CHAPTER V

METHODOLOGY
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The main purpose of this chapter is to provide details regarding objectives of the study, selection of the sample, tools used, procedure undertaken, and statistical techniques applied, which have been furnished below.

OBJECTIVES OF THE PRESENT RESEARCH

Apart from developing scales for assessing parents' (both mothers' and fathers') behaviour involvement, personal involvement, cognitive stimulation, and cognitive behaviour, the present investigation attempted to find the answer to the following research queries:

• How far do intelligence and parental (both maternal and paternal) involvement variables affect the academic achievement of children?

• How far do the motivational resources of control understanding, perceived competence, and self-regulation affect the academic achievement of children?

• What role does intelligence play in influencing the motivational resources of control understanding, perceived competence, and self-regulation?

• What role do the varied dimensions of parental (both maternal and paternal) involvement play in influencing children's motivational resources of control understanding, perceived competence, and self-regulation?

• Is the hypothesized model* applicable for upper elementary and secondary school children?

• Is the hypothesized model* applicable for girls and boys?

* Figure 1 (p. 133)
SAMPLE

Sample of the present study consisted of 947 school students (418 girls and 529 boys) selected from different co-educational schools of Panchkula and Mohali. Out of these, 496 were upper elementary school students (212 girls and 284 boys) studying in fifth and sixth classes (average age = eleven years, one month), and 451 were secondary school students (206 girls and 245 boys) studying in ninth and tenth classes (average age = fourteen years, seven months). Children coming from intact, two-parent families, and those residing with their parents were included in the sample. Moreover, the present investigation was restricted to those English medium schools where one tends to find children coming from middle to upper middle class families.

TOOLS USED

The following four tests measuring diverse aspects of parental involvement were developed by the investigator (for details, see chapter IV) for use in the present study:

1) Parental Involvement Scale (Behaviour) [PINS-B],
2) Parental Involvement Scale (Personal) [PINS-P],
3) Parental Involvement Scale (Cognitive Stimulation) [PINS-CS], and
4) Parental Involvement Scale (Cognitive Behaviour) [PINS-CB].

Apart from these scales, the following tools were also used:

1) Coloured Progressive Matrices (CPM; Raven, 1956),
2) Standard Progressive Matrices (SPM; Raven, 1958),
3) Multidimensional Measure of Children's Perceptions of Control (MMCPC; Connell, 1985),
4) Perceived Competence Scale for Children (PCS; Harter, 1982), and
5) Self-Regulation Questionnaire (SRQ; Ryan & Connell, 1989).
1) COLOURED PROGRESSIVE MATRICES (RAVEN, 1956)

This test is used to assess the capacity of the individual at the time of the test to develop a systematic pattern of reasoning. The test as a whole can be described as a scale "of observation and clear thinking".

The test comprises of three sets (A, Ab, and B) of twelve problems each, with thirty-six problems in total that the subject is required to solve. The problems are presented in an increasing order of difficulty so that the solutions to the initial problems are self-evident, while they become increasingly difficult to judge as the problems progress. Hence, the test has been named "Progressive Matrices". In each problem, six alternatives are presented to the test-taker out of which only one of them is the correct one. The subjects' task is to judge this correct alternative out of the multitude of alternatives presented. The way in which the problem figures and alternatives are presented ensures that the successful completion of the test would denote true intellectual capacity of the individual. This test is culture-free, and its validity and reliability are very well-established. It was used to assess the intelligence level of elementary school children.

2) STANDARD PROGRESSIVE MATRICES (RAVEN, 1958)

This test was used to assess the intelligence level of secondary school children. It consists of five sets (A, B, C, D, and E) of twelve problems each, thus comprising of a total of sixty problems. In each set, the first problem is as nearly as possible self-evident. The problems which follow become more and more difficult to solve. Each problem consists of a series of geometrical designs that are logically related to each other. Out of these series of designs, one geometrical portion is missing. Six to eight alternatives are provided to the subject out of which only one alternative is the correct one. Five sets provide five
opportunities for the subject to grasp the logical method of solving these problems, and thereby, his/her intellectual ability is assessed. Each subject is given the same set of problems in the same order and is asked to work at his/her own speed. The test can be administered as an individual or a group test, and it can also be self-administered. An individual's total score on all the sixty problems is indicative of his/her mental ability. This test too, is culture-free, and its validity and reliability are very well-established.

