBSE schools in Ernakulum. Schools in Kerala state can be divided into those in the government sector, private schools in the aided sector, and the unaided sector comprising private schools affiliated to the CBSE, ICSE, and international boards of education.

Ernakulum is an urban, industrial area in the central part of Kerala. With its multicultural population drawn from all parts of India, it was considered a good representative of an Indian city. CBSE is one of the boards that has affiliated schools in every state and Union territory of the country with a centralized board governing the syllabus, resources, pedagogy and assessment. Unlike the education board in different states, it is has a good degree of uniformity. This would ensure that a fairly homogenous sample could be formed, even if children were drawn from different schools affiliated to CBSE.

The base population was estimated to be approximately 50,000 children, in 30 CBSE schools in Ernakulum city. At an average of 30 children per section in each class, and atleast 2-3 sections per class, there would be approximately 90-100 children per class in each school i.e. about 300 children in classes 3, 4 and 5 from each school. The universe, from which a sample may be drawn, will thus be approximately 9000. Research suggests that atleast 10-20% of school-going
children have academic and behavioural problems. Therefore within this universe, at least 900-1800 children can be assumed to be the group from which the sample can be drawn.

3.6.1 UNIT OF STUDY: The unit of study was the child studying in classes 3, 4, or 5 in any of the CBSE affiliated schools in Ernakulum.

3.7 SAMPLING: This study is based on children from specific classes, listed by teachers and whose parents have given their consent to being included in the programme. Therefore, a stratified purposive sampling procedure was followed for inclusion in the study.

3.7.1 PILOT PHASE: A list of schools in Ernakulum city, affiliated to the CBSE was obtained from the Telephone directory, along with an online search. Fifteen schools within a radius of 5-6 kilometres from the hospital were selected, since the training was supposed to take place in the hospital. The schools authorities were contacted by telephone, and a letter detailing the programme was sent to the respective Principals.

Five schools denied permission for the study. In the remaining 10, sensitization programmes were conducted for teachers (and parents, upon request). Notices were then put up in each school, with details of the programme and contact information. Thus, at the first stage, students were included, primarily on the basis of parental interest in the programme.

Eighteen children were enrolled in the programme at different points in time, of which 6 dropped out after the initial sessions. Attempts were made to contact them, but parents cited difficulties in bringing the child for all the sessions. The common reasons cited were suitability of time (both parents employed, difficulty for the caregiver in bringing the child to the hospital) and expense (of transport). One parent expressed doubts regarding the usefulness of the programme. The pilot study was thus completed with 12 children. Data from 9 children matched for age and class were taken; this formed the control group.

3.7.2 FINAL STUDY: The size of the sample was estimated, based on the results of the pilot study. Sample size was calculated with 95% confidence and 80% power for each outcome variable- marks, score on the MISIC and the scores on
the SDQ-parent and teacher versions. The minimum sample required for different study variables varied between 5 and 20. The sample size was thus fixed at 20.

Five schools that were closest to the hospital were then selected. Each school was visited and teachers were requested to give the names of children in their respective classes who were scoring between 40 and 60% in the school exams. The contact numbers of these children were also requested.

A total number of 80 names were given in the lists. The parents were then contacted; the purpose and details of the study were explained to them. On an average, atleast 3 telephone calls were required for parents to clarify doubts regarding the programme and give their consent for their children to participate. Twenty nine parents confirmed their participation; later, nine of them opted out citing several reasons. The programme was conducted free of cost, except for the initial registration at the hospital. No monetary or other incentives were offered to the children who participated in the programme.

One of the limitations often cited in intervention research is the absence of a control group. This study tried to overcome the limitation by including a group of children from the same population, who did not undergo the programme. Difficulties in obtaining parental consent and ethical considerations prevented the inclusion of a group of controls who were exposed to an alternate computer-based programme or other related activity such as video games.

