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COMPUTATION ERRORS ON MEASURES OF CENTRAL TENDENCY BY MASTERS STUDENTS: IMPLICATIONS FOR ANDRAGOGY

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Abstract
The purpose of the study was to identify computation errors on statistical measures of central tendency made by masters students. It was motivated by the desire to find an error basis for targeted remedial activities for the group. The study used a case study of one group of students in one university. Data was collected from a census of 103 students' answer scripts analysed for errors. These were complemented by answers from a simple random sample of 60 students who responded to Newman's (1977) error analysis prompts. The study found that the majority of students are in the (46-50) years group. There are more male than female students. Errors revealed include results interpretation, incorrect formula decoding, illogical presentation of solutions, substitution and addition of decimals. Possible sources of errors include omission of a pre-requisite exercise on basic arithmetic, algebra and algebra operations, incorrect operation order stemming from rote learning and hurried solution presentation, use of large group making it difficult for tutor to attend to individual weaknesses, use of power point for a large group of adults whose eye sight can be affected by light intensity variations affects formula decoding. Newman's (1977) error analysis revealed that adult students' computation errors are more pronounced on the transformation, process and encoding levels. The study has the following implications for andragogy:

1. *Structuring of introductory arithmetic and algebra exercises.*
2. *Involving students in data collection rather than presenting hypothetical cases for numerical calculations.*
3. *Linking graphical to algebraic solutions for evaluation and concept development.*
4. *Asking students to exchange notebooks and mark each other's notes guided by the tutor who points at error target points.*
5. *Complementing power-point presentations with photocopies of example solutions given to students as handouts.*

Key Words: *measures of central tendency, adult students, statistics, computation errors.*

Introduction

This study which explored computation errors in statistics was encouraged by Green (1992) who pointed out that statistical concepts provide a fascinating area to explore. In fact, statistics terms the statistician regards as straightforward and obvious (mean, mode, median, variability, distribution) are the distilled wisdom of several generations of the mathematically ablest minds. It is too much for us today to expect that there will not be a struggle by teachers to pass on this inheritance and by students to receive and internalize for application without errors and mistakes in the process.

From the above platform this study accepts that mathematics learners, be they primary or secondary school children or adults at university level make mathematics computational errors against their wish and expectations of their teachers. This is supported by Legutko (2007) who observes that students' errors in mathematics are inevitable, they arise from the mathematics itself, textbooks or are results of teaching. Ressell (2001) justifies mistakes as a learning ingredient when he/she notes that the most powerful learning experiences results from making mistakes. Booker (1989: 101) pointed at the teacher variable as a source of errors when he/she said, "the origins of many errors are rooted not so much in students but in the manner children are introduced to mathematics". Booker's (ibid) observation is justified from the perspective that the teacher is the most important variable in a teaching–learning encounter. The teacher activates all other variables in the system.

Teachers set the classroom learning standards and determine deviations from them in the form of students' errors. Mathematics error identification then is an important aspect of informative evaluation. It can be done during lecture discussions or when the lecturer marks students' assignments and in-class tests. Teachers can use students' errors to reflect on their teaching methods, textbooks used and the needs of the student. In fact, known and predicted errors help teachers speculate questions and answers during the lesson planning stage. In this case error analysis provides a basis for student targeted instruction to correct the errors. This discussion funnels down to mathematics error analysis being an indispensable activity for any serious mathematics teacher. It is more important for teachers of adult learners. The majority of them would have been out of formal school for a long time.

Contextual Analysis

Chinhoyi University of Technology (CUT) has several first degree programs and currently (2011) one postgraduate Master of Science in

Strategic Management Degree which started in 2005. It has two main admission requirements: a first degree pass in any recognized discipline from any approved university and at least two years experience in managerial post. The criterion implies that all students for this programme are managers. They are also the working adults managing different sectors of Zimbabwe's economy. Considerations of the nature of the student population called for the Master of Science in Strategic Management degree to be offered on a block-release basis to reduce interruptions of their work-place schedules. These entry qualifications are silent on mathematics content although strategic management functions requires accurate data analysis and interpretation. One can conclude that such students bring different mathematics skills and experiences into the classroom.