3) MULTIDIMENSIONAL MEASURE OF CHILDREN'S PERCEPTIONS OF CONTROL (MMCPC; CONNELL, 1985)

This questionnaire measures children's perceptions of the sources of control over their successes and failures in three domains (viz., cognitive, social, and physical) and generally. Three sources are included, viz., internal, powerful others, and unknown sources. Items are worded as statements about the control of a success or failure to which children indicate their agreement or disagreement on a four-point scale.

In the present study, the main interest was in whether or not children report understanding the sources of control (rather than what source they believe controls significant outcomes). Thus, the focus was on the "unknown" subscale in the cognitive domain (Appendix E). For consistency with other measures, an individual's score for unknown control was reversed and referred to as his/her scores on control understanding. For each statement, scores ranged from one to four, with a score of one indicating low control understanding and a score of four showing high control understanding.

The alpha coefficient of reliability for the subscale under consideration has been reported by its author (1985) to be .68 (for a sample of 355 pupils in third through sixth grades) and .67 (averaged for...
two junior high school samples; N=275, N=405). The author has used information on additional self-report variables related to motivation and self-concept for purposes of validation of the current measure. Moreover, teachers' assessments of children's competence in different domains, and both standardized achievement and intelligence scores have also been obtained by the author, which further establish the validity of the entire scale, and in particular, of the subscale which was used in the present investigation.

Since the scale has not been much used on Indian samples, the present investigator made an attempt to assess its reliability. Alpha reliability of the "unknown" subscale of this test in the cognitive domain was found to be .86 for a group of 150 upper elementary school children (studying in fifth and sixth classes), while it was .82 for a group of 102 secondary school children (studying in ninth and tenth classes).

4) THE PERCEIVED COMPETENCE SCALE FOR CHILDREN (HARTER, 1982)

This self-report scale assesses perceived competence in three domains (viz., cognitive, social, and physical), and a general self-worth subscale is also included which is independent of any particular skill domain. There are seven items in each subscale, resulting in a 28-item scale. All items are rated on a four-point scale, with a score of one indicating low perceived competence and a score of four reflecting high perceived competence. In the present investigation, the main interest was in the cognitive subscale (Appendix F). Therefore, the scores of each subject were summed up for all the items of this subscale in order to obtain a summary score for perceived competence in the cognitive domain.

Subscale reliability has been assessed by Harter (1982) by employing coefficient alpha. For a sample of 341 students in third
through sixth grades, these values are .76, .78, .83, and .73 for the cognitive, social, physical, and general subscales respectively. Across all samples considered by the author (including students in third through ninth grades drawn from primarily middle and upper middle class populations), reliabilities range from .75 to .83, .75 to .84, .77 to .86, and .73 to .82 for the four subscales respectively. The test-retest reliabilities of these subscales have been reported by its author to be .78, .80, .87, and .70 (for a sample of 208 pupils retested after 3 months) and .78, .75, .80, and .69 (for a sample of 810 pupils retested after nine months) for the four subscales respectively.

The convergent validity of this scale has also been established by its author. Across samples, Harter found that the correlation between pupil ratings and teacher ratings is in the .40's. Harter also found that the factor pattern of this scale is very stable across grades 3-6, and also for grades 7-9.

The present investigator made an attempt to evaluate the reliability of the "cognitive" subscale of the test which was proposed to be used in the present study. Moreover, since only the item abbreviations of the test items were readily available, the present investigator elaborated these items, which were scrutinized by other eminent psychologists (including the supervisor). Then, the alpha reliability of this subscale was examined, which was found to be .68 and .69 for upper elementary (N=184) and secondary (N=108) school children respectively.

