

## **IDENTIFYING AND SEQUENCING OF THE ELEMENTARY CONCEPTS OF MEASUREMENT OF MASS**

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In this paper attempts have been made (a) to identify all the elementary concepts of the major concept 'measurement of mass' and (b) to find the sequential order of these elementary concepts. Total 715 elementary concepts have been identified and sequenced.

*Keywords:* measurement, mass, elementary concepts.

### **1. INTRODUCTION:**

Mathematics nourishes our intellectual faculty. It improves our habits of argumentation, power of reasoning, judgment of any difficult situation and arriving at a correct decision. These are the characteristics of a civilized person. Thus mathematics plays a silent role in promoting our civilization. But it is observed that in our formal education, many learners can not achieve the specific content of school mathematics properly. They became weak in the subject. In this regard, Becker (2001) said, "Research has documented the failure of mathematics education for too many elementary school students." In India, the present status of school mathematics is not cheering up according to different reports and comments of mathematicians (Buch, 1991, Batra, 1995). But according to the great psychologist & philosopher Piaget (1973), "Every normal child is capable of learning mathematics." Therefore some causes are involved on account of the said unwanted situation. Improper content organization in the syllabi is an important factor that will be discussed in this paper. In this connection, Pushpanadham (1998) stated, "Mathematics is the subject which requires proper understanding of the concepts and their interrelations." Chilana (1984) opined, "Mathematical concepts should be graded in such a way that there is a proper sequence in their growth and development." Again the comment of 'Ben Clarke Pacific Institutes for Research' (2006) on Early Mathematics Assessment is "Emerging evidence suggests difficulty in mathematics is relatively stable over time. The importance of a logical scope and sequence is paramount." So it may be concluded that the proper sequence of 'basic concepts' according to their logical and psychological hierarchy should be maintained in the teaching-learning system of mathematics.

In our country, although the syllabus framing and content organization are made on the basis of experts' opinion but no systematic analytical method is applied in this process. As a result, many gaps are developed in the entire teaching-learning system which is very harmful to the students of mathematics because mathematics is purely a logical science. Therefore, to remove the said conceptual gaps, concept identification and its proper sequencing have an important role. The researcher has identified and sequenced the basic concepts of mathematics through 'text book scanning process' and

'task analysis technique'. In this regard, identification of the basic concepts and their sequencing is a worthwhile enterprise which has not yet been undertaken by others.

It has been made some contribution towards identification and sequencing of some basic concepts and framing of a model syllabus also (Sk., 2003a; 2003b; 2005a; 2005b; 2006a; 2006b; 2006c; 2006d; 2007a; 2007b; 2007c; 2007d; 2008a; 2008b; 2008c; 2008d; 2008e; 2008f; 2008g; 2009a; 2009b; 2009c; 2009d; 2009e; Sk. & Samanta, 2009a) .

In this paper, an attempt has been made for identification and sequencing the elementary concepts of measurement of mass.

## **2. DEFINITIONS:**

### **2.1 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.

### **2.2 First level sub-concepts:**

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

### **2.3 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.

### **2.4 Elementary concept:**

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

## **3. OBJECTIVE OF THE STUDY:**

The objective of the study is to identify different elementary concepts and their sequential order of measurement of mass.

## **4. PROCEDURE:**

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 (WBBPE), West Bengal Board of Secondary Education (WBBSE), National Council of Educational Research and Training (NCERT) and other available books from the market were collected in the first stage (Malhotra & Gupta, 2000; 2002a; 2002b; 2002c; NCERT, 1996; 1997; 1998; 2000; 2002a; 2002b; 2003a; 2003b; 2004a; 2004b; WBBPE, 2001a; 2001b; 2002a; 2002b; WBBSE, 1998; 2001; 2004; 2005)

#### 4.2 Analysis of text books:

These books were analyzed to identify ‘measurement of mass’ 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 has also been applied on arithmetical and algebraic problems of mathematics question papers of 10<sup>th</sup> standard of Madhyamik Pariksha (1999, 2000) of WBBSE, Indian Certificate of Secondary Education (ICSE) Examination (2005, 2006) of the Council for the Indian School Certificate Examinations, School Certificate Examination (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. The gaps in the concepts detected by the researcher were filled in by him at the initial stage.

#### 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 ‘measurement of mass’ incorporating the experts’ opinion was developed.

