

IMPACT OF INSTRUCTIONAL MATERIAL ON THE CONCEPTUAL UNDERSTANDING IN MATHEMATICS AT SECONDARY SCHOOL LEVEL

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ABSTRACT

The conceptual understanding is the foundation of any kinds of subject centered learning for the students. Due to the conceptual understanding only, a student can develop correlation among various subject-branches and other subjects which remain with them. There are several surveys and research programmes which indicate that the students are very weak in their knowledge of Mathematics subject and have negative attitude towards it. In order to achieve in-depth knowledge in any subject, one has to have a conceptual clarity of it. For that researcher prepared 13 hours Programme based on instructional material to develop a conceptual understanding in the subject of Mathematics. The programme was based on 20 concepts. The pre-test(post-test) was developed by the researcher for the study to impact the programme on conceptual understanding in Mathematics at secondary school level. This is an experimental study. There were pre-test, treatment and post-test for the target group. For logical analysis and interpretation of data, t-test was used. Findings of the study suggested that the present instructional material in the subject of Mathematics was significantly effective for developing conceptual understanding in the students of class-9 at secondary school level. The results also suggest that the impact of the study material was same on boys and girls.

Key-words: *Conceptual understanding, Instructional material*

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INTRODUCTION

There are two main perspectives for learning Mathematics. One has its relation with the physical world while the other has its relation with the various branches of Mathematics.

In today's circumstances, Mathematics is considered as a difficult subject. In today's world 'Mathematics' is required at each and every step of life but such essential requirement for life does not get its due importance in our

education. Today teaching of Mathematics has become limited to textbooks only. Although the teaching methods and techniques like lecture method, team teaching technique, inductive - deductive method, use of audio visual aids etc. is amply used in Mathematics subject. But still the students could not understand the common meaning of the various concepts of Mathematics. They could not identify the essential and main characteristics of

mathematical concepts. They could not give practical examples based on the concepts of Mathematics. They could not differentiate between the two concepts. The subject is framed on the basis of the Concepts. The Mathematics subject came into existence when too many concepts of Mathematics got together. If the concepts of Mathematics can be developed among the students, the mathematics subject can become natural among the students and they can become positive towards Mathematics subject. In this way, conceptual understanding is very important in Mathematics subject.

The researcher had Mathematics as main subject at the Post Graduate Level. Besides when the researcher was a teacher trainee in B.Ed. course, he realized that the most of students did not have proper understanding for various concepts of Mathematics Subject. Thus, the dissatisfaction regarding the teaching - learning of Mathematics subject was main basis of the present study. As a result the researcher decided to construct and study the impact of instructional material for the conceptual understanding of class-9 students in Mathematics subject.

Theoretical background

A concept is both a mental construct of the individual and the societally accepted meaning of one or more words that express the particular meaning. Concept is related to one's changing and developing mental structure. Students learn different concepts through various subjects in schools and colleges. On the basis of specific characteristics, concepts are concluded. Klusmeire¹ (1980) given main eight attributes of concept. They are 1. Learnability, 2. Usability, 3. Validity, 4. Generality, 5. Power,

6. Structure, 7. Instance abstractness, 8. Instance numerousness. It is essential to know that how mental process occurs when one's learn concept. Learning activities, controlled experiments, evaluation etc. should be conducted during the learning of concepts in classroom. Gilford described mainly five steps for conceptual understanding. These are 1. Cognition, 2. Memory, 3. Productive thinking convergent, 4. Productive thinking divergent, 5. Evaluation. According to Klusmeire² (1980), there are total four steps for mental development of concepts. These are 1. Concrete level, 2. Identity level, 3. Classificatory level, 4. Formal level.

Explanation of Important Terms

The following terms are used in the present study.

Impact

Impact is the sum total of measured and reported effect. In this research, impact would mean the difference of scores on the pre-test and post-test on experimental group on conceptual understanding.

Conceptual Understanding

Concepts are play pioneer role in meaningful learning. For interpretation of information, concepts are provided crucial knowledge structure. Sensory experiences, perception, discrimination and conception are essential matters for conceptual understanding. Here in this research, conceptual understanding would mean the enrich understanding and clarification of concepts in the subject of Mathematics through instructional material.

Instructional Material

Instructional material are the base around which learning activities generally built.

Textbooks are limited source for learning concepts. So instructional material enrich or supplement to the content of textbooks. Instructional material included both content and techniques of teaching-learning.

Instructional material, in this research, included teaching-learning activities done through pair work, group work, learning questions and other strategies applied for conceptual understanding of selected concepts. The duration of programme through this instructional material were 13 hours.