5) SELF-REGULATION QUESTIONNAIRE (SRQ; RYAN & CONNELL, 1989)

This scale (Appendix G) assesses children's styles of regulating their academic behaviour. Each item represents a reason as to why the student performs activities such as doing homework and classwork,
followed by a four-point scale on which the child indicates how true that reason is for his/her behaviour. Four subscales varying from less to more autonomous self-regulation are included: (i) external (activities engaged in to avoid external consequences or to obey rules), (ii) introjected (behaviour oriented to obtaining adult approval or to avoid guilt or anxiety), (iii) identified (to achieve a self-valued goal), and (iv) intrinsic (for the inherent enjoyment of the activity). The means for each of the four self-regulatory styles are computed. Then, a weighted score is calculated by combining the scores on the four self-regulatory styles. The formula for weighting that is used is to multiply the "external" score by -2, the "introjected" score by -1, the "identified" score by 1, and the "intrinsic" score by 2. These weighted scores are then added to compute an index of self-determination in learning that has been referred to as the "Relative Autonomy Index" (RAI; Grolnick & Ryan, 1987a, 1989).

Ryan & Connell (1989) report that the internal consistency (alpha) estimates for each reason category range from .62 to .82, indicating moderate to high levels of internal consistency within all the three samples: the urban sample (children from fourth through sixth grades), the suburban sample (children from third through sixth grades), and the rural sample (children from third through sixth grades).

For purposes of validation of this scale, the authors report significant correlations of the subscales of this questionnaire with Harter's (1981b) and deCharms' (1976) measures. Correlations with perceived internal control subscale of Connell's (1985) measure reveals that perceived internal control is most strongly related with the two middle, internalized subscales of introjection and identification in both urban and suburban samples, with less strong relations between control beliefs and either, intrinsic or external categories. The authors also report
that child endorsement of internalized reasons for achievement-related behaviors is associated with being rated as more motivated by adults, and external reasons for action as being uncorrelated or negatively related to it.

Like other tests measuring different motivational resources, the reliability of this questionnaire too, was examined by the present investigator due to dearth of Indian studies utilizing the same. The alpha reliabilities of the four subscales, viz., external, introjected, identified, and intrinsic were found to be .72, .72, .76, and .80 respectively for upper elementary school children (N=150) studying in fifth and sixth classes, while these were .73, .79, .74, and .68 respectively for secondary school children (N=110) studying in ninth and tenth classes.

PROCEDURE

The aim of the present investigation was to study academic achievement in relation to intelligence, parental involvement, and children's motivational resources, viz., control understanding, perceived competence, and self-regulation at upper elementary and secondary school levels. For this purpose, 947 students from different schools of Panchkula and Mohali were included in the sample. After establishing proper rapport with the subjects, scales measuring the above-mentioned variables were administered in small groups and in at least three sittings. Instructions for each test were given at the top of each questionnaire. The subjects were told that the information revealed by them would be kept confidential. Academic achievement of each child was noted from the school records. For this purpose, the total marks obtained by each child in the last two consecutive examinations were considered, and their average was taken as an index of scholastic accomplishment.
SCORING

The scoring for different tests was done as per the details given in their respective manuals/articles. The scores of each subject on intelligence, control understanding, perceived competence, self-regulation, and academic achievement as well as on mothers' and fathers' behaviour involvement, personal involvement, cognitive stimulation, and cognitive behaviour were obtained.

STATISTICAL TECHNIQUES USED

Each proposed linkage in the hypothesized mediational model (presented in figure I, p. 133) represents a hypothesis. In order to examine the causal model, the statistical techniques used were correlational analysis and path analysis (Judd & Kenny, 1981).