The final sample thus consisted of 20 children in the E group, with 20 matched (passive) controls in the C group. The distribution of boys and girls in the 3 classes were almost equal; therefore, both boys and girls were included.
List of participants

Parents contacted

No consent
Excluded

Consent
Included in sample

E group (n=20)

C group (n=20)

Pre-intervention assessment

MISIC, SDQ-P and SDQ-T, Marks

Intervention

MISIC, SDQ-P and SDQ-T, Marks

3 months later Follow up assessment

Marks

Immediate Post-intervention assessment

No intervention
3.8 SAMPLE SELECTION CRITERIA

3.8.1 INCLUSION CRITERIA:

Students of class 3, 4 or 5 in a CBSE school
Age between 8 and 11 years
Average marks obtained in the school assessment, between 40-60%

3.8.2 EXCLUSION CRITERIA:

Prior diagnosis of a medical or psychiatric condition.
Use of devices such as spectacles, hearing aid, callipers.
Repetition of a class

3.9 TOOLS USED: The socio-demographic and clinical profile of the children was studied using an interview check-list for parents. The outcome or dependant variables were the scores on the test of intelligence(IQ), marks obtained in school exams and the rating of behaviour by parents and teachers.

3.9.1. THE DEVELOPMENTAL PSYCHOPATHOLOGY CHECKLIST (Kapur, Barnabas, Reddy, Rozario & Hirisave, 2002), with 124 items divided into 6 subsections, namely developmental history, developmental problems, psychopathology, psychosocial factors, temperamental profile and social supports and assets of the child. This was developed by Kapur et al. to be used by the investigator while interviewing parents/teachers. This checklist has been developed in India and has been used in a child mental health setting. Each of the sections of the checklist has a cutoff score. If the score obtained by the child is above the cutoff level in any section, that area is considered a potential problem area for the child. The checklist has an interclass correlation (reliability) coefficient of 0.965. It has been validated against the Child Behaviour Check List (CBCL), one of the most widely used tools in Child Psychiatry.

3.9.2. MALIN’S INTELLIGENCE SCALE FOR INDIAN CHILDREN (MISIC), an adaptation of the Weschler Intelligence Scale for Children developed by in 1966 to assess the cognitive abilities of the child. This is used for children aged 6 to 15 years. This battery comprises 11 sub-tests, 6 of which form the verbal
scale and 5 on the performance scale. The tests in the verbal scale include information, comprehension, analogies, arithmetic, vocabulary and digit span. The tests on the performance scale include picture completion, block design, object assembly, mazes and coding. The neuropsychological functions tapped by the various sub-tests include attention, concentration, working memory, vigilance, recall, mathematical reasoning, judgment, visuo-spatial construction and visual integration.

The score on each subtest yields an IQ score for each age group. The reliability of the battery by the test-retest method yielded a Pearson’s product moment correlation coefficient of 0.91 for the Full scale IQ results. Concurrent and congruent validity yielded a coefficient of 0.63. The test was done, prior to intervention for Group 1.

The initial assessment for the entire sample was done by the investigator. The post-intervention assessment for the E group was done by a psychologist who was blind to the initial scores. This was done at the hospital. The control could not be brought to the hospital and hence was assessed at the respective schools, by the researcher.

3.9.3. A record of the SCHOLASTIC PERFORMANCE OF THE STUDENT was obtained from school in Maths, English and Science. Marks refer to the scores obtained by the child in the major school examinations. Three sets of marks were used- the first being at the start of the study, prior to beginning the programme. The second set of marks was recorded after the training was completed for the experimental group and simultaneously for the control group. A third set of marks was recorded atleast 3 months after the training was completed. The final marks obtained in every term was used, this is a composite of marks obtained on unit tests as well as a term exam.

3.9.4 STRENGTHS AND DIFFICULTIES QUESTIONNAIRE (Goodman, 1997). This a 25 item, 3 point rating scale which assesses the child on 5 dimensions- Emotional disorders, hyperactivity, conduct problems, peer problems and pro-social behavior. A total cut off score of 11 with individual cut offs for
each of the 5 dimensions was used. It is used for children from ages 3 to 16 years, with a self-rating version for children above 11 years.

Reliability and validity co-efficients have been adequate (0.6-0.7). Scores above the cutoff are considered to be indicators of “caseness”. The SDQ is one of the few scales that can be used as a screening tool or to study the effects of intervention. In this study, the pre and post intervention scales were used. It has been used in different countries and has been translated into several Indian and international languages.

The parent version was used while interviewing parents both before as well as after training of the children in the E group. This procedure was also followed for parents of children in the C group.

