An investigation into first year elective science and integrated science students' understanding of length in measurement at Kadjebi Asato Senior High School (KASEC)

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Abstract
Conversion within quantities of same units and between quantities of different units is a thorny subject to students at Kadjebi Asato Senior High (KASEC) and its treatment by tutors sometimes becomes very difficult such that most tutors resort to handling the subject theoretically / abstractly. When this happens most students seemed not to comprehend the subject. In view of this, one aspect of the DTML-Conversion models (i.e. D-Conversion model) was used. The DTML-Conversion Models is a model that has been designed by the researcher to make the teaching of conversion in measurement very easy to tutors and meaningful to students.

Based on the findings of an earlier study on an investigation into first year Elective Science and Integrated Science Students' Understanding of Length in Measurement at Bueman Senior High School (BUSEC), the researcher further carried a study but on students of Kadjebi Asato senior high school in order to see whether the same problem of students as existed at BUSEC, exist too in KASEC, since BUSEC is a sister school to KASEC. The D-Conversion Model was tested on ninety eight (98) 2011/2012 first year Elective and Integrated science students' at Kadjebi Asato senior high school by first teaching conversion of length using the traditional method which is the Conversion-factor for a period of two hours.

A cross survey design technique was employed with ninety eight (98) students of which a five item test was administered, collected and recorded. Comparison of the two test results i.e. Test before the lesson (TBL), and Test with the use of the D-Conversion model (TDC) showed that, Elective and Integrated Science students seemed to comprehend conversion of length in measurement when the D-Conversion model was employed to the conversion-factor method.

This study has revealed that indeed the D-Conversion model has helped the first year Elective Science and Integrated Science students' of KASEC to grasp the concept of conversion of length and that understanding of Integrated Science students and Elective Science students has almost been bridged, the classroom implication is that, the use of the D-Conversion model would enable the practical teaching of conversion in measurement.

And when this is done, students are in the position to better understand the concept of conversion.

Keywords: The D-Conversion model, Test before the lesson (TBL), and Test with the use of the D-Conversion model (TDC)

1.1 INTRODUCTION

Conversions are an integral part of much scientific practice, for example to allow for ease of data processing, to enable comparison and standardization and to support the understanding of physical quantities and processes (Molyneux & Sutherland, 1996). It is therefore crucial for students to become competent in converting between units.

Conversion within quantities of same units and between quantities of different units is a thorny subject to students and its treatment by tutors sometimes becomes very difficult such that tutors resort to handling the subject theoretically/ abstractly. When this happens most students seemed not to comprehend the subject. One aspect of the DTM-Conversion model and DTML-Conversion model (Kumassah, 2011; Kumassah, 2012) was adopted and used in this study from the premise that learning to convert between units of measurement is critical to a learners' development in the realm of science and other courses and that having access to a general method would support students' efficiency in converting (Butterfield, Sutherland & Molyneux-Hodgson, 2000). The focus for using one aspect of the DTML-Conversion model in this study was on the role of a general rule for converting and this arose out of a detailed observational study of first year Elective Science and Integrated Science Students' of KASEC working through their Physics and Integrated Science course on Measurement (Physics Syllabus, 2008; Integrated Science Syllabus, 2008).

1.2 RESEARCH HYPOTHESIS

The aim of the study was to find out science students perform better to integrated science students. In view of this the study was guided the following research hypothesis;

1. There is no significant statistical difference between Elective Science Students' and Integrated Science Students' understanding of length in measurement before the introduction of the D-Conversion model.
2. There is no significant statistical difference between Elective Science Students' and Integrated Science Students' understanding of length in measurement after the introduction of the D-Conversion model.

1.3 STATEMENT OF THE PROBLEM

It has been reported that Conversion within quantities of same units and between quantities of different units is a thorny subject to students (Butterfield, Sutherland & Molyneux- Hodgson, 2000; Kumassah, 2012) and its treatment by tutors sometimes becomes very difficult such that most tutors resort to handling the subject theoretically / abstractly ((Butterfield, Sutherland & Molyneux-Hodgson, 2000). When this happens most students seemed not to comprehend the subject (Kumassah, 2012). In view of this, a follow up study on first year students' of Kadjebi Asato senior high school (KASEC) became prudent, as the same problem existed in Bueman Senior High school (Kumassah, 2012), a sister school to KASEC.