One of the compulsory courses done during the first semester of the Master of Science in Strategic management degree is Quantitative management. Its main focus is the development of decision making skills based on interpretation of quantified business variables. Mathematics computational algorithms are not emphasized. The argument is that these students are managers whose role is to make decisions on analysed data results rather than the analysis algorithms.

The average Master of Science in Strategic Management class has 160 adult students. Large classes are accepted to enable the programme to finance itself. Teaching and learning is done in the lecture room using lecture methods and power-point presentations. Tutorials are compulsory to enhance concept development and application. Assignments calling for mathematics computations are done in groups and supervised during tutorials. This is done to enable the manager to be mathematically literate and enable him/her to evaluate and supervise subordinates who analyse the data.

Research Problem

The researcher who is a tutor for Quantitative Management is disturbed by the observation that Master of Science in Strategic Management students are failing to get full marks on word problems requiring the computation and interpretation of measures of central tendency (mean, mode and median) for grouped data. Students' submit incomplete solutions and sometimes their responses are wrong when compared to a standard accepted answer from the marking guide. The study of computation errors is an important initial stage for targeted remedial instruction.

Study Objectives

The problem motivated this study to:

1. Identify errors or mistakes that students make when computing measures of central tendency for grouped data.
2. Deduce possible sources of such errors.
3. Suggest targeted instructional methods to correct the errors.

Study Rationale

This study is relevant to researchers and teachers of statistical concepts to adult learners. It is important considering that:

1. Statistics, specifically computational errors on measures of central tendency by adult students has received less attention in research than other mathematical topics.
2. Most research in statistics was carried out in experimental situations and little concerned with the normal classroom practice.
3. The majority of studies on mathematics focused on primary school children and college students (pedagogy) in other countries and little was done to explain errors by adult learners (andragogy) in Zimbabwe's universities.
4. Most of the studies were carried out by psychologists rather than educators of statistics.
5. Students' errors can be analysed and targeted instructional methods formulated because an incorrect answer shows that the student has a different understanding which should be used to refocus the student. It helps to understand adult statistics learners as a unique group.

Adult Learners

The researchers' experiences as a tutor of adult learners for statistical concepts in Zimbabwe confirmed Salih's (2003) observation that adult learners are not big children. Therefore pedagogical skills (teaching and learning of children) cannot be an accurate substitute for andragogy (helping adults to learn). There is need to understand adult students through an analysis of their characteristics, learning strategies and mathematical errors reflected in their oral and written responses to problems.

Lecturers for adult learners should derive instructional guidance from Knowle's (1984) andragogical model. It is based on the following four main assumptions and possible instructional implications:

1. Adult learners bring in theories and concepts of mathematics and mathematics learning experiences from their previous encounters with the subject. This assumption calls for pre-tests to determine the levels of knowledge and experiences brought in. These can be a source of assumed knowledge activities to provide a base for new knowledge.

2. Adults need to know the purpose of their learning before they can invest effort and resources in the learning process. This implies that the lecturer should spell out the course objectives and provide the course outline on the first encounter with students.

3. Adults are used to making their decisions in everyday life hence require self direction over the nature, content and approach to their learning. Lecturers can provide a course with optional topic content and mode of learning.

4. Adults learn more effectively when dealing with tasks and problems they perceive to be real, related to and arising from the demands of their everyday lives. This calls for lecturer freeing him/her self from textbook problem examples with a foreign content to problem examples derived from Zimbabwe' context.

Rogers (2002:15) classified adult learners into four character categories: Activists, Observers, Theorists and Experimentalists. Each group has specific implications for instruction as shown in the table below:

Table 1, Characteristics of Adult Learners

Group	Learner Characteristic and Implication
Activists	Learn by involving themselves in various activities. Involve them in actual data collection before teaching and calculation of mean, mode and median.
Observers	Prefer to wait and watch what is going on before they decide to act. Involve them in end of group discussion presentation reports and exercise evaluation.
Theorists	Like to generalize from their experiences and apply what they learn in one arena to another. Lecturer can make them lead groups in real life problem solving tasks.
Experimentalists	Enjoy devising new approaches and try them out to see what happens. Provide problems which require different techniques. Ask them to evaluate group discussion answers.

This grouping implies that one group of masters students can be composed of adult learners at different points of the spectrum. There are those who want to be taught everything and those who wish to find everything for themselves.

Bell and Gilbert (1996) in Bean (2003) classified adult learners' learning strategies into three surface, deep and strategic levels.