The term "path analysis" was introduced by the biologist Sewall Wright (1934, 1960) to refer to a form of causal analysis that is quite similar to the simultaneous-equation approaches of the econometricians. It is not a method for discovering causes, but a method applied to a causal model formulated by the researcher on the basis of knowledge, theory and research. In the words of Wright:

"... the method of path coefficients is not intended to accomplish the impossible task of deducing causal relations from the values of the correlation coefficients. It is intended to combine the quantitative information given by the correlations with such qualitative information as may be at hand on causal relations to give a quantitative interpretation" (Wright, 1934, p. 193).
"In cases in which the causal relations are uncertain, the method can be used to find the logical consequences of any particular hypothesis in regard to them" (Wright, 1921, p. 557).

As has been pointed out by Covington & Omelich (1979, pp. 1488-1489), "Path analysis allows for all determining factors as specified by a causal model to be incorporated into an overall predictive analysis, thereby permitting an estimation of the relative contribution (both direct and indirect) of each determinant to variations in the dependent variable(s).... For a proper interpretation of the analysis to follow, it is important to bear in mind that path analysis is not a procedure for demonstrating causality. Rather it is a method for tracing out the implications of a set of causal assumptions that the theoretician is willing to impose on a system of relationships".

Path analysis was performed in the present investigation in order to explain the workability of the hypothesized model (presented in figure I, p. 133) and not to confirm or disconfirm it. Paths in a recursive model were specified, which means that the arrows between the variables point in one direction only. In other words, a set of variables in recursive models are ordered in such a way that the direction of causality can plausibly be unidirectional. That is, if one variable might be a cause of another variable, it can't be affected by the latter, even indirectly through other variables. For instance, in the present investigation, intelligence was presumed to be prior to motivational resources, and was assumed not to be affected by the latter, even indirectly through other variables following it in the path.

Arrows in such models indicate "a weak causal ordering" and not direct causal relationships. In other words, it is assumed that if a causal
relationship does exist amongst the variables, the cause is in the direction of the arrow rather than the reverse. The variables included in such path models and their presumed direction of causality is based on time precedence, theoretical orientation, previous research and logic.

In causal analysis, distinction is drawn between exogenous and endogenous variables. According to Kerlinger & Pedhazur (1973, p. 308), "...an exogenous variable is a variable whose variability is assumed to be determined by causes outside the causal model. Consequently, the determination of an exogenous variable is not under consideration in the model. Stated differently, no attempt is made to explain the variability of an exogenous variable or its relations with other exogenous variables." If there are two or more exogenous variables in the system, they may correlate with each other, although no causal direction may be specified. In the present investigation, intelligence and the four parental (both maternal and paternal) involvement dimensions, viz., behaviour involvement, personal involvement, cognitive stimulation, and cognitive behaviour were the exogenous variables. Since which variable precedes the other is a controversial issue as far as intelligence and parental involvement variables were concerned, no arrows were specified showing causal links for those variables, and relations between the exogenous variables in the system remained unanalyzed (Kerlinger & Pedhazur, 1973, p. 308).

Endogenous variables are those whose causes lie within the system. It is one "...whose variation is explained by exogenous or endogenous variables in the system" (Kerlinger & Pedhazur, 1973, p. 308). In the present context, the endogenous variables considered were control understanding, perceived competence, self-regulation, and academic achievement.
Path coefficients were estimated by beta weights (B) from standard multiple regression analysis (Kenny, 1979, chapter 4). The variables were arranged in an order of temporal precedence based on previous research and theory. Hypothesized relationships between the independent, mediator, and dependent variables have been given in table 10 by means of structural equations. Every path diagram can be converted into a system of equations that reflect the linkages drawn in the diagram. One structural equation can be written for each variable. Some investigators write equations for the exogenous variables (such as \( z_1 = e_1 \)), which indicates that \( z_1 \) is influenced by unmeasured residual variables. But for most of the present purposes, such equations for exogenous variables are not necessary since the investigator is not concerned with the causes of such variables, and so, they are not stated in the present context.

