METHODOLOGY

3.0 Introduction

This is an exploratory study which attempts to analyze the computational errors in whole number division made by a sample of Form One students. The analysis focuses on the following areas:

1. Identify the types of computational errors in division made by the Form One students.

2. Analyse the distribution of the error types among the different groups of achievers.

3. Identify the procedures used in the division computation that lead to the incorrect responses.

4. Explore the possible sources of the computational errors.

5. Compare the types of errors exhibited by the different groups of achievers.

3.1 The Sample

The sample of the study was taken from a suburban National Secondary School in the West Coast of Sabah. It consisted of fifty-four Form One students, who had just completed six years of primary school education. They had sat for the standardized examination, UPSR (*Ujian Penilaian School Rendah*) in the previous year. These students came from several rural National Primary Schools within a radius of about 20

kilometers from this secondary school. The sample comprises students of various indigenous races of Sabah, such as Kadazandusun, Bajau, Melayu Brunei, and Murut. They are collectively referred to as the *Bumiputeras*.

As the study attempts to compare the error patterns between the different achieving groups, purposeful sampling (Wiersma, 1995) was employed. Five different groups of mathematics achievers were selected from five Form One classes. Selection of the sample was done with the help of the mathematics teachers of the school. The mathematics performance (grade A, B, C, D, and E) in the UPSR examination was used as a measure of their mathematics achievement. Ten students were selected for each of the five grades. However, when the test was administered, four other students volunteered to participate in the test. The sample thus comprises fifty-four Form One students: twenty-five boys and twenty-nine girls. The distribution of the sample according to their mathematics grades is shown in Table 1.

Table 1

Frequency Distribution of Subjects According to Performance in Mathematics

Mathematics Grade	Sex		Total
	Boys	Girls	
A	5	5	10
B	4	6	10
C	7	5	12
D	5	5	10
E	4	8	12
Total	25	29	54

3.2 Description of Instrument

The instrument for this study is adapted from *The Schonell Diagnostic Arithmetic Test* (Schonell, 1957). The Schonell Diagnostic Arithmetic Test consists of twelve tests on the four basic operations. Only Test 9, on "Graded Division" is adapted for the instrument in this study. The Schonell Diagnostic Arithmetic Test is preferred over other instruments because the test covers only simple basic computations for the primary level. Moreover, the items were designed to take into account the common difficulties in division computation such as basic fact errors, zero difficulties, regrouping, remainder, and other procedural errors.

The initial test consists of eleven steps, or levels. There are four items in each level. Four similar items are recommended in order to differentiate systematic errors from careless errors. However, for the instrument used in this study, the researcher have added another level, level 12. This is because the result of the pilot study using Schonell's test could not provide avenues to examine the error in "omitting final zero when zero is not final in the dividend". Thus Level 12 consists of four items for "zero is not final in the dividend but there is final zero in the quotient", in order to examine the above zero error. Consequently, the final instrument consists of a total of 48 simple division items, involving the use of divisors from 2 to 12 (see Appendix A). The items require only simple, basic procedures that are necessary in the division computation.

All the test items contain only numbers and operations in symbols. Thus the test avoids the usage of language, which may affect the

solutions of the students. Moreover, the questions are given in vertical form only since this form is more commonly used in the computational exercises.

Table 2 gives the detailed description of the test items and a comparison of their difficulties and skills involved. For each level, the difficulties involved in the items (Schonell, 1957) and their equivalent skills as stated in the KBSR mathematics syllabus (Malaysia,1995) are given. Levels 1 to 4 contain items without regrouping and without remainder, whereas, Levels 5 to 12 contain items that require regrouping and with remainders. The dividends range from two-digit numbers to six-digit numbers and the divisors are mainly one-digit numbers. Only two items, one each with 11 and 12 as divisors, are included in level 9.

Table 2

Description of Items and Their Equivalence in KBSR Syllabus

Level	Items	Description	KBSR syllabus
1	$4\overline{)44}$ $2\overline{)84}$ $3\overline{)96}$ $6\overline{)666}$	Divisor is contained in every figure of the dividend; no regrouping, no remainder.	Division of any number less than 1000 with any one-digit number without regrouping, no remainder.
2	$2\overline{)682}$ $4\overline{)844}$ $3\overline{)696}$ $2\overline{)2426}$	Same as level 1, but with larger number, no regrouping, no remainder.	Division of any number not more than 10 000 with any one-digit number without regrouping, no remainder.
3	$3\overline{)906}$ $2\overline{)806}$ $4\overline{)840}$ $3\overline{)690}$	Zero at end or in middle of dividend, no carrying, no remainder.	Division of any number less than 1000 with any one-digit number without regrouping, no remainder.
4	$4\overline{)800}$ $3\overline{)900}$ $6\overline{)600}$ $8\overline{)1600}$	Double zeros at end of dividend, double zeros in quotient, no regrouping, no remainder.	Division of any number not more than 10 000 with any one-digit number without regrouping, no remainder.

