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Sequencing of the Elementary Concepts of Unitary Method and Identifying These are Used in M.P., I.C.S.E. Examination and S.C.E.

Research Article

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Abstract: In this paper, total identified 27 elementary concepts of the major concept unitary method have been sequenced and presented here. This work was done by 'text book scanning process', 'task analysis technique' and incorporating 'experts opinions'. Here, It is also identified the elementary concepts which were used to solve the arithmetical problems of mathematics question papers of 10th standard of Madhyamik Pariksha (M.P.) (1999, 2000) of West Bengal Board of Secondary Education (W.B.B.S.E.), Indian Certificate of Secondary Education (I.C.S.E.) Examination (2005, 2006) of the Council for the Indian School Certificate Examinations (C.I.S.C.E.), School Certificate Examination (S.C.E.) (1999, 2000) of Visva-Bharati (a Central University). This study will help the entire curriculum development of school mathematics.

MSC: 97C99, 97D99, 97F99.

Keywords: Major concepts, elementary concepts, Identifying, sequencing, unitary method, text book scanning process, task analysis technique.

1. Introduction

The teachers and the persons, who are concerned with educational system, are all known that the conceptual gaping of the content and learning gap block the logical sequence of learning which is a main hindrance for learning and not only that it creates a phobia if the subject is mathematics.

The author had identified and sequenced the elementary concepts of major concepts of mathematics to remove the conceptual gaping and to present sequentially the elementary concepts of mathematics up to secondary level if there is any blockage. It had been done by 'text book scanning process', 'task analysis technique' and 'experts opinions' (26, 27, 28). Even, the author has identified the elementary concepts which are used in M.P.(1999 & 2000), I.C.S.E. Examination (2005 & 2006) and S.C.E. (1999 & 2000) (24,25,29,30,31). He has also identified 27 elementary concepts of unitary method which were not presented in (26).

In this paper, all these elementary concepts of unitary method have been presented sequentially and at the same time which concepts were used to solve the arithmetical problems of mathematics question papers of M.P. (1999 & 2000), I.C.S.E Examination (2005 & 2006) and S.C.E. (1999 & 2000) have been identified considering the curriculum development of the subject.

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2. Objective of the Study

(i) The objective of the study is to present identified different elementary concepts and their sequential order of unitary method.

(ii) To identify the elementary concepts of unitary method which were used to solve the arithmetical problems of M.P (1999 & 2000), I.C.S.E Examination (2005 & 2006) and S.C.E. (1999 & 2000).

3. Definitions

3.1. Major Concept and Sub-concepts

A Major concept is an idea which is complete in itself and is comprehended through a sequential process of step-by-step partial comprehension of its related concepts. These related concepts are called sub-concepts which are not complete in itself but are parts of the major concept.

Examples of major concepts are 'addition of whole numbers including the familiarity of the numbers', 'subtraction of whole numbers', 'measurement of mass', 'fraction', 'decimal', 'rational number' etc.

For the major concept such as 'Addition of whole numbers including the familiarity of the numbers', its sub-concepts are 'addition of one-digit numbers including zero where the sum is one-digit number', 'addition of one-digit numbers where the sum is two-digit number' etc.

3.2. First Level Sub-concepts

The sub-concepts which are obtained after immediate derivation of a major concept are called first level sub-concepts.

3.3. Second Level Sub-concepts and Others

When the derivation of first level sub-concepts are continued, the other sub-concepts so obtained stage by stage are called second level, third level etc.

3.4. Elementary concept

A sub-concept which can not be split further will be called an 'elementary concept'.

4. Materials and Methods

Procedure adopted has been discussed below:

4.1. Collection of Text Books

The prescribed text books of mathematics from Class-1 to 10 of West Bengal Board of Primary Education (W.B.B.P.E.), W.B.B.S.E., National Council of Educational Research and Training (N.C.E.R.T.) and other available books from the market were collected in the first stage (1-23).

4.2. Analysis of Text Books

These books were analyzed to identify unitary method as a major concept and their elementary concepts of arithmetic mainly.

4.3. Task Analysis of Question Papers

In the identification and sequencing of basic concepts, task analysis technique had also been applied on arithmetical problems of mathematics question papers of 10^{th} standard of M.P. (1999, 2000) of W.B.B.S.E., I.C.S.E. Examination (2005, 2006) of C.I.S.C.E., S.C.E. (1999, 2000) of Visva-Bharati (a Central University).

4.4. Sequencing of Concepts

The identified major concept and their elementary concepts were sequenced keeping in view the logical order of the subject and the psychological order of learners.