Expressing all variables in standard score form (z score), the equations for all the endogenous variables are given in table 10, where the \( e \)'s stand for the variables not included in the model. For instance, the equation

\[
z_6 = p_{61}z_1 + p_{62}z_2 + p_{63}z_3 + p_{64}z_4 + p_{65}z_5 + e_6
\]

indicates that variable 6 is dependent on variables 1,2,3,4,5, and on "\( e_6 \)" which stands for variables outside the system affecting variable 6. Similar interpretations apply to other equations. Judd & Kenny (1981) have suggested a three-step procedure for examining mediational models, which was followed for the present investigation.

**STEP 1:**

According to these authors, in order to establish mediation, the independent variable(s) must be shown to affect the dependent variable. Therefore, the dependent variable, viz., academic achievement
<table>
<thead>
<tr>
<th>Variables</th>
<th>Structural Equations</th>
</tr>
</thead>
<tbody>
<tr>
<td>$z_1$ : Intelligence</td>
<td>$z_6 = p_{61} z_1 + p_{62} z_2 + p_{63} z_3$</td>
</tr>
<tr>
<td>$z_2^*$ : Parental behaviour involvement</td>
<td>$z_6 = p_{64} z_4 + p_{65} z_5 + e_1$</td>
</tr>
<tr>
<td>$z_3^*$ : Parental personal involvement</td>
<td>$z_7 = p_{71} z_1 + p_{72} z_2 + p_{73} z_3$</td>
</tr>
<tr>
<td>$z_4^*$ : Parental cognitive stimulation</td>
<td>$z_7 = p_{74} z_4 + p_{75} z_5 + e_2$</td>
</tr>
<tr>
<td>$z_5^*$ : Parental cognitive behaviour</td>
<td>$z_8 = p_{81} z_1 + p_{82} z_2 + p_{83} z_3$</td>
</tr>
<tr>
<td></td>
<td>$z_8 = p_{84} z_4 + p_{85} z_5 + e_3$</td>
</tr>
<tr>
<td>$z_6$ : Control understanding</td>
<td>$z_9 = p_{91} z_1 + p_{92} z_2 + p_{93} z_3 + p_{94} z_4$</td>
</tr>
<tr>
<td></td>
<td>$z_9 = p_{95} z_5 + p_{96} z_6 + p_{97} z_7 + p_{98} z_8 + e_4$</td>
</tr>
</tbody>
</table>

* For the variables $z_2^*, z_3^*, z_4^*, z_5^*$, the term “parental” will refer to “maternal” for mothers’ model and “paternal” for fathers’ model.

All variables are given in standard score ($z$) form.
(variable 9) was regressed upon all the independent variables, viz., intelligence (variable 1), parental behaviour involvement (variable 2), personal involvement (variable 3), cognitive stimulation (variable 4), and cognitive behaviour (variable 5).

**STEP II:**

Next, the independent variables must be shown to affect the mediator variables. Thus, the motivational resources, viz., control understanding (variable 6), perceived competence (variable 7), and self-regulation (variable 8) were each regressed on intelligence and the four dimensions of parental involvement as depicted in figures II, III, and IV.

**STEP III:**

In the final step, the dependent variable is regressed upon all exogenous and mediator variables. So, academic achievement was regressed on intelligence, parental involvement, and children's motivational variables as depicted in figure V.

Mediation is established if the links of the independent variables with the dependent variable are absent or substantially reduced, controlling for the mediator variables. In other words, if the strengths of the paths between the independent and dependent variables are absent or reduced in the last step (step III) as compared to those obtained in step I, mediation is said to be established.