Level	Items	Description	KBSR syllabus
5	5)‾1515‾ 7)‾6342‾ 9)‾8136‾ 8)‾4856‾	Divisor is not contained in first digit of dividend, embedded zero in quotient, no embedded zero in dividend, no carrying, no remainder.	Division of any number not more than 10 000 with any one-digit number, with regrouping from tens to ones, no remainder.
6	4)‾27‾ 8)‾53‾ 9)‾80‾ 7)‾61‾	Dividend under 100; divisor is not contained in the first digit of dividend, one-digit quotient, with remainder.	Division of any number less than 1000 with any one-digit number without regrouping, with remainder.
7	7)‾50‾ 4)‾97‾ 9)‾89‾ 6)‾57‾	Dividend under 100, divisor is not contained in the first digit of dividend, one-digit quotient, with remainder.	Division of any number less than 100 with any one-digit number with and without regrouping, with remainder.
8	5)‾156‾ 4)‾167‾ 7)‾149‾ 6)‾128‾	3-digit dividends, divisor not contained in the first digit of dividend, no regrouping, with remainder.	Division of any number less than 1000 with any one-digit number, without regrouping, with remainder.

Level	Items	Description	KBSR syllabus
9	$9\overline{)372}$ $12\overline{)759}$ $8\overline{)697}$ $11\overline{)569}$	3-digit dividends, divisor not contained in the first digit of dividend, larger divisors, with regrouping, with remainders.	Division of any number less than 1000 with any one-digit or two-digit number, with regrouping from tens to ones, with remainder.
10	$3\overline{)248}$ $6\overline{)745}$ $5\overline{)3462}$ $7\overline{)5573}$	3- or 4-digit dividends; with regrouping, with remainders.	Division of any number less than 10000 with any one-digit number with regrouping from hundreds to tens and tens to ones, with and without remainder.
11	$8\overline{)29643}$ $5\overline{)25237}$ $7\overline{)49010}$ $9\overline{)307868}$	5- or 6-digit dividends, embedded zero in quotient, with regrouping, with remainders.	Division of any number not more than 100 000 with any one-digit number, with regrouping, with and without remainder.
12	$2\overline{)81}$ $3\overline{)962}$ $4\overline{)9523}$ $6\overline{)3723}$	2- to 4-digit dividends, zero not final in dividend, zero final in quotient, with regrouping, with remainders.	Division of any number not more than 10 000 with any one-digit number, with regrouping, with and without remainder

Sources:
The diagnostic arithmetic test manual, by F.J. Schonell, 1957, London, Edinburg: Oliver and Boyd.
Sukatan pelajaran matematik sekolah rendah, Kementerian Pendidikan Malaysia, 1995, Kuala Lumpur: Dewan Bahasa dan Pustaka.

3.3 Validity of Instrument

The final instrument was examined by a panel of three mathematics teachers and a mathematics educator for its content validity, with reference to the magnitude of the numbers used and the skills in division as listed in the KBSR Syllabus (Malaysia, 1995). The panel agreed that the instrument was suitable for the Form One students.

3.4 Pilot Study

The initial instrument consisting of 11 levels was first tested in a pilot study on 30 Form One students in a secondary school in Selangor. However, analysis of the errors revealed that the instrument did not contain items for analyzing zero error in "omitting final zero in quotient when zero is not final in the dividend". The researcher then added level 12 to the instrument. Level 12 consists of four items that intend to examine this error. The final instrument used in this study thus consists of 12 levels, with four items in each level (see Appendix B).

3.5 Procedure of Data Collection

Approval for carrying out the study was obtained from the Educational Planning and Research Division (EPRD). Permission for conducting the study in the selected school was then obtained from the State Director of Education of Sabah. The researcher made preliminary visits to the school to make arrangement for conducting the study. Selection of the sample was done with the help of the mathematics teachers from the school.

The instrument was administered to the sample by the researcher, with the help of the mathematics teacher, in a classroom during school hours. The students answered all items in the paper provided. Any extra papers used for rough working were also collected for analysis. There was no time limit for the test. The students took between 40 minutes to one hour to complete the test. During the test, the students were not allowed to discuss among themselves. They were, however, encouraged to check their own computations. The written responses were collected immediately after the students had completed the test.

After the preliminary analysis of errors based on the written test, eight students were selected for individual interviews. The interviews were conducted one week later because of the time needed for scoring the test and the analysis of the errors. The interview sessions were conducted in an empty classroom and were audio recorded.

3.6 Analysis of Data

Analysis of data was based on the students' written responses in the tests. The responses to the test items at each skill level were scored. The incorrect responses were then analyzed for patterns of errors. The analysis of errors included identifying the types of computational errors in division computation, and the distribution of the error types among the different groups of achievers. Furthermore, selected individual interviews of students were conducted to obtain further clarification on the procedures used in the computations. Comparisons were made on the common error types made by the different groups of achievers.