Their learning strategies are presented in table 2, below:

Table 2: Adult learners' learning strategies

Nature of student	Main Concern	Learning strategies
Surface level student has no background content of statistics	To complete the course with a pass (50%)	▪ Serious about writing notes and photocopying handouts for procedural knowledge ▪ Memorization of fragmentary facts ▪ Pays attention to all course content ▪ Aims to get the correct or right answer ▪ Assimilates unaltered chunks of course material verbatim for regurgitation in the exam
Strategic level student has knowledge of statistics content and its applications	To establish appropriate content for specific tests evaluation and synthesis	▪ Applies surface level approaches in a flexible combination contingent with perceived nature of task ▪ Solve one problem with more than one approach and evaluate solutions

One can deduce that the main variable determining the student's style of learning is the student' statistics background. Those students who dropped mathematics at "O" level proceeded to do a first degree which required no mathematics can operate at surface level. Those who passed mathematics at "O" level, "A" level and first degree will operate at the strategic level. Lecturers are encouraged to administer pre-tests to determine students' levels of knowledge. The rationale for considering adult students' mathematics knowledge prior to instruction is two fold. First, university students would have acquired considerable knowledge about measures of central tendency (mean, mode, median) from previous learning and everyday experiences. Second is that learning is a result of the integration between what the student is taught and his/her current ideas or concepts of the topic (Posner, Strike and Hewson, 1982).

Mathematics as a Discipline

According to Atherton (2003) in the interaction between the teacher, the learner and the subject being taught, the subject is not neutral. Mathematics specifically imposes its own language and logic which contribute to students' errors. Johnson and rising (1972:3) regarded mathematics as a way of thinking which encompasses arithmetic (science of numbers and computation), algebra (language of symbols and relations), geometry (study of shapes, size and space), statistics (science of interpreting data and graphs) and calculus (study of change, infinity and limits). From an applied angle Howson (1988) considered mathematics as a study of patterns (any regularity inform or idea such as sequences). It is a language which adds precision to communication using ideograms (symbols for ideas such as Σ for sum of) to facilitate computations.

This study is looking for errors in three aspects of mathematics: arithmetic (numbers and computation), algebra (language of symbols) and statistics (interpretation of data) within the context of measures of central tendency for grouped data.

Measures of central tendency provide a convenient way of describing a set of data with a single number (Gay, 1979). One can consider measures of central tendency to be a descriptive quantification of variable grouping within a distribution. The three indices of central tendency are the mode, for nominal data, median for ordinal and mean for interval and ratio data. The values of these measures of central tendency are used to describe the distribution of large samples in research and real life situations. Their relationships and distribution description are shown in table 3, below:

Table 3, Measures of central tendency distribution description

Relationship	Distribution description
Mean < Median < Mode	Negatively skewed distribution
Mean = Median = Mode	Normal distribution
Mean > Median > Mode	Positively skewed distribution

For grouped data, the following formulas are provided in students' formula booklets; hence there is no need for students to cram them.

(a)Sample mean, $\bar{x} = \frac{1}{n}\sum f_i x_i$

Where,n = sample size, f_i = frequency, and x_i = class mid-point

(b)Median, $M_e = L_m + \frac{C_m(\frac{1}{2}n - F_{m-1})}{f_m}$

Where Lm = lower limit of median class

C_m = class width of median class

F_{m-1} = cumulative frequency of class just before the median class.

f_m = frequency of median class

(c)Mode, $M_0 = L_m + \frac{C_m(f_m - f_{m-1})}{2f_m - (f_{m-1} + f_{m+1})}$

Where f_m = frequency of modal class

f_{m-1} = frequency of class just before the modal class

f_{m+1} = frequency of class just after modal class

The availability of a formula suggests the development of procedural knowledge. According to Mtetwa (1999), procedural knowledge refers to knowing what? When? and How? to manipulate rules and steps to obtain the desired result. It may not include the (rationale) why? procedures work that way. Chinamasa (2008) encouraged teachers to develop the rationale as a basis for conceptual knowledge. The rationale enables students to examine and apply mathematical content structures, relationships, objects and ideas in real life situations.

