Using the Computer to Diagnose Pupils’ Difficulties in Addition and Subtraction

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The use of IT in schools has become an in thing in Singapore schools. Teachers have been encouraged to use IT or computers and to integrate them into their lessons because certain modes of instructions have been shown to be effective in teaching, especially the drill and practice mode of instruction. It is interesting to see if the integration of computers improves other aspects of learning such as problem solving and mathematical thinking.

There are many ways the computer can be used as a tool in school instruction. One way is for managing pupils’ ability. A computer can be used as a management tool. The objective of this project is to develop a computer system so that pupils’ ability, especially their weaknesses in mathematics, can be diagnosed and assessed.

Conceptual Framework

Development of the automated computer system is research based. Children’s inability to compute is basically because of their misconception of some mathematical procedures that have been built into their mental structure. Their erroneous mental structure has given rise to their systematic computation errors. Their consistent systematic errors in computations is a reflection of their erroneous mental structure which have to be identified first before any prescriptions can be given to the pupils. In other words their systematic responses in any mathematical computation is an indication of their thinking. The power of the computer is to capture any response that is a reflection of their problems and remediation can then be carried out on the basis of the identification.

Objectives

The objectives of the study were to classify a set of error patterns in addition and subtraction of whole numbers.

• develop a computer system for analyzing pupils’ erroneous algorithm in addition and subtraction of whole numbers and

• use the computer system for further identifying pupils’ errors in the two operations.

Sample and Methodology

The sample for this study consisted of 3000 underachieving pupils from various schools. These were the pupils identified by teachers from the various schools as underachievers.

A diagnostic test on the addition and subtraction of whole numbers was constructed which was based on the predetermined objectives. The objectives for the tests were

1. Adding a one digit number and another one digit number
2. Subtracting a one-digit number from another one digit number
3. Adding a two digit number and another two digit number
4. Subtracting a two digit number from another two digit number
5. Adding a three digit number from another three digit number
6. Subtracting a three digit number from another three digit number
7. Adding a single digit number and another two digit number
8. Subtracting a single digit number from another two digit number
9. Adding a two digit number and another three digit number
10. Subtracting a two digit number from another three digit number

Each objective was further subdivided into various sub-objectives involving the use of the following variables: use of zeros, renaming and regrouping, and use of zeros, regrouping or renaming at various places of numbers. In each objective or sub-objective, four parallel items were used to test the subjects’ knowledge of the algorithmic skills. This was to ensure that the different types of errors were identified, viz. systematic errors and non-systematic errors.

The diagnostic test was administered to the 3000 subjects. Pupils’ responses to each item were marked and incorrect responses were carefully analyzed to determine the actual error pattern of each mistake made.

Results of Tests

A set of error patterns was identified in addition and subtraction. The following summarizes the error patterns of each operation.

Addition

1. Treating addition as multiplication. 0+N=0
2. Treating numbers near 10 as 10
3. Adding ones without regrouping and assigning hundreds and tens to the wrong place value.
   1. The hundreds value is missing after addition
   2. Converting a near 10 addend to 10 and adding
   3. Adding from left to right and regrouping to the right
   4. Adding digits from all numbers disregarding place value
   5. Adding ones from the second addend to both ones and tens of the first addend
   6. Regrouping from ones to tens unnecessarily.
(7) Subtracting instead of adding
(8) Not regroup in the higher place
(9) Add tens to both tens and hundreds

Subtraction

(1) Any number that subtracts a zero gives zero. N-0 = 0
(2) Regrouping unnecessarily from tens although it is not needed
(3) Writing 0 as the answer when regrouping is required but decrement is correct (Zero after regrouping)
(4) Writing 0 as the answer when regrouping is required and no renaming is carried out (Zero instead of regrouping)
(5) No regrouping. Subtract smaller from bigger number.
(6) Zero minus a number gives the number. No renaming. 0 - X = X
(7) Regroup from the left most digit instead of regrouping from the digit immediately to the left
(8) Always regroup from the extreme left irrespective if necessary
(9) Skip doing the exercise when regrouping is needed
(10) Skip the column when regrouping is needed and go on to the next
(11) When borrowing is needed, put a zero as the answer for the column
(12) After regrouping from 0, use 0 instead of 9 for subtraction in tens.
(13) Performing addition instead of subtraction
(14) Subtract the single digit of the subtrahend from both digits of the minuend

Computer System for Diagnosis

It was envisaged that teachers would find it difficult to memorize all these error patterns. It is also time consuming to analyze an individual's error in performing operations in whole number. Hence an automated system was developed to reduce the burden of teachers who would, presumably, be reluctant to perform the above tasks without such a system.

The system allows teachers to select the objectives of each operation. Four questions will be randomly generated by the computer based on each sub-objective identified above. A pupil who is undergoing the test is permitted to spend as much time as needed to answer each question. The time taken by the pupil for each question will be recorded by the computer. Based on the responses of the pupil, the computer will be able to analyze the pupil's error and error pattern can be printed out if the pupil has committed a systematic error. The information provides tremendous help to teacher in determining appropriate remediation.

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A Portable Software for Tracking and Monitoring Daily Lifestyle Habits - On-going Research in Schools

Quck Jin Jong, Chia Tet Fatt, Michael Chia, John Wang and Joyce Mok

Five professors at the National Institute of Education (NIE) have designed a world's first - a portable software that is able to give users instant health assessments and appropriate advice everywhere they go. The five professors are Drs. Quck Jin Jong, Chia Tet Fatt, Michael Chia, John Wang and Joyce Mok.

"HITS (HealthTrek Information Tracking System) is an intelligent health-building gadget of tomorrow that is available today," said Michael Chia, from the Physical Education and Sports Science Academic Group. "It is a smart software because personal choices are recognized and appropriate personal recommendations are given on demand and in real time". HITS was officially launched to schools on the 2nd of May 2002.

Users can record what they eat, their physical activities, and moods for up to a week. They can then get their health reports and recommendations from the PDA. The system can also calculate the number of days needed to lose/gain weight that is physiologically sound and healthy.

"There is a safe weight loss/gain weight schedule that is realistic, and importantly based on positive behaviour change in terms of food and physical activity consumption," said Michael Chia. "By tuning in to your needs, HITS facilitates lifestyle change, taking into account how you feel, what you eat and what forms of physical activity you do."

HITS is housed in a 16MB personal digital assistant (PDA) and is designed to monitor status of body weight, fluid intake, physical activity patterns and mood for over a period of one week. Based on the information provided, HITS can provide remediation suggestions that are cognizant of those promoted by the Health Promotion Board of Singapore.