### 5. SALIENT POINTS OF STUDY:

Total 715 elementary concepts have been identified and sequenced after **analyzing** the major concept ‘measurement of mass’. The hierarchy of different levels is made according to the logical order of the concept. At the first level sub-concepts comprise introduction of the concept, units of measurement, conversion of different units and arithmetical operations. Considering this 7 first level sub-concepts are obtained which are expressed in a tabular form in Table-1.

Table-1. First level sub-concepts of the major concept ‘Measurement of mass’

Serial nos.	First level sub-concepts
1	Concept of mass and its units
2	Conversion of units of mass
3	Addition involving mass

4	Subtraction involving mass
5	Multiplication involving mass
6	Division involving mass
7	Simplification involving mass

The splitting of sub-concepts is continued through different levels until elementary concepts are reached. The result obtained in such a process is given below in a tabular form.

Table-2. Detailed list of different levels of sub-concepts of the major concept: measurement of mass

1	2	3	4	5	6	7	8	9
First level sub-concept sl. nos.	Number of second level sub-concept	Number of third level sub-concept	Number of fourth level sub-concept	Number of fifth level sub-concept	Number of sixth level sub-concept	Number of seventh level sub-concept	Number of eighth level sub-concept	Total number of elementary concepts
1	10	1+1+1+ 1+1+ 1+1+1+1+2	—	—	—	—	—	11
2	2	2+2	5+5	8+8	—	—	—	16
3	2	6+4	12+8	46+32	52+32	—	—	84
4	2	6+4	12+8	46+32	52+32	—	—	84
5	2	6+4	18+12	70+48	76+48	—	—	124
6	2	6+4	18+12	72+48	—	—	—	120
7	2	2+2	4+8	16+40	79+90	182+90	186+90	276
							<b>Grand Total</b>	<b>715</b>

The Table-2 depicts the major concept: measurement of mass which has seven (1,2,.....,7) first level sub-concepts. 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....., then i indicates the first level sub-concept no., j indicates the second level sub-concept no., k indicates the third level sub-concept no. etc.

**Analysis of detailing out of the first level sub-concept no-2** only has been done for the economy of space. Total 16 elementary concepts of sub-concept no-2 have been presented below. As and when an elementary concept is reached it is illustrated by an example with a 'Q' mark.

**The second level sub-concepts of sub-concept no. 2: Conversion of units of mass.**

2.1: Conversion of units of mass without using decimal system.

2.2: Conversion of units of mass with using decimal system.

**The third level sub-concepts of sub-concept no. 2.1: Conversion of units of mass without using decimal system.**

2.1.1: Expression of mass involving different units from word form to numeral form and vice-versa.

2.1.2: Changing one unit from another.

**The fourth level sub-concepts of sub-concept no. 2.1.1: Expression of mass involving different units from word form to numeral form and vice-versa.**

2.1.1.1: Expression of mass involving different units from word form to numeral form.

Q. Express into numeral form.

Four kilograms seven decagrams three grams.

2.1.1.2: Expression of mass involving different units from numeral form to word form.

Q. Express into word form.

Kilogram	hectogram	decagram	gram	decigram	centigram	milligram
2	3	4	5	1	7	0

**The fourth level sub-concepts of sub-concept no. 2.1.2: Changing one unit from another.**

2.1.2.1 Changing units involving kilogram and gram.

2.1.2.2 Changing units involving gram and milligram.

2.1.2.3 Changing units involving any unit.

**The fifth level sub-concepts of sub-concept no. 2.1.2.1: Changing units involving kilogram and gram.**

2.1.2.1.1 Changing higher units into lower units.

Q. Convert into gram.

5 kilogram 200 gram

2.1.2.1.2 Changing lower units into higher units (expressed in mixed unit form).

Q. Convert into mixed unit form.

7300 gram.

**The fifth level sub-concepts of sub-concept no. 2.1.2.2: Changing units involving gram and milligram**

2.1.2.2.1 Changing higher units into lower units.

Q. Convert into milligram.

2 gram 500 milligram

2.1.2.2.2 Changing lower units into higher units (expressed in mixed unit form).

Q. Convert into mixed unit form.

2500 milligram.

**The fifth level sub-concepts of sub-concept no. 2.1.2.3: Changing units involving any units.**

2.1.2.3.1 Changing higher units into lower units.

Q. Convert into centigram.

4 gram.

2.1.2.3.2 Changing lower units into higher units (expressed in mixed unit form).

Q. Convert into mixed unit form.

222 centigram.

**The third level sub-concepts of sub-concept no. 2.2: Conversion of units of mass with using decimal system.**

2.2.1: Expression of mass involving different units from word form to numeral form and vice-versa.