Students' Errors in Mathematics

In this study errors are systematic deviations from acceptable mathematical computation procedures. Radatz (1980) argues that students' errors in mathematics education are not simply a result of ignorance, stupidity and situational accidents. Most students' mistakes are not due to unsureness, carelessness or unique situational conditions. Rather, students' errors are the result or product of previous experiences in the mathematics classroom. This perception encourages teachers to analyse students' errors, suggest their sources and write instructive comments for students with difficulties. According to Frank (2009) assumptions behind teachers studying learners' mathematical errors are that: (1) errors are an indicator of the difficulties encountered in learning the target concepts. (2) it enables teachers to predict likely errors for a group of learners and provide remedial teaching. (3) they point to the possible strategies used by students to learn. (4) they are a source of understanding learners' development stages. These sentiments call for the current study on measures of central tendency computation errors made by adult learners.

Researchers have taken different angles for projecting their studies on error analysis. Russell (2002) noted that primary school children committed the following: (1) mechanical errors arising from hurried approaches and forgotten steps. (2) Application errors showing students' misunderstanding of one or more steps. (3) Knowledge gaps reflecting lack of concepts and unfamiliarity with terminology and (4) incorrect operation order stemming from rote learning.

Cohen and Spenciner (2007) focused on word problems and found that students; (1) had difficulty with reading, (2) showed inability to relate context of the problem to real life situation, (3) failed to distinguish relevant from irrelevant information, (4) were unable to identify the number of steps required to solve the problem and (5) had trouble with mathematical operations of directed numbers. These findings cannot account for errors made by adults in Zimbabwe.

Although these studies were done with children and not adults, what is clear is that: (1) language contributes to errors in mathematics computation. (2) the researchers analysed students answer scripts. (3) their methods did not require the student to explain the rationale for his/her application of a particular procedure.

In addition to language difficulties Radatz (1979) also reported that pupils mathematics errors were a result of: (1) deficient mastery of pre-requisite skills for example counting before addition and subtraction. (2) Insufficient facts and concepts. (3) Incorrect concept association and (4) the application of irrelevant rules of operation.
Booker (1989) was interested in the use of errors for targeted instruction. He/she observed that errors originated from the following during teaching:

(1) Incoherent structure of presenting mathematics content. (2) Use of inappropriate textbook examples for concept formation. (3) Unsuitable exercise problems, for example those emphasizing drill of procedure with no evaluation and rationale. (4) Underestimating the necessity for basics by teaching before pre-testing. (5)

Inappropriate teacher response to students' errors. (6) Inaccurate selection of method for subject content understanding and (7) class work based on the work of selected students asked to work on the board while the rest copy the solution.

A more comprehensive method of analyzing errors suggested by Newman (1977) involve asking a student five prompts to help determine where errors occur. The prompts are:

1. Please read the question to me. If you don't know a word leave it out. (reading)
2. Tell me what the question is asking you to do. (comprehension)
3. Tell me how you are going to find the answer. (transforming)
4. Tell me what to do to get the answer. Speak aloud as you do it so that I can understand how you are thinking. (Process or skills)
5. Now write down your answer to the question (Encoding in symbols or words).

Clements (1980) used Newman's prompts to analyse 726 Grade 5 to 7 pupils' errors in Papua New Guinea. He/she found that 50% of the errors first occurred at the reading, comprehension and transformation levels. Since Newman's prompts are hierarchical, Clements (ibid) concluded that teacher remedial activities focused on procedural method are misdirected. Further studies by Ellerton and Clements (1996) revealed that different questions produced quite different error patterns. Lankford (1994) extended the application of Newman's error analysis to adult learners. She found that nurses had errors at the comprehension and transformation level. What is not yet clear is the type of computation errors, their sources and classification from Zimbabwe's adult students.

METHODOLOGY

Research Design

This study applied a descriptive case study to facilitate the identification, quantification and description of students' computational errors and their distribution. Descriptive research designs facilitate data source and method triangulation. In this study it enabled documentary analysis and application of Newman's prompts. Since only one group of students in one university was used, the case study is appropriate to allow institutional factors to be accounted for.

Instruments

The researcher structured the tutorial task below for the purpose of error analysis after teaching the content.