The first year students of KASEC study two major subjects' i.e. Elective Science and the Rest Subjects (i.e. Integrated Science and other Subjects) just as done at BUSEC. Elective Science students in this research are assumed to have much knowledge and understanding of science from their Junior High Schools, while the Rest Subjects students are also assumed not to have much knowledge and understanding of science from their Junior High Schools.

If this assumption is true, then a study must be carried out to ascertain this assumption.

1.4 LITERATURE

Efforts have been made to understand the effectiveness of science students in terms of promoting students' understanding of the science concepts in measurement (Cardamone, 2007). However, many pure science, science education and engineering students perceive measurement as a difficult subject, because to them measurement deals with abstract laws or principles, concepts and models (Schauer, Ozvoldova & Lustig, 2007). This problem faced by students did not only surfaced in measurement but also surfaced in conversion too. This is because conversion within quantities of same units and between quantities of different units has become a thorny subject to students (Butterfield, Sutherland & Molyneux-Hodgson, 2000; Kumassah, 2012) and its treatment by tutors sometimes becomes very difficult such that most tutors resort to handling the subject theoretically / abstractly ((Butterfield, Sutherland & Molyneux-Hodgson, 2000). When this happens most students seemed not to comprehend the subject (Kumassah, 2012).

Although measurement forms part of the senior high school science curricula in Ghana (physics syllabus, 2008; integrated science syllabus, 2008), it is not clear as to the level at which senior high school students in Ghana understand the basic ideas of measurement of length (WAEC, 2000, 2002 and 2006). All what is usually expected is that after the senior high school course, students should able to use an array of data analysis technique, such as calculating the mean, (physics syllabus, 2007; integrated science syllabus, 2007) but not the understanding of the concepts of measurement, most especially conversion (Anamuah-Mensah, Mensah, & Otuka, 2001).

1.5 METHOD

RESEARCH DESIGN

The design of this study was a cross-sectional survey design. It is a research initiated to carefully examine problems faced students in understanding of length in measurement in the Jasikan district of Ghana at one time (Ary, Jacobs & Razavieh, 2002; Ray, 2003). The cross-sectional survey technique was used to test the research hypothesis of the study on;

1. Whether there was significant statistical difference between Elective Science Students' and Integrated Science Students' understanding of length in measurement before the introduction of the D-Conversion model.
2. Whether there was significant statistical difference between Elective Science Students' and Integrated Science Students' understanding of length in measurement after the introduction of the D-Conversion model.

POPULATION

Four hundred and twenty students formed the population of the study i.e. ninety eight Elective science students and three hundred and twenty two Integrated Science students

SAMPLE SIZE

Ninety eight students formed the sample of the study i.e. forty nine Integrated Science Students and forty nine Elective Science Students

SAMPLING PROCEDURE

Simple random sampling technique was employed in selecting the sample for the study (Ary & Razavieh, 2002). Microsoft Excel was used in selecting the sample from two classes' i.e. elective science class and integrated science class. The Microsoft Excel assigned random numbers to students' names that were imputed into it. Fifteen percent (15%) sample size was selected from seven classes of integrated science students with a population of three hundred and twenty two, while (50%) sample size was selected from two classes of elective science students with a population of ninety eight. This 15% sample size of the integrated science students and 50% of elective science students (Ary & Razavieh, 2002) was sufficient for this study. The differences in the percentages of the sample size was due to the fact that the researcher wanted a uniform / same sample size from each population i.e. integrated science students and elective science students.

ANALYSIS

Independent sampled t-test was used to test the research hypotheses. Independent t-test was used because there was no interaction between elective science students and integrated science students of KASEC.

1.6 DISCUSSIONS AND RESULTS

Research Hypothesis one: there is no significant statistical difference between Elective Science Students' and Integrated Science Students' understanding of length in measurement before the introduction of the D-Conversion model, sought to find out whether Elective Science students understand conversion of length in measurement better to Integrated Science students before the introduction of the D-Conversion model. Here

diagnostics test results of the Elective Science students and the Integrated Science students were compared.

Before the D-Conversion model was introduced to the students, a five item test on conversion of length was administered to the students (Appendix B). This test served as a diagnostic test on students to see their entry behaviours before the lesson. The results (Table 1a) showed that 38.8% of elective science students were able to convert in length and thus were a little above the average mark (2.5) while (Table 1b) also showed that 18.4% of integrated science students were able to convert in length and thus were also a little above the average mark. This meant clearly that the 2011/ 2012 first year elective science and integrated science students' of Kadjebi-Asato Senior High School before the introduction of the D-Conversion model had difficulty in converting between one dimension lengths, since non of the students' group was able to exceed the 50% (Table 1a; Table 1b). This result agreed with a study conducted earlier by the researcher on an investigation into Jasikan College of Education (JASICO) Diploma in Basic Education students' understanding of length in measurement. A more vivid of this result is shown in figure 1.