Significance of the Study

The content of Mathematics is the indispensable part of mathematical teaching. The conceptual development is the most essential thing in Mathematics subject content. There are many researches conducted on Mathematics subject content but there are very few researches conducted in the area of conceptual development in Mathematics subject. The significance of the present study can be clarified by discussing its utility and possible implications on various fields.

- The instructional material for conceptual development can be useful to the students of Std. 5 to 9.
- Positive Attitude can be developed among the students with the help of this programme and Mathematics subject can become even more comprehensive.
- Supplementary material can be made available to the teacher trainees of B.Ed. for various units and sub units of Mathematics.
- The investigators at M.Ed. / M.Phil. Level can conduct their researches for conceptual development in Mathematics and other subjects also.

- The Programme for Conceptual Understanding can also be very useful to the in-service teachers for their classroom teaching.

Objective of the Study

- To prepare instructional material for the conceptual understanding in Mathematics for secondary school students.
- To study the impact of instructional material on the conceptual understanding in Mathematics at secondary school level in relation to gender.

Variables

Independent Variable

1. Instructional Material on conceptual understanding
2. Gender: Male and Female

Dependent variable

1. Conceptual understanding in Mathematics subject

Hypothesis

1. There will be no significant difference between the mean scores on the pre- test and post- test of students in the experimental group.
2. There will be no significant difference between the mean scores on the pre- test and post- test of male students in the experimental group.
3. There will be no significant difference between the mean scores on the pre- test and post- test of female students in the experimental group.
4. There will be no significant difference between the mean scores on the pre-test and post- test of male and female students in the experimental group.

Research Method

This is an experimental study with quantitative method of interpretation. The one group pre test – post test design was accepted for this study. There were pre test, treatment and post test.

Population

All the students studying in Gujarati medium secondary school of Vallabh Vidyanagar city was the population for this study.

Sample

A group of 50 students studying in Bavisgam Vidyalaya of Vallabh Vidyanagar was selected by 'random sampling'.

Tools for the Study

Tools for quantitative data

1. Pre-Test (Post-Test) was developed by the researcher. In this research Pre-test and Post-test were same.

Construction of Pre-Test(Post-Test)

In present study Pre-Test and Post-Test were same. Pre-Test(Post-Test) was constructed by researcher. Following points were kept in mind for construction of Test.

1. Question types based on objectives of Bloom Taxonomy.
2. Question types based on difficulty level.
3. Weightage of marks for selected concepts.
4. Number of questions of selected concepts.

In primary stage, researcher had constructed test contained 65 multiple choice questions on selected concepts. Then this test was given to three secondary school teachers for deciding the level of difficulty of each question. After this procedure, researcher had constructed final form of the test which contained total 45

multiple choice questions of 100 marks. Researcher had decided scoring scheme according to difficulty level of questions i.e. 1 mark for questions of easy level, 2 marks for questions of medium level and 3 marks for questions of hard level.

Preparation of Instructional Material for Conceptual Understanding

In this study, some objectives were kept in mind for preparing instructional material.

These objectives were played pioneer role for conceptual understanding in students.

Following were the objectives.

Students

1. represent general characteristics of concepts.
2. show core elements of concepts.
3. discriminate concepts from each other.
4. apply concepts in new situation.
5. identify concepts on basis of characteristics.
6. solve the learning question based on concepts.
7. give practical examples of concepts.
8. think logically on learning questions.
9. show practical uses of concepts in day to day life.

Instructional material contained total 20 concepts of mathematics including Algebra (7 concepts) and Geometry (13 concepts). Concepts were selected by three point rating scale. This rating scale was given to subject experts for selecting the concepts which were essential for the Mathematics of standard-9. On the basis of opinions of subject experts following concepts shown in the Table-1 were selected for preparing instructional material.

Table - 1 : List of Concepts

Branch	No.	Concept	Particular
Algebra	1	Set	Definition, Types, Application
	2	Mode	Definition, Characteristics, Application
	3	Polynomial	Definition, Types
	4	Linear Equation	Definition, Difference between Equation and Identity
	5	Trigonometric Ratios	Formulae, Application
	6	Cartesian Product	Definition, Application
	7	Exponent	Definition, Rules
Geometry	8	Non-linear points	Definition, Uses in other concepts
	9	Plane	Definition, Examples
	10	Parallel Lines	Definition, Measurement, Examples
	11	Bisector of Line segment	Definition, Difference between Bisector and Perpendicular bisector
	12	Ray	Definition, Relation with Line and Line segment
	13	Congruent Angles	Definition, Idea in Triangles
	14	Angles by Parallel Lines and its Transversal	Different types of Angles
	15	Triangle	Definition, Types based on Angles and Sides
	16	Congruence	Definition, Examples
	17	Concurrent Lines	Definition, Examples
	18	Quadrilateral	Definition, types
	19	Circle	Definition
	20	Perimeter	Definition, Examples, Application

The Instructional material was prepared of each concept at primary stage and given to subject expert for first review. As for suggestions after first review researcher had studied day to day life examples of concepts, word origin of concepts based on dictionary and encyclopedia and special characteristics of concepts based on different references of mathematics. After reformation of instructional material again given to subject experts for finalization, the instructional material was prepared in mainly three parts.