The speed of vehicles at a road section close to Hillview primary school were presented in the table 4, below:

Table 4, Measures of central tendency task

Speed	*35-45*	*46-65*	*66-70*	*71-150*
Frequency	*33*	*40*	*30*	*20*

Calculate and interpret the (a) mean (b) Mode (c) Median

The task was done under test conditions to ensure that students present individual responses and allow test emotional stress factors to prevail naturally. An hour was allowed to reduce the effect of time. The next set of instruments were the 103 student answer scripts. These were analysed for students' computation errors. Scripts also provided a record of students' errors without the rationale hence the need for interviews using Newman's (1977) prompts guide for students' rationale and possible error classification.

The prompts are:

1. *Please read the question to me. If you don't know a word leave it out. (reading)*
2. *Tell me what the question is asking you to do. (comprehension)*
3. *Tell me how you are going to find the answer. (transforming)*
4. *Tell me what to do to get the answer. Speak aloud as you do it so that I can understand how you are thinking. (Process or skills)*
5. *Now write down your answer to the question (Encoding in symbols or words).*

Population and sampling

The population of this study was composed of all 186 masters students registered for Quantitative Management course in January – July 2011. All the students had done the course and were good sources for errors arising from their previous experiences and the teaching done at the university. A census of the 103 scripts for students present was taken. Since the script population was finite, probability sampling for Newman's interview was appropriate. Errors were expected to be uniformly distributed hence simple random sampling applied. Students' registration numbers were matched with computer generated random numbers to select 60 participants for interviews.

Data collection

Data collection was initiated by the administration of the test. Students were informed that the test was an error diagnostic instrument. Its findings were to be used as a basis for their revision session error targeted tutor instruction. The researcher invigilated and marked the test scripts. During marking errors were recorded and frequency tables generated for errors appearing more than once. Errors were also indicated on students' scripts for them to benefit from the study.

The tutor carried out one-on-one interviews with 60 students selected in the sample. Participants accepted to have their responses coded on Newman's prompt guide. Frequency tables were generated for discussion.

Findings and Discussions

Table 5, Participants' distribution by Age and Gender N = 103

Age Group (in years)	30–35	36–40	41–45	46–50	51–60	Total
Male	6	17	17	20	2	62
Female	3	8	9	16	5	41
Total	9	25	26	36	7	103

The table shows that there are more male (60%) than female (40%) participants in the group. Findings are inclined to be influenced by male dominance. The majority (35%) of participants are in the (46 – 50) years group. This group has a high probability of making computation errors. According to Bean (2003) age is a serious variable in computational tasks. As the complexity of tasks increase, ability decline with age.

Table 6, Students' errors from scripts N = 103

Concept	Type of Error	Frequency
Mean	1. Failed to identify correct formula	41 (40%)
	2. Inability to identify real class limits	30(29%)
	3. Unable to calculate class midpoint	26 (25%)
	4. Incorrect formula copied	39(38%)
	5. Incorrect substitution	10(10%)
	6. Inaccurate division	17(17%)
	7. Failure to interpret results	32(31%)
Median	1. Failed to copy correct formula	90(87%)
	2. Unable to identify median class	70(68%)
	3. Real class limits not used	55(53%)
	4. Incorrect substitution in formula	21(20%)
	5. Wrong addition of decimals	48(47%)
	6. Failure to interpret results	98(95%)

Mode	1. Failing to copy correct formula	96(93%)
	2. Frequency identifies not used to identify modal class	85(82%)
	3. Inability to identify modal class	63(61%)
	4. Real class limits not used	51(50%)
	5. Incorrect substitution in formula	28(27%)
	6. Wrong removal of brackets	59(57%)
	7. Incorrect adiion of decimals	50(49%)
	8. Failure to interpret results	63(61%)

Discussion of Results

1. Students are making errors in the contextual interpretation of measures of central tendency; the mean (31%); median (95%) and mode (61%). This distribution of errors can be accounted for by students' use of memorization of textbook definitions of median as a term that occupies a central position when they are in order.
   Answers like "*the speed on the centre of table is 63.3 km/h*" were common. Such students can be classified by Bell and Gilbert (1996) as operating on the surface level. They show a limited background content of statistics. Only (31%) could not interpret the mean correctly. One can attribute this to the frequent use of the word "average" in everyday life, which calls for the use of everyday examples during instruction.