Table 1a: Elective Science Students Test Scores (N= 49)

Test Scores	Frequency	Percent
1	8	16.3
2	22	44.9
3	19	38.8

Table 1b: Integrated Science Students Test Scores (N= 49)

Test Scores	Frequency	Percent
1	21	42.9
2	19	38.8
3	9	18.4

Figure 1a: Graphical Results of Diagnostic Test of Elective Science Students

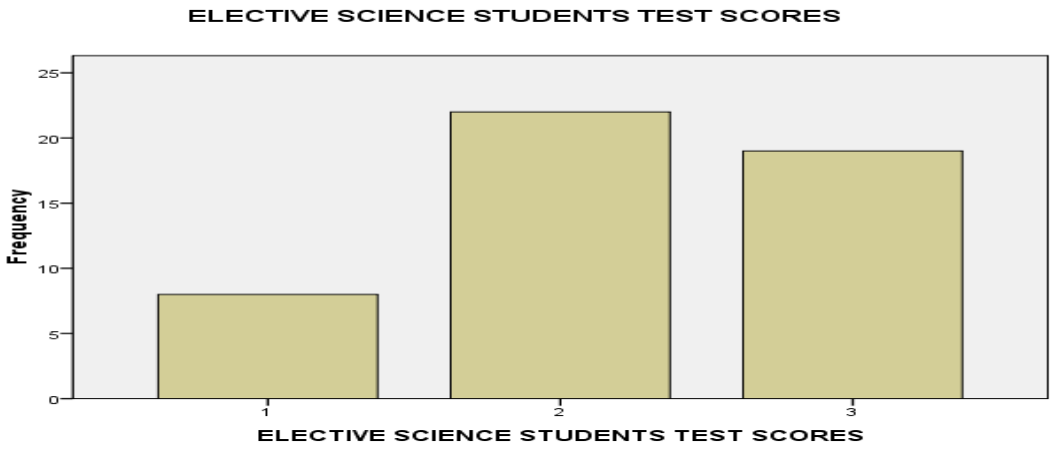
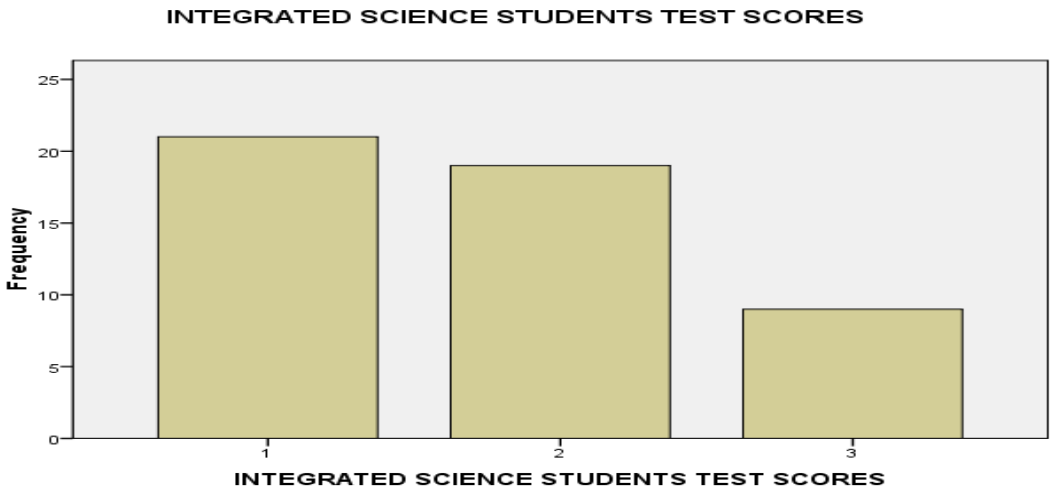


Figure 1b: Graphical Results of Diagnostic Test of Integrated Science Students



There was a statistical difference between Elective science and Integrated science students (Table 3b) understanding of length in measurement ($t = 2.266$, $P < 0.05$) before the introduction of the D-Conversion model. This meant that before the introduction of the D-conversion model, Elective Science students showed a much understanding of conversion of length in measurement to the Integrated Science students.