The teacher version was used while interviewing teachers before and after training of the children in the E group. The rating of children in the C group was done at the same time. In the initial assessment, the teachers were not aware of which children would actually attend the programme.

3.10 INTERVENTION PACKAGE: The Brain Function Therapy (BFT) program was conceptualized and designed by the developer Mukundan (2003) as computer aided cognitive retraining program which is commercially available and used in various clinical groups. The programme is aimed at multiple neuropsychological functions such as recognition (characters, words, numbers) spatial comparison, response inhibition, continuous performance and sequencing (temporal and alphanumeric). The computer control of the cognitive tasks only facilitates accurate control and change of exposure times, tasks or data material, and allows recording of the performance related factors. The tasks used are derived and modified mainly from the NIMHANS neuropsychological battery. The software of the program was developed by Axxonet Solutions India, as per the administration program designed by the developer. The program involves presentation of stimulus material on a computer monitor with increasing difficulty levels set in terms of duration of exposure and the units of information, to be recognized in a given trial.
Performance is evaluated in terms of the accuracy of the response of the subject to increasing difficulty levels. The exposures time, the inter-trial duration, and complexity of the stimuli are controlled, and set to increase on graded manner to increase the efficiency of detection/processing by the subject. The following modules from BFT were used in the study:

3.10.1 ALPHABET PRESENTATION. One to four alphabets can be simultaneously presented on the computer monitor. Both size (1-3 cm) and duration (from 20 ms onwards) of presentation can be set by the therapist. Inter-trial interval can be set and randomly varied. The subject is expected to choose one of the three modes of responding: (a) respond to the numbers and letters seen by typing the same using the keyboard, (b) call out the numbers/letters, (3) point to the numbers/letters printed on a board, made available to the subject. The numbers/letters are presented by the computer from a data file prepared by the examiner. The same data file can be used repeated across training sessions. Based on accuracy and speed of responding, the exposure time can the inter-trial intervals can be stepwise varied. The exposure time can be decreased by 1 ms or its multiples in stepwise manner across sessions. Both mean speed and accuracy of response are recorded and stored by the system. The task is expected to improve attention, speed of number and letter recognition, and working memory processing ability.

3.10.2 WORD IDENTIFICATION. Three to four letter words are presented one by one. Both size and duration of presentation can be varied. Inter-trial interval is randomly varied. The subject’s task is to identify the word from a list of 4 words presented simultaneously or from memory. One of the alphabets of the word is presented smaller than the rest so that it is difficult for the subject to make a comparison visually or using visual imagery. List of words are presented from a pre-prepared data file in a random manner. The task is expected to improve word recognition and working memory processing ability (when recognition is made from memory).

3.10.3 VISUOSPATIAL COMPARISON: A target figure appears in the middle of top half of the screen. Four figures of which one is the same as the one
presented as target, appear in lower half of the screen and across it. There are three levels of comparison. In level one, the subject makes a direct comparison of the target figure with the comparison figures. The comparison figures appear in the lower half. The subject must enter the number of the figure from the keyboard. If the subject cannot type, he must point it out with finger, or call out the number of the comparable figure, and examiner enters the respective number. In the second level of target comparison from memory, the target comes on the screen along with figures for comparison and stays for the preset duration. In the third level of presentation, the comparison figures appear after the target figures disappear. The exposure time of the target figure can be preset. The interval between the target figure and the comparison figures can be also varied. The subject is taken from level one to three for spatial comparison. The same task is repeated at three levels in which the target figure is (a) equal to or (b) smaller, or (c) bigger in size than the comparison figures. The subject is taken from equal size comparison to small and bigger size comparisons. The task is expected to enhance visuo-spatial analysis, recognition, and comparison abilities along with working memory processing ability especially using visuo-spatial processing and buffer memory.