2.2.2: Changing one unit from another.

**The fourth level sub-concepts of sub-concept no. 2.2.1: Expression of mass involving different units from word form to numeral form and vice-versa.**

2.2.1.1: Expression of mass involving different units from word form to numeral form.

Q. Express into numeral form.

Seventy thousand seven hundred point one two grams.

2.2.1.2: Expression of mass involving different units from numeral form to word form.

Q. Express into word form.

Kilogram hectogram decagram gram decigram centigram milligram

7 0 4 . 5

**The fourth level sub-concepts of sub-concept no. 2.2.2: Changing one unit from another.**

2.2.2.1 Changing units involving kilogram and gram.

2.2.2.2 Changing units involving gram and milligram.

2.2.2.3 Changing units involving any unit.

**The fifth level sub-concepts of sub-concept no. 2.2.2.1: Changing units involving kilogram and gram.**

2.2.2.1.1 Changing higher units into lower units or mixed units.

Q. Express into gram changing the place of decimal point.

210.25 kilograms

2.2.2.1.2 Changing lower units into higher units.

Q. Express into kilogram changing the place of decimal point.

75.5 gram

**The fifth level sub-concepts of sub-concept no. 2.2.2.2: Changing units involving gram and milligram.**

2.2.2.2.1 Changing higher units into lower units or mixed units.

Q. Express into milligram changing the place of decimal point.

210.25 grams

2.2.2.2.2 Changing lower units into higher units.

Q. Express into gram changing the place of decimal point.

2 milligram

**The fifth level sub-concepts of sub-concept no. 2.2.2.3: Changing units involving any units.**

2.2.2.3.1 Changing higher units into lower units or mixed units.

Q. Express into centigram changing the place of decimal point.

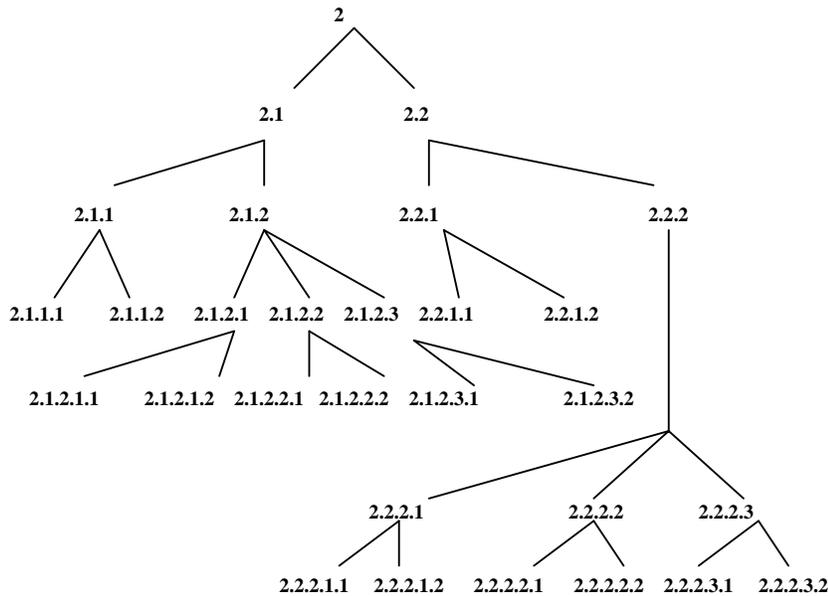
0.004 gram

2.2.2.3.2 Changing lower units into higher units.

Q. Express into gram changing the place of decimal point.

0.5 centigram.

A tree-like structure has been developed from the splitting of the first level sub-concept no.-2 which is depicted below.



## 6. IMPLIMENTATION:

Ideal gapless and properly sequenced mathematics syllabi for class I to IV standard have been framed (Sk., 2006b; 2008b; 2009e) by implementing the research findings.

## 7. CONCLUSION:

1. This methodology will help to mark different types of conceptual gaps of mathematics in the syllabus, text books and entire teaching learning process because applying this methodology it has been possible to identify that several conceptual gaps in the existing syllabi and recommended text books of some standard educational Boards. This will help in framing ideal gapless syllabi and developing good text books in future.
2. It will also help to diagnose the particular areas of weakness of students and also in planning for necessary remedial measures.
3. Backward learners can be detected easily and remedial method for them can be applied.

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

## 8. FURTHER STUDY:

The diagnostic study may be taken on large number of samples of classes I, II, III & IV on 'measurement of mass'.

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