Table 3a: Group Statistics for Diagnostic Test results before the lesson

	Elective Science Students Test Scores	N	Mean	Std. Deviation	Std. Error Mean
Integrated Science Students Test Scores	2	22	1.9091	.75018	.15994
	3	19	1.4211	.60698	.13925

Table 3b: Independent Samples Test for Diagnostic Test results before the lesson

		Levene's Test for Equality of Variances		t-test for Equality of Means		
		F	Sig.	t	df	Sig. (2-tailed)
Integrated Science Students Test Scores	Equal variances assumed	.152	.699	2.266	39	.029
	Equal variances not assumed			2.301	38.856	.027

Research Hypothesis two: there is no significant statistical difference between Elective Science Students' and Integrated Science Students' understanding of length in measurement after the introduction of the D-Conversion model, sought to find out whether Elective Science students still have an upper hand in the understanding of conversion of length in measurement to Integrated Science students after the introduction of the D-Conversion model. Here test results of the Elective Science students and the Integrated Science students after the introduction of the D-Conversion model were compared.

The D-Conversion model exposes students to practical aspect of conversion on length. The D-Conversion model was introduced in order to see whether students will be able to understand conversion of length better. The results (Table 2a) showed that 51% of Elective Science students were able to convert in length and thus were within the four (4) marks. However 20.4% of elective science students were still below the average mark (2.5). 65.3% (51 +14.3) of Elective Science students' hard excellent marks. The word excellent mark as used here meant students whose test scores were within the 4^{th} and the 5th mark (Table 2a).

Also (Table 2b) results showed that 42.9% of Integrated Science students were above the average mark i.e. they are within the three (3) marks and 38.8% i.e. (32.7 + 6.1) of Integrated Science students had excellent marks i.e. marks that are within the 4^{th} mark and the 5^{th} mark. These result again agreed with a study conducted earlier by the researcher on

an investigation into Jasikan College of Education (JASICO) Diploma in Basic Education students' understanding of length in measurement (Kumassah, 2012). The 14.3% (Table 2a) of Elective Science students and the 38.8% (Table 2b) of Integrated Science students showed that the use of the D-Conversion model to some extent helped improved upon Elective Science and Integrated Science students understanding of conversion of length in KASEC. A more vivid of this result is shown in table 2 and figure-2.

Table 2a: D-Conversion model Test Scores of Elective Science students (N= 49)

Test Score	Frequency	Percent
2	10	20.4
3	7	14.3
4	25	51.0
5	7	14.3

Table 2b: D-Conversion model Test Scores of Integrated Science students (N= 49)

Test Score	Frequency	Percent
2	9	18.4
3	21	42.9
4	16	32.7
5	3	6.1

Figure 2a: Graphical Results of D-Conversion model Test score of Elective Science students