1. Kernel of the concept: This part includes sub concepts, word origin, general

characteristics, special characteristics and day to day life examples of concepts.

2. Classroom Activities: In this part, various learning activities were constructed based on main concept and sub concepts. These activities included Overhead projector activity, Flash-cards activity, pair work activity and group work activity.
3. Learning Questions: Here five to six learning questions were prepared for evaluation of each concept.

Implementation of Experiment

First of all pre test was conducted for experimental group. Then programme based on

instructional material was implemented on experimental group. Last, post test was conducted on the same group. Thus programme contained total 19 periods. Time duration was 40 minutes for each period. Total time was 13 hours.

Data Collection

The quantitative data collection work done before an experiment and after an experiment.

These were as under.

1. Pre-Test - quantitative data(before an experiment)
2. Post-Test - quantitative data(after an experiment)

Data Analysis and Interpretation

The null hypothesis was tested with the help of the t-test and effect size(Cohen's d)

Table – 2 : Impact of Instructional material on conceptual understanding of secondary school students in experimental group

Test	No	Mean	SD	t-value
Pre-test	50	52.02	15.74	10.07**
Post-test	50	69.04	11.75	

** Significant at 0.01 level

Table No-2 reveals that t-value is greater than the table value 2.69(df-49) at 0.01 level. It means the mean score of post-test on conceptual understanding is significantly higher than that of mean score of pre-test of the experimental group. So, the null hypothesis no-1 "There will

be no significant differences between the mean scores on the pre test and post test of students in the experimental group." Thus, instructional material was effective on the students of std-9 for conceptual understanding.

Table – 3 : Impact of Instructional material on conceptual understanding of secondary school students in relation to gender in experimental group

Independent Variable	Level of Independent Variable	Test	Dependent Variable (Conceptual Understanding)			t-value	Effect size Cohen's(d)
			No.	Mean	SD		
Gender	Male	Pre-test	25	48.68	16.83	6.49**	1.2
		Post-test	25	66.80	11.70		
	Female	Pre-test	25	55.36	14.12	8.19**	1.2
		Post-test	25	71.28	11.60		

**Significant at 0.01 level

For df-24 the table value for independent variable i.e. Gender (for both male and female) is 2.79 at 0.01 level. The t-values for Gender i.e. male and female are greater than the table value. It shows significant difference in mean scores at 0.01 level. So, the null hypothesis no-2 “There will be no significant difference between the mean scores on the pre-test and post-test of male students in the experimental group.” and the null hypothesis no-3 “There will be no significant difference between the mean scores on the pre-test and post-test of female students in the experimental group.” were rejected. Thus, instructional material was effective on male students and females too. Table No-3 also shows that the effect size (d) for the male and female of experimental group is same. Therefore hypothesis no-4 “There will be no significant difference between the mean scores on the pre-test and post-test of male and female students in the experimental group.” was accepted. It means that gender is not that much of an effective variable so far instructional material based on conceptual understanding are concerned.

Findings of the Study

1. The instructional material on the basis of conceptual understanding in the subject of Mathematics was effective for students of std-9.
2. The instructional material was effective on boys as well as girls.
3. The result of this study reveals that the impact of instructional material based on conceptual understanding was same on girls and boys.

In former research Ghariya, N.N.² (1999), Parmar, J.G.⁴ (2000), Patel, G.B.⁵ (1990), Shah, M.⁶ (1983), Sutariya, K.M.⁷ (1985), Suthar,

B.M.⁸ (1987) Vora, M.Y.⁹ (1976), shows significant impact of instructional material in conceptual understanding.

Conclusion

Conceptual understanding is foundation for learning process of any subject. On the basis of these findings and its analysis, we can say that teaching of concepts in the subject of Mathematics should be introduced through this instructional material from very prior stage of formal education. Moreover the study also suggested that different teaching-learning techniques based on word origin, word meaning, uses of concepts in day to day life, examples and non-examples of concepts, general and specific characteristics of concepts, learning questions of concepts, difference between the concepts should be developed and applied in classroom teaching for conceptual understanding in the subject of Mathematics.

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