3.10.4 WORKING MEMORY: This task presents a single or two digits number in the middle box, which is accompanied by matrix of 8 cells with numbers in each cell on the four sides. The numbers in the matrix of cells contains numbers one greater than and one smaller than the number presented in the centre. There are three levels of performance: In the first level the central number and the matrix of cells appear together. The subject is instructed to enter the cell number which contains the number preceding the central number first and then the cell number which has the following number. Once the cell number is entered, the number in the cell appears to the left and right respectively of the central number. In the second level the central number and the matrix appear together, but the central number disappears after the preset exposure time. In level three, the matrix of cells and the numbers appear only after the central number has disappeared. In this level the subject must hold the central number in the mind and look for the preceding and following numbers and enter their respective cell numbers. The
exposure time of the central number and the interval between disappearance and
the appearance of the matrix can be preset and randomly varied. A subject is
started with long exposure time in the first level and instructed to perform at level
two and three. The exposure time is decreased by tens of millisecond and the
interval between central number disappearance and the appearance of the matrix is
gradually increased across sessions. A data file contains information about the
numbers that are to be presented in the central box. The test is a working memory
task using numbers in which the subject has to mentally hold and process, and
switch processing.

3.10.5 CONTINUOUS PERFORMANCE TEST: This is a typical ‘n’ back test,
in which there is a continuous presentation of different geometric figures one after
the other in which a figure may occasionally repeat itself, when the subject make
response using the keyboard. The inter-trial interval can be arranged to randomly
vary around a preset value. The repetition of the figure is randomly arranged and
the random order and the figure details are set in a data file.

3.10.6 TEMPORAL SEQUENCING. The program delivers three single digit
numbers one after the other. The exposure time and the intervals are to be set.
After the presentation of the third number, another two numbers are presented in
sequence. These two numbers may have the same sequence as the first two
numbers and or numbers two and three. The subject is expected to detect if the
fourth and fifth number have the same sequence as that of the first and second or
second and third numbers. If a sequence is detected, the subject is expected to
respond using the keyboard. This is a test of attention and working memory in
which the subject must hold on two sequences and detect one of their presences in
a later task.

3.10.7 RESPONSE INHIBITION: This is a training program for initiating and
strengthening cognitive control on motor responses. The subject is trained in
acquiring control over response through inhibition of irrelevant responses and
delay of relevant responses. The program is adapted from the original 'Go-No Go'
design. The program trains the subject not to respond or inhibit responding against
a strong desire or impulse to respond. This program must be executed personally
by the subject without the aid of a therapist. Data presentation: A triangle or a square is used as the target stimuli. Either of them is presented randomly in the center of the computer monitor. The subject is trained to learn to respond or inhibit responding to the target stimuli. The total therapeutic procedure consists of four levels of training.

At level 1, a triangle or a square patch appears in the centre of the screen. The figure appears inside a dotted line box. The exposure time and pre-exposure delay are to be set in the beginning. Simultaneously a smaller triangle or square appears either in the left or the right bottom corner of the screen. The subject is expected to respond if both the figures are triangles or if both are squares. If both are triangles, he may press any key left to y, h and b, whereas if the two figures are squares any key right to y, h and b may be pressed. There are totally 40 presentations. This program trains the patient to respond to two triangle presentations with left hand finger and the two square presentations with the right hand finger.

At level 2, the bottom figure need not be the same as the central figure. The bottom figure appears after the central figure according to a preset delay. Response is made only if the central and bottom corner figures are identical. No response is to be made if a square and triangle or vice versa appears. The response is to be made by pressing the key on the side (corner) where the correct smaller figure appears.

Level 3 is similar to the second level except that the response is made by the finger of the opposite hand by pressing the opposite side key.

At level 4, after the display of the central figure, a similar figure appears in the bottom corner, after a certain preset delay (Inter Stimulus delay 1), another figure appears on the opposite corner. The second figure that appears in the opposite corner may be identical or different. The subject is instructed to respond only if the second bottom figure is also identical. The response is to be made on the side of the first bottom figure, using the corresponding finger. At this level the subject
must wait until the second small figure appears on the opposite side to detect if it is the same or different from the first small figure and respond accordingly.

The BFT program records all correct responses and the response time taken for entering making the response using the keyboard. The response data is entered against the date of training and a report can be generated which provides the response data of any two dates selected by the user. With the permission of the developer, the programme was loaded into the hospital system and was used for the study. Based on the pilot study, 7 tasks were chosen from the 10 available in the BFT. The number of sessions was fixed as 20. The tools for measurement (outcome variables) were finalized.

3.11 DESIGN: Intervention research has often been affected by study design. Case studies, small group studies, absence of a control group are some of the limitations mentioned in meta analysis. This study attempts to overcome some of these limitations by including a group of matched controls. The design of the study is experimental, with a group of children who undergo the enrichment programme and a matched group of children who do not undergo the programme.