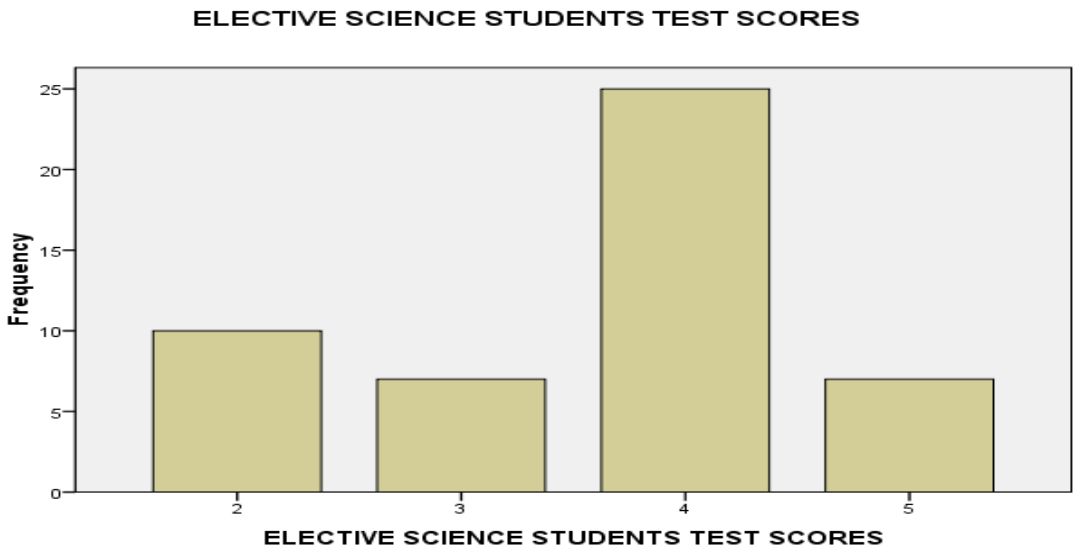
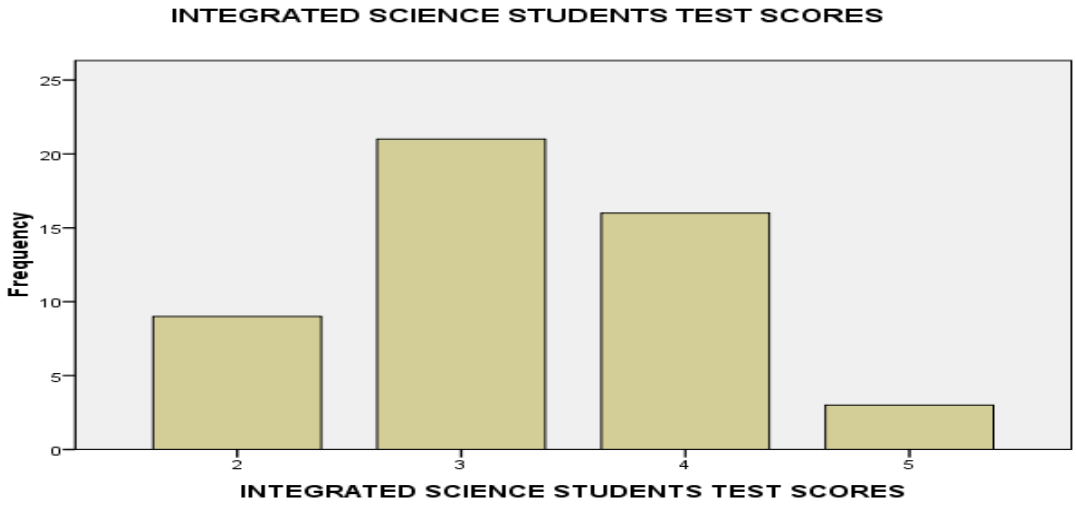


Figure 2b: Graphical Result of D-Conversion model Test score of Integrated Science students



There was no statistical difference between Elective Science and Integrated Science students (Table 4b) understanding of length in measurement (t= 0.667, P > 0.05). This meant that the use of the D-conversion model helped improved Integrated Science students understanding of conversion of length in measurement to the level of Elective Science students.

Table 4a: Group Statistics for Test scores with the use of D-Conversion model

	Elective Science Students Test Scores	N	Mean	Std. Deviation	Std. Error Mean
Integrated Science Students Test Scores	3	7	3.1429	.37796	.14286
	5	7	2.8571	1.06904	.40406

Table 4b: Independent Samples Test for Test scores with the use of D-Conversion model

	Levene's Test for Equality of Variances	t-test for Equality of Means

		F	Sig.	t	df	Sig. (2-tailed)
Integrated Science Students Test Scores	Equal variances assumed	39.273	.000	.667	12	.518
	Equal variances not assumed			.667	7.477	.525

1.7 CONCLUSION

In conclusion, this study has revealed that indeed the D-Conversion model has helped the first year Elective Science and Integrated Science students' of KASEC to grasp the concept of conversion of length. Most especially, the D-Conversion model improved the understanding of Integrated Science students understanding of conversion to the level of Elective science students. In view of this finding where understanding of Integrated Science students and Elective Science students has almost been bridged, the classroom implication is that, the use of the D-Conversion model would enable the practical teaching of conversion in measurement. And when this is done, students are in the position to better understand the concept of conversion.

However, the researcher is not conclusively saying that the use of the D-Conversion model in teaching conversion should be the only appropriate tool to be used by teachers, educators, policy makers, curriculum developers and students in teaching and learning of conversion in measurement. But its use might have a long standing effect on students understanding of conversion at all levels of education in Ghana and elsewhere.

