CHAPTER SIX

CONCLUSIONS, GENERALIZATIONS AND FURTHER POSSIBILITIES
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The present study has attempted
to investigate the relationship between step-size and the
three levels of Bloom's taxonomic categories in the
cognitive domain. A third variable, sex, was also introduced
in order to study its effect singly as also in relationship
with other two variables.

The objectives of the study
also included the development of a programme in elementary
algebraic concepts and operations in two versions, namely,
in small step-size and large step-size. Further, each
version of the programme was developed at three levels of
the taxonomic categories and the objectives of the
programme included the preparation of an achievement test
in elementary algebraic concepts and operations.

The study covered the target
population of grade VI students of secondary schools in
Siala. The sample was randomly selected from six of the
ten secondary schools in Siala. The size of the sample
was 300 with boys and girls equal in number. The subjects
were divided into four experimental groups of 75 each
through the process of randomization. The four experimental groups were: (i) Small Step (boys); (ii) Small step (girls), (iii) Large step (boys), and (iv) Large step (girls).

The experiment was conducted within the framework of a 2x2x5 mixed factorial design. It involved two step-sizes, two levels of sex, and three levels of taxonomic categories. Step-size, sex and taxonomic category constituted independent variables while the amount of attainment recorded by the subjects as dependent variable. Each experimental group was observed under all levels of factor C but each experimental group was assigned only one combination of factor A x B.

The main and the interaction effects of step-size (A), Sex (B), and taxonomic category (C) were analysed by the analysis of variance.

It may be mentioned that the findings and conclusions have to be considered strictly in relation with the objectives of the study and the delimitations as outlined in the introductory chapter of the report.

It may also be stressed that the generalizations arrived at should be considered relevant and tenable only in relation to the population
similar to the one defined for the present study.
Before describing the principal findings of the present experiment, it may be worthwhile to take notice of the following important features of the programme for a meaningful evaluation of the findings.

The co-efficient of reliability of the achievement test was computed by the application of KR-21 formula. It was found to be .94.

The content validity of the achievement test was established by ascertaining the correspondence between the test and the representativeness of the content structure in relation to the behavioural objectives. While the achievement test was developed for the purpose of the experiment on a normal population, criterion test was also constructed to measure the terminal behaviour developed through the programme in algebraic concepts for a population of students of average ability only. The reliability coefficient of the criterion test was found to be .95 by employing the formula KR-21. The validity of the criterion test was established by agreement between the test and the representativeness of the content structure in relation to the behavioural objectives.
Both the formats of the programme were validated against the internal criteria of error rate, programme density, and the external criterion of 90/90. The programme formats were found valid in terms of these criteria.

The error rate of the small-step version of the programme as a whole was found to be 2.1 and for its knowledge, comprehension and application categories formats, the value was calculated to be 1.5, 1.9 and 4.3 respectively. Likewise, the error rate for the large step version of the programme as a whole was found to be 2.3 and the corresponding values for knowledge, comprehension and application category formats were 2.4, 2.6 and 4.2 respectively. Thus the error rates of both the versions of the programme were well within 5 percent error criteria. It may be stated, however, that the small step programme had slightly lower error rate than the large step programme. This finding is confirmed by a parallel study conducted by V.A. Morris, et al., (1970).

The programme density as obtainable through type token ratio (TTT), was found to be .60 for the small step format and .64 for the large step format. This indicates a higher rate of presentation of material in the case of large step version of the
programmes as compared to the small step version.

The sequence progression of
the programme format studied with the help of scalograms
revealed that there was definite indication of errors
from high achievers to low achievers showing thereby an
appropriate logical connection in terms of performance
of the high and low achievers on the criterion test.
This also leads us to conclude that there is a logical
sequence among all the programme units for each format
as prepared.

Both the small step and the
large step versions of the programme were also evaluated
in terms of 90/90 standard. A standard of 83.1/90
was obtained for the small step format of the programme
and 89.2/90 for the large step version of the programme.

The significance of the
difference in initial learning
and post learning among the
experimental groups, taken separately, was analysed by
analysis of variance. The F-ratio for pre-test was
obtained to be less than 1. For df 3 and 296, it was not
found significant even at .01 level of confidence. It
may, therefore, be safely inferred that the four
experimental groups did not differ significantly in
initial learning.
The F-ratio for the post-test was found to be 14.79. It was significant at both the levels of confidence. It might be inferred that the experimental groups differed significantly in post-earning. Speaking differently, the differences among the means for post-test scores were attributable to the treatment effects.

The F-ratio for the main effect of step-size was obtained to be 40.52 for df 1 and 236. It was found highly significant at both the levels of confidence. It may, thus, be inferred that difference between the treatment effects of two step-sizes was highly significant implying rejection of the null hypothesis in this case. Again the fact that this factor has significant mean square may form the basis for the observation that the small step-size seems to be superior to the large step-size programmed presentation in algebraic concepts to class VI students.

The superiority of the small-step in the programmed material, as found in this study, is, in agreement with the results of the studies conducted by Evans, Glaser and House (1959); Coulson and Silberman (1960); and Blank, Douglas Mackie and Fred,
G Emskine (1970). In all these studies it has been found that the small step programs produced significantly better performance than the large step one. However, there was some difference of time since the small steps took slightly longer time than the large steps.

The main effect of the factor relating to B (Sex) was calculated to be 3.57 for df 1/296. It was not found significant even at .05 level of confidence. The null hypothesis in this case is accepted. It may, thus, be stated that sex as a factor does not influence the performance in any of the programmed presentations.