3.12 TOPIC FINALIZATION: The final study was decided upon based on the results of the pilot study. Changes in the procedure, tools and the intervention programme were made on the basis of the feedback from the schools, parents, children and discussions with the Thesis Committee and Scientific Committee of the Amrita Deemed University.

3.13 COLLECTION OF DATA: The pilot study was carried out between April 2005 and May 2007. The initial 6 month period was spent in contacting schools, correspondence, and conducting sensitization programmes in the schools that consented to participating in the programme. The intervention package was then used. Initially the number of sessions decided upon was 30. Based on the children’s performance, parental feedback and the logistic difficulty (planning individual sessions for children in the hospital after school hours), this number was reduced to 20. The tasks and the measures of the dependant variable were then finalized. The final study was carried out between July 2008 and December 2009.
In order to meet **objective 1**, teachers of classes 3, 4, and 5 were asked to **identify** children who obtained marks between 40 and 60% in the major class assessments. A list of such children was obtained from each school. The parents of these children were contacted telephonically and the purpose of the study and other relevant details were disclosed to them. Children were included in the study, if their parents gave their verbal and subsequently, written informed consent. The parents who agreed to participate in the study were interviewed using the DCPL.

The cognitive profile of the children was obtained by using the MISIC (**objective 2**). In order to meet **objective 3** (social and behavioural profile of children), the ratings of teachers and parents regarding the selected children was obtained, using the SDQ- teacher and parent forms. The academic functioning of the child was noted by recording the marks obtained in the school tests (**objective 4**).

In order to meet **objective 5**, 20 children underwent the BFT programme for 20 sessions over a period of 3 months. The remaining 20 formed the matched control group. The entire group was re-assessed, on the MISIC, SDQ and marks.

In order to meet **objective 6**, a follow up assessment was done, after 3 months, using the marks alone.

The children in the control group underwent the pre and post assessments. Their marks during this period were recorded, before intervention, immediately after intervention and 3 months after intervention.

**3.14 ANALYSIS OF DATA:** The data were entered and analysed using the SPSS package, version 11.

**Percentage analysis** was done for the socio-demographic and clinical sections of the DCPL.

**Frequency distributions** were used for the scores obtained on the MISIC to obtain a neuropsychological profile of the children and of the marks obtained.

The homogeneity of the 2 groups was analysed using the **chi square test**.

The **t test and paired t test** using actual and relative percentage change scores were used to analyse the within and between group differences on the pre and post
measures. In variables where a between group homogeneity was not found, prior to intervention, the analysis of co-variance was also done. This helped to statistically adjust for the initial difference in the mean score and then calculate the variance.

The effect size (ES) was then calculated in order to assess the practical impact of the intervention. Both within group effect size and between group effects were calculated, using the following formula:

\[
\text{Within group ES} = \frac{\text{Mean score pre-treatment} - \text{Mean score post treatment}}{\text{Standard Deviation of the pre-treatment scores}}
\]

\[
\text{Between group ES} = \frac{\text{Mean score post treatment of E group} - \text{Mean score of C group}}{\text{Pooled pre-treatment standard deviation of both groups}}
\]

Pooled SD was calculated using Cohen’s formula (1977)

Case studies of 2 children who underwent the programme are included, in order to understand individual variations in response to intervention.

Thus, the final results contain both quantitative as well as qualitative analysis of the variables under study.

3.15 LIMITATIONS OF THE STUDY: This study was conducted in an urban area of the state, on a sample drawn from CBSE schools. It may not therefore be immediately generalisable to the larger universe of children in similar age groups/classes.

This is a study based on a small group of children who have not been previously diagnosed or referred for help. Being a hospital-based intervention study, on a heterogeneous, developing population, there are several factors that could affect the results. However, the use of a matched control group should help minimize the effect of several factors. In addition, there are few reported studies, especially from India using computer-based programmes on young children at risk. The results of this study could hence be of use in planning research on a larger scale in this group.
3.16 ETHICAL CONSIDERATIONS: The study was approved by the ethics committee of the Institution. Written consent was obtained from parents before children were included in the study. For children in the control group, suitable help was given after the study was complete.