4.5. Experts Opinions

The major concept and their elementary concepts with examples were given to experts for their comments. The experts were requested to add or omit or alter the sequence of concepts as they felt necessary.
Finally, the sequential form of elementary concepts of the major concept 'unitary method' incorporating the experts' opinion was developed.

4.6. Identifying Used Elementary Concepts

The elementary concepts of unitary method used to solve the arithmetical problems which had been done at 4.3 Task analysis of question paper were identified.

5. Salient Points of the Study

The major concept no.-1: unitary method has been divided into two first level sub-concepts which are expressed in tabular form in Table-1. Each first level sub-concept has been divided into different sub-concepts. Total identified 27 elementary concepts have been sequenced. The splitting of sub-concepts is continued through different levels until elementary concepts are reached. In this investigation each sub-concept is numbered with a position value of different levels i.e. when a sub-concept is denoted by i.j.k.l. . . ., then i indicates the major concept no., j indicates the first level sub-concept no., k indicates the second level sub-concept no, l indicates the third level sub-concept no. etc. The numbers of different elementary concepts of the each first level sub-concept are shown in Table-2.

Sl. No.	First level sub-concept
1.1	Simple unitary method
1.2	Applications of unitary method

Table 1. **List of first level sub-concept of major concept no.-1: Unitary method**

1	2	3	4
First level sub-concept sl. Nos.	Number of second level sub-concept	Number of third level sub-concept	Total number of elementary concepts
1.1	3	–	3
1.2	12	2+2+2+2+2+2+ 2+2+2+2+2+2	24
Grand Total			27

Table 2. **Detailed list of different levels of sub-concepts of the major concept no.-1: Unitary method**

The process of detailing out of first level sub-concepts has been done. Here, total identified 27 elementary concepts have been presented. In the presentation, the elementary concepts of the sub-concepts have been elaborated giving question (Q) for better clarification.

Here '$*$' represent the concepts which had been introduced in the prescribed text books of W.B.B.S.E. & N.C.E.R.T. both '$**$' represent the concepts which had been introduced in the prescribed text books of N.C.E.R.T. only but not in W.B.B.S.E. '$* * *$' represent the concepts which had been introduced in the prescribed text books of W.B.B.S.E. only but not in N.C.E.R.T.

'$* * **$' represent the concepts which had not been introduced in the prescribed text books of W.B.B.S.E. & N.C.E.R.T.

The second level sub-concepts of sub-concept no. 1.1: Simple unitary method.

1.1.1 Concept of simple unitary method ($*$).

Q. What is the concept of simple unitary method?

1.1.2 Expression of the common language into mathematical tabular form ($* * *$).

Q. Express the following problem as mathematical tabular form.

The cost of 17 post cards is Rs. 8.50. Find the cost of 25 post cards.

1.1.3 Expression of the mathematical tabular form into common language form ($* * *$).

Q. Make a problem from the following mathematical tabular statement.

Number of pen	Cost (in Rs.)
11	37
17	?

The second level sub-concepts of sub-concept no. 1.2: Applications of unitary method.

1.2.1 Finding the values of desired objects.

1.2.2 Finding the desired number of objects.

1.2.3 Applying simple unitary method more than once to solve a sum.

1.2.4 Relationship between consumption of fuel or fare with distance travelled.

1.2.5 Relationship between earning and expenditure.

1.2.6 Relationship among weight or volume or length with number of objects or expenditure.

1.2.7 Relationship between fare and person.

1.2.8 Relationship between land and production.

1.2.9 Relationship between money and time.

1.2.10 Relationship between filling of tankers and time.

1.2.11 Relationship between power and volume.

1.2.12 Relationship among miscellaneous.

The second level sub-concepts of sub-concept no.1.2.1: Finding the values of desired objects.

1.2.1.1 Solution of the given problem and writing proper answer. ($*$)

Q. Solve the following problem and write the answer properly.

The cost of 5 exercise books is Rs. 25.25. Find the cost of 13 exercise books.

1.2.1.2 Formation of the problem and working out its solution. ($* * **$)

Q. Make a problem of unitary method involving the values of desired objects and then solve.

The second level sub-concepts of sub-concept no.1.2.2: Finding the desired number of objects.

1.2.2.1 Solution of the given problem and writing proper answer. (∗)

Q. Solve the following problem and write the answer properly.

The cost of 15 envelopes is Rs. 60. How many envelopes can be bought for Rs. 20?

1.2.2.2 Formation of the problem and working out its solution. (∗ ∗ ∗∗)

Q. Make a problem of unitary method involving the desired objects and then solve.

The second level sub-concepts of sub-concept no.1.2.3: Applying unitary method more than once to solve a sum.