All regression analyses outlined above were conducted separately for mothers' and fathers' involvement variables (for reasons explained in chapter I). To avoid confusion, these have been referred to as the mothers' or the fathers' models, denoting whether maternal or paternal involvement factors were considered while performing regressions.
FIGURE II: CONTROL UNDERSTANDING REGRESSED ON ALL EXOGENOUS VARIABLES

FIGURE III: PERCEIVED COMPETENCE REGRESSED ON ALL EXOGENOUS VARIABLES

FIGURE IV: SELF-REGULATION REGRESSED ON ALL EXOGENOUS VARIABLES
Direct, Indirect, And Total Effects

Path analysis allows one to estimate direct, indirect, and total effects of variables in a system. One variable may affect another directly (direct effect) or indirectly through other variables (indirect effect). The total effect is the sum total of both the direct and the indirect effects. For instance, in the present context, intelligence may affect academic achievement directly (i.e., \( p_{91} \)) or by means of influencing the three motivational variables, which in turn affect achievement (indirect effects). Several researchers such as Kerlinger & Pedhazur (1973) provide detailed accounts of these effects and how to obtain the same.

Direct effect of one variable on the other is indicated by the direct path from the former to the latter, and is indicated by the corresponding path coefficient (or beta coefficient). In the present context, the path coefficients obtained in step II give the direct effects of each of the independent variables \( (1,2,3,4,5) \) on the mediator variables \( (6,7,8) \), and these are indicated by \( p_{61}, p_{62}, ..., p_{65}; p_{71}, ..., p_{75}; p_{81}, ..., p_{85} \). The path
coefficients obtained in step III explained above (i.e., \( p_{1}, p_{2}, p_{3}, \ldots, p_{9} \)) denote the direct links from the independent and mediator variables to the dependent variable (viz., academic achievement).

Indirect effects are the cross-products of the constituent direct effects. For example, the indirect effect of intelligence (variable 1) on academic achievement (variable 9) via control understanding (variable 6) has been (depicted pictorially and) explained below:

\[
\begin{array}{c}
1 \quad p_{61} \quad 6 \quad p_{96} \quad 9
\end{array}
\]

Indirect effect of intelligence on academic achievement through control understanding

\[= \text{(Direct effect of 1 on 6)} \times \text{(Direct effect of 6 on 9)}\]
\[= p_{61}p_{96}\]

Similarly, the indirect effect of intelligence on academic achievement through perceived competence (variable 7), as denoted by the causal chain

\[
\begin{array}{c}
1 \quad p_{71} \quad 7 \quad p_{97} \quad 9
\end{array}
\]

is \( p_{71}p_{97} \), and that of intelligence on academic achievement through self-regulation (variable 8) is \( p_{81}p_{98} \).

Causal analysis allows us to calculate the total indirect effect of a variable. For example,

Total Indirect effect of intelligence on achievement =

Indirect effect of intelligence on achievement through control understanding 

+ 

Indirect effect of intelligence on achievement through perceived competence 

+ 

Indirect effect of intelligence on achievement through self-regulation

\[= p_{61}p_{96} + p_{71}p_{97} + p_{81}p_{98}\]
On the same lines, the indirect effects of parental involvement variables on academic achievement were calculated in the present investigation.

A variable's total effect is the sum total of its direct and indirect effects, i.e.,

\[ \text{Total effect} = \text{Direct effect} + \text{Indirect effects} = \text{Direct effect} + \text{Total indirect effect} \]

The simplest way to measure the total effect of a variable is to leave the mediating variables out of regression (Darlington, 1990, p. 174). In the present context, the total effects of the independent variables on academic achievement were obtained by regressing the latter on the former, without taking the mediator variables of motivation into consideration (and was the same as step I explained above). The beta coefficients so obtained denote the total effects of the exogenous variables on achievement. Since no variable was assumed to mediate between the motivational variables and academic achievement, no indirect effects were involved in their case. Therefore, the direct effects of motivational variables on achievement were the same as their total effects.

The significance level of the direct and total effects are directly obtained, since they are the significance levels associated with the corresponding beta weights. However, one way to check the significance of indirect effects is by assessing the overall goodness-of-fit of the model (Covington & Omelich, 1979), which shall be dealt with (after examining the appropriateness of the mediational model) in chapter VI.