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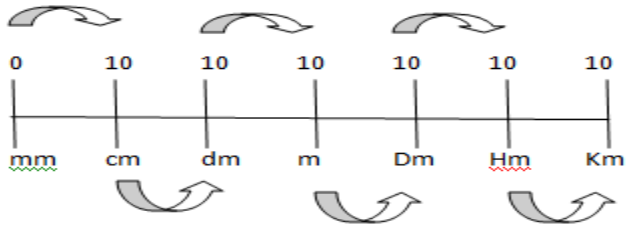
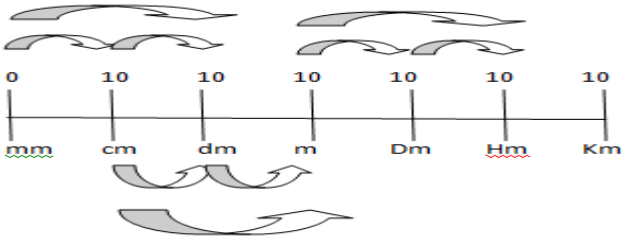
Appendix A

The D-Conversion model (adopted from Kumassah E.K, 2011)

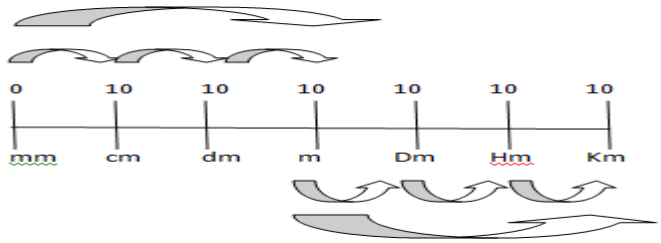
One Step/ Movement



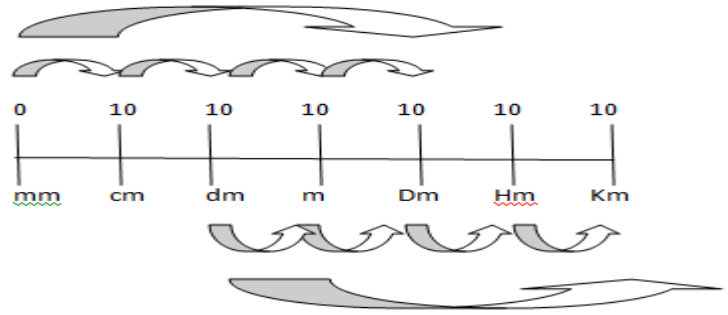
Two Step/ Movement



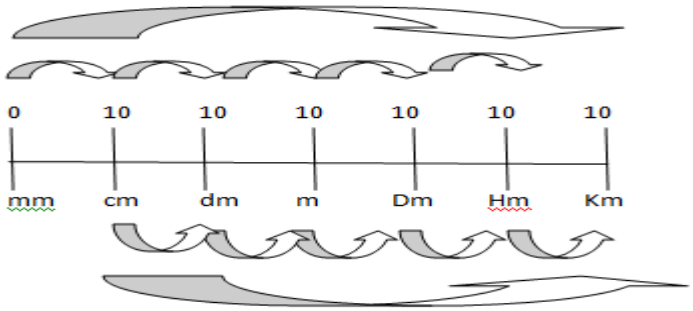
Three Step/ Movement



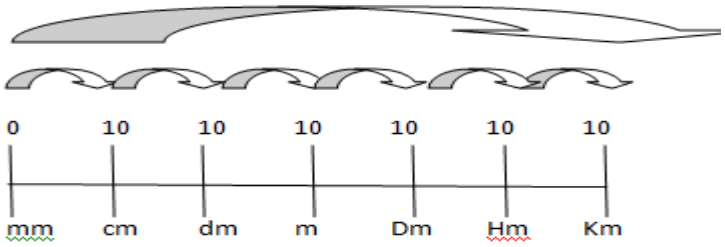
Four Step/ Movement



Five Step/ Movement



Six Step/ Movement



Appendix B

Test Items	Correct Answer	Scoring Rubric
1. change 1.5mm to ?cm	0.15cm	1 mark
2. convert 1.5dm to ?Dm	0.015Dm	1 mark
3. change 98Hm to ?cm	980000cm	1 mark
4. convert 98m to ?Km	0.098km	1 mark

5.	change 1.5km to ?mm	1500000mm	1 mark

Conversion factor i.e. between mm to cm, dm, m, Dm, Hm, and Km

$10(1\times10^{1})$ mm = 1cm

$100(1\times10^{2})$ mm =1dm

$1000(1\times10^{3})$ mm = 1m

$10000(1\times10^{4})$ mm = 1Dm

$100000(1\times10^{5})$ mm = 1Hm

$1000000(1\times10^{6})$ mm = 1Km