1.2.3.1 Solution of the given problem and writing proper answer. (∗ ∗ ∗)

Q. Solve the following problem and write the answer properly.

The cost of wood for preparing 3 tables is Rs.1693.50 and the cost of wood for preparing 2 chairs is Rs. 888. A carpenter gets an order to make 11 tables and 20 chairs. How many cost of wood will have to sell?

1.2.3.2 Formation of the problem and working out its solution. (∗ ∗ ∗∗)

Q. Make a problem of unitary method more than once involving the desired number of objects and then solve.

The second level sub-concepts of sub-concept no.1.2.4: Relationship between consumption of fuel or fare with distance travelled.

1.2.4.1 Solution of the given problem and writing proper answer. (∗)

Q. Solve the following problem and write the answer properly.

A car can travel 240 km in 15 litres of petrol. How much distance will it travel in 20 litres of petrol?

1.2.4.2 Formation of the problem and working out its solution. (∗ ∗ ∗∗)

Q. Make a problem of unitary method involving the relationship between consumption of fuel or fare with distance travelled and then solve.

The second level sub-concepts of sub-concept no.1.2.5: Relationship between earning and expenditure.

1.2.5.1 Solution of the given problem and writing proper answer. (∗ ∗ ∗∗)

Q. Solve the following problem and write the answer properly.

Abdur Rahim Mondal expends Rs. 100 from his earning Rs. 125 in a day. Now, what amount will be expended from his earning Rs. 250 in a day if the rate of expenditure is same?

2.5.2 Formation of the problem and working out its solution. (∗ ∗ ∗∗)

Q. Make a problem of unitary method involving the relationship between earning and expenditure & then solve.

The second level sub-concepts of sub-concept no.1.2.6: Relationship among weight or volume or length with number of objects or expenditure.

1.2.6.1 Solution of the given problem and writing proper answer. (∗)

Q. Solve the following problem and write the answer properly.

The weight of 72 books is 9kg. What is the weight of 80 such books?

1.2.6.2 Formation of the problem and working out its solution. (∗ ∗ ∗∗)

Q. Make a problem of unitary method involving the relationship among weight or volume or length with number of objects or expenditure & then solve.

The second level sub-concepts of sub-concept no.1.2.7: Relationship between fare and person.

1.2.7.1 Solution of the given problem and writing proper answer. (∗∗)

Q. Solve the following problem and write the answer properly.

The bus fare of 5 passengers is Rs. 75 to go a particular distance. How much fare will be paid for 25 passengers to go the same?

1.2.7.2 Formation of the problem and working out its solution. (∗ ∗ ∗∗)

Q. Make a problem of unitary method involving the relationship between fare and person & then solve.

The second level sub-concepts of sub-concept no.1.2.8: Relationship between land and production.

1.2.8.1 Solution of the given problem and writing proper answer. (∗∗)

Q. Solve the following problem and write the answer properly.

The yield of paddy from 2 bighas of land is 960 kg. Find the number of bighas of land required for a yield of 1440 quintals?

1.2.8.2 Formation of the problem and working out its solution. (∗ ∗ ∗∗)

Q. Make a problem of unitary method involving the relationship between land and production & then solve.

The second level sub-concepts of sub-concept no.1.2.9: Relationship between money and time.

1.2.9.1 Solution of the given problem and writing proper answer. (∗∗)

Q. Solve the following problem and write the answer properly.

Ratan Mondal earns Rs. 7200 in 12 months. How much does he earn in 5 months?

1.2.9.2 Formation of the problem and working out its solution. (∗ ∗ ∗∗)

Q. Make a problem of unitary method involving the relationship between money and time & then solve.

The second level sub-concepts of sub-concept no.1.2.10: Relationship between filling of tankers and time.

1.2.10.1 Solution of the given problem and writing proper answer. (∗∗)

Q. Solve the following problem and write the answer properly.

If 8 oil tankers can be filled by a pipe in 4 hours; how much time will be taken by the pipe to fill 3 such oil tankers?

1.2.10.2 Formation of the problem and working out its solution. (∗ ∗ ∗∗)

Q. Make a problem of unitary method involving the relationship between filling of tankers and time & then solve.

The second level sub-concepts of sub-concept no.1.2.11: Relationship between power and volume.

1.2.11.1 Solution of the given problem and writing proper answer. (∗∗)

Q. Solve the following problem and write the answer properly.

A pumping set of 1.5 kilowatts can raise 1500 litres of water from a well of certain depth in certain time. Pumping set of how many kilowatts is needed to raise 4500 litres of water from the well of the same depth and in the same time?

1.2.11.2 Formation of the problem and working out its solution. (∗ ∗ ∗∗)

Q. Make a problem of unitary method involving the relationship between power and volume & then solve.

The second level sub-concepts of sub-concept no.1.2.12: Relationship among miscellaneous.