The result that there is no significant difference in the attainment of boys and girls of standard VI in learning of algebraic concepts, through a programmed text, has special importance in view of a number of studies quoted by Carmichael (Manual of Child Psychology, 1966) indicating superiority of boys in mathematical reasoning as compared to girls. This seems to warrant the conclusion that if girls are taught algebraic concepts through a programmed text, they can do as well as boys.

The F-ratio for the main effect relating to taxonomic category was found to be 99.59 for df, 2/592. It was, thus, found highly significant at both
the levels of confidence. Further, the significant mean square proved that the means of knowledge, comprehension and application categories differed significantly in affecting learning. Examination of these three means as also of the t-ratios for various differences among these means shows that performance of the students was highest for the knowledge category and least for the application category.

**INTERACTION EFFECTS**

The interaction effects of $A \times B$ (Step-size and Sex), $A \times C$ (Step-size and taxonomic category), $B \times C$ (sex and taxonomic category), and $A_B \times C$ (Step-size, Sex, and taxonomic category) were also analysed by F test. The significance of interaction effects was further examined by applying 't' test in order to locate significant treatment combinations.

The $A \times B$ interaction was not found significant even at .05 level of confidence. It means that the A effect, that is the difference between $A_1$ and $A_2$ - small step-size and large step-size - is independent of the sex of the subject. The $A_B \times B$ interaction is identical with the $B \times A$ interaction and the statement about the difference between $A_1$ and $A_2$ being independent of $B$ is also equivalent to stating that the difference between $B_1$ and $B_2$ is independent of $A$. The inference warrantable from this is
that the treatment effects of both the small step-size and the large step-size are equally effective for both boys and girls. Thus, the null hypothesis in regard to A x B interaction is retained and the research hypothesis that for programmed presentation in elementary algebraic concepts, boys would exhibit significant performance as compared to girls is, therefore, rejected.

The A x C interaction with an F-ratio of 27.34 was found significant at both the levels of confidence. This indicates that at least some of the differences among \( C_1 \), \( C_2 \) and \( C_3 \) are not independent of the levels of A (step-size). In other words, a statement about the step-size effect must be qualified by the particular level of the taxonomic category involved, or a statement about the taxonomic category effect, must be qualified by the particular level of step-size involved. This leads to the rejection of the null hypothesis and confirmation of the hypothesis that the interaction of step-size and taxonomic category is significant.

In order to locate the exact nature of the AxC interaction, t-ratios were also calculated. The t-ratio for the interaction of small step program with knowledge category and that of small step program with comprehension category were found to be significant. It may, therefore, be asserted that the small step program
interacts significantly both with knowledge and comprehension categories. This partially confirms the hypothesis of the study that small step-size programmes in Algebra developed at the knowledge level of the taxonomic category yields significant performance on the criterion test.

The BxC interaction was also found to be significant at both levels of confidence. This also indicated that the difference between various levels of taxonomic category are not independent of sex. The null hypothesis may, thus, be rejected. It may, therefore, be stated that there is significant interaction in performance in the three categories of taxonomies and the sex.

From a scrutiny of t-ratios of the BxC interaction, the t-ratios for the interaction of girl’s group with knowledge category and that of boy’s group with comprehension category were found to be significant. This provides us a basis to conclude that girls’ performance seems to be significant in knowledge taxonomic category while that of boys’ performance is significant in the comprehension category.

The AxBxC interaction was also found significant indicating thereby that step-size, sex and taxonomic category interact with each other significantly. The null hypothesis in this case may, therefore, be rejected and the hypothesis of the present study confirmed that there
is significant interaction among step-size, sex and taxonomic category.

The significant $A_xB_xC$ interaction implies that the value of step-size x the taxonomic category interaction is not independent of the two levels of sex.

From a close observation of t-ratios for $A_xC$ interaction at $B_2$ level, it was found that for boys, the small step programme interacted significantly with knowledge and comprehension categories. Again, from a scrutiny of t-ratios for $A_xC$ interaction at $B_2$ level, it was found that for girls also, the small step programme interacted significantly with knowledge and comprehension categories.

From this it could be inferred that both in the case of boys and girls, for knowledge and comprehension categories of behaviours, the small step programme is prone to evidence better performance.

In view of the foregoing discussion, the following conclusions appear tenable:

- The small step programme is probably more effective in regard to attainment on programmed materials than large step programmes.
- There seems to be no significant differences between the attainments of boys and girls on programmed materials.
- Both small step and large step programmes seem to have no significant effect on sex.
- The small step programme seems to be more effective for knowledge and comprehension categories than large step programmes.
- The small step programme or the large step programme appears to be equally effective for the application category.
- Taxonomic category seems to have significant effect on the performance of boys and girls.
- Girls' performance seems to be significantly superior in the knowledge category.
- Boys' seen to perform significantly better in the comprehension category.
- The small step programme for knowledge and comprehension categories of behaviour, both for boys and girls, appears to be significantly more effective than the large step programme.

FURTHER POSSIBILITIES

Some suggestions, with regard to further possibilities in the field may be given as follows:

- A study may be designed for investigating the effect of step-size in relation to response mode and levels of intelligence.
- An experimental study may be undertaken for examining the effect of step-size in relation to prompts and levels of intelligence.

- An experimental study may be conducted for evaluating the interaction effects of achievement motivation, step-size and three levels of taxonomic categories.

- The present study may be replicated with programmed material on some topic other than Algebra.