1.2.12.1 Solution of the given problem and writing proper answer. (∗)

Q. Solve the following problem and write the answer properly.

In a school, 5 students need 500 gm rice for mid-day meal in a day. Then, how much rice will be needed for 50 students per day?

1.2.12.2 Formation of the problem and working out its solution. (∗ ∗ ∗∗)

Q. Make a problem of unitary method involving the relationship among miscellaneous & then solve.

Now, the elementary concepts among the above presented 27 elementary concepts of unitary method were used in M.P.(1999 & 2000), I.C.S.E. Examination (2005 & 2006) and S.C.E. (1999 & 2000) have been identified and their frequency of use are counted which are shown below in Table-3.

1	2	3	4	5	6
M.P. (1999 & 2000)		I.C.S.E. Examination (2005 & 2006)		S.C.E. (1999 & 2000)	
Elementary concept no.	Frequency of use	Elementary concept no.	Frequency of use	Elementary concept no.	Frequency of use
1.1.1	3	1.1.1	1	1.1.1	1
1.1.2	3				
1.2.1.1	2	1.1.2	1	1.2.12.1	1
1.2.9.1	4				
1.2.12.1	1	1.2.12.1	2		
Total	13	Total	5	Total	2

Table 3. **List of elementary concepts of unitary method used in M.P., I.C.S.E. Examination and S.C.E.**

Table-3 reveals that total 5 elementary concepts (1.1.1, 1.1.2, 1.2.1.1, 1.2.9.1 and 1.2.12.1) of unitary method and their total frequency of use is 13 have been used to solve the arithmetical problems of mathematics question papers of M.P. (1999 & 2000) but to solve the arithmetical problems of I.C.S.E. Examination's mathematics question papers (2005 & 2006) 3 elementary concepts (1.1.1, 1.1.2 and 1.2.12.1) and its frequency of use is 5 was needed. But only 2 elementary concepts (1.1.1, 1.2.12.1) of unitary method were used in S.C.E. (1999 & 2000).

A tree-like structure has been developed from the splitting of the major concept no.-1: unitary method which is depicted below.

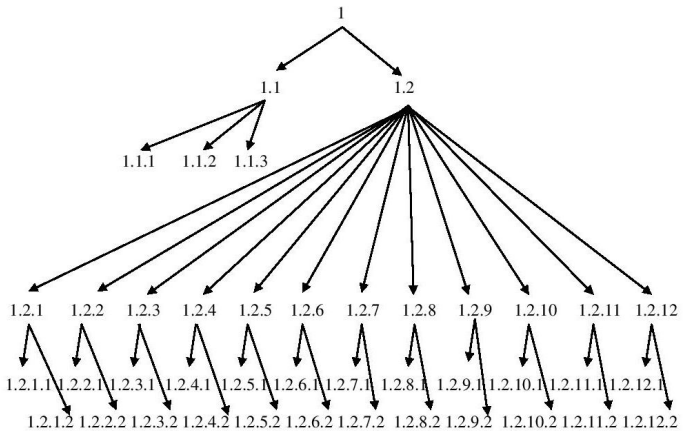

Figure 1. **Tree like structure of the elementary concepts of unitary method**

6. Conclusion

i). This methodology will help to mark different types of conceptual gaps of mathematics in the syllabus, text books and entire teaching learning process.

ii). Total 27 identified elementary concepts of unitary method have been sequenced and presented here. Total 9 elementary concepts out of 27 had been taken into consideration in the prescribed text books of mathematics of W.B.B.P.E./W.B.B.S.E. whereas N.C.E.R.T's text books had considered 12 elementary concepts which have been presented in the salient points of the study.

iii). From the above presentation of the elementary concepts and the presentation of Table-3, it is clear that the elementary concept no. 1.1.2 used in I.C.S.E. Examination, but it was not introduced in the prescribed text books of mathematics of N.C.E.R.T. Again the concept no. 1.2.9.1 used in M.P. whose frequency of use is highest in the study but not included in the prescribed text books of mathematics of W.B.B.P.E & W.B.B.S.E. whereas N.C.E.R.T.'s text book had been considered it. According to use of the elementary concepts of unitary method in the present study, here, frequency of use of elementary concept in M.P.> frequency of use of elementary concept in I.C.S.E. Examination> frequency of use of elementary concept in S.C.E.

iv). It will also help to diagnose the particular areas of weakness of learners and also in planning for necessary remedial measures.

v). Backward learners can be detected easily and remedial method for them can be applied.

vi). This study will help sequentially to develop the activities of unitary methods for better understanding of learners.

vii). Special interest for mathematics can be enhanced which will be helpful for entire science education.

7. Further Study

To undertake diagnostic study on large number of samples of classes-V on unitary method.

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