2.There were three main forms of incorrect formulas presented by students. Out of 103 students 41(40%) copied the formula for mean of ungrouped data instead of the formula for mean of grouped data. There were two erroneous interpretations of the formula: $\bar{x} = \frac{1}{n}\sum_{i=1}^{k} f_i x_i$

(a) $\bar{x} = (40 x 33) + (55.5 x 40) + (68 x 30) + (110,5 x 20) \div 123$

$\bar{x} = 1320 + 2220 + 5040 + 17,97$

(b) $\bar{x} = \frac{(40 x 33)}{33} + \frac{(55.5 x 40}{40} + \frac{68 x 30}{30} + \frac{110,5 x 20}{20}$

These errors can arise from a lack of understanding of the rationale behind the formula, procedure and notation. Newman (1977) can categorise it as a comprehension error.

Tutor can point out the error during introduction of mean for grouped data. Notation of formula can be presented in this expanded form:

$$\bar{x} = \frac{1}{n}\sum f_x = \frac{\sum f_x}{n} = f_1x_1 + f_2x_2 + \cdots + f_nx_n$$

The expanded form need to be emphasized to enhance students' understanding of the formula. Asking students to exchange notebooks and mark each others' work with the tutor focusing them on the error points can be useful.

1. Students who do not pay attention to detail presented two incorrect versions of the formula for the median (87%) and mode (93%). The first formula error version was:

$$\text{Median, Me} = \frac{Lm + Cm\left(\frac{1}{2}n - Fm - 1\right)}{f_m}$$

Incorrect division lines

$$\text{Mode, Mo} = \frac{Lm + Cm\,(f_m - f_{m-1})}{2f_m\,(f_{m-1} + f_{m+1})}$$

Lm – the lower class limit of both the median and modal classes is NOT part of the numerator.

This error can be classified as a transcription error resulting from overgeneralised view, failure to understand the formula or faulty sight. Since power-point presentation is used in these lecturers, findings may confirm Howard (2002) who found that older eyes are more susceptible to glare and adapt more slowly to changes in light and dark. This observation calls for more studies to test whether use of power point presentations has an influence on adult students' vision and ultimate learning outcomes.

The second formula error was a result of failure to interpret subscripts (m + 1) and (m-1) in the formula for the mode. This can also be a result of transcription error and limited understanding of the rationale for the location of the mode within the modal class. The incorrect formula presented by students is:

$$\text{Mode, Mo} = Lm + \frac{Cm(f_m - f_{m-1})}{2f_{m-(f_{m-1} + f_{m+1})}}$$

The tutor can reduce this error by introducing mode of grouped data using graphical method in which the mode is estimated from the histogram as shown in fig 1, below.

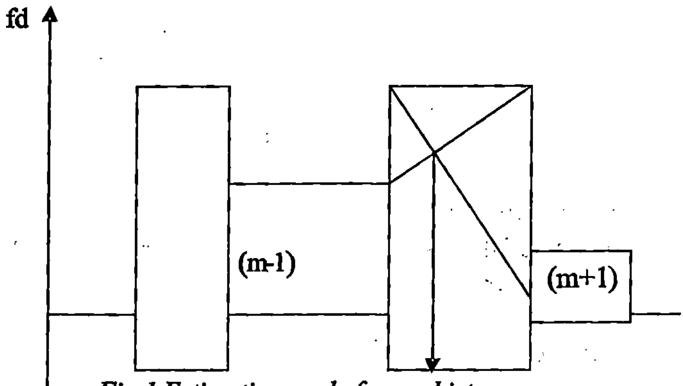

Fig 1,Estimating mode from a histogram

Notation using brackets for subscripts $f_{(m-1)}$ and $f_{(m+1)}$ are locating classes. After students have copied the formula they can exchange notebooks to mark only the formula transcribed.

4. The main solution presentation error was the omission of logical sentences and use of equal signs. It results in meaningless figures such as:

$$\frac{(40 \, x \, 30)}{33} + \frac{(55.5 \, x \, 40}{40} + \frac{68 \, x \, 30}{30} + \frac{110{,}5 \, x \, 20}{20}$$

$$\frac{7790}{123}$$

$$= \underline{63{,}3}$$

Such errors result from students' concentration on computations to get the answer. Bean (2003) expect such errors from surface learners with no background of subject. Tutors can emphasize the need for logical presentation and award no marks for such solutions.

Table 7, Newman's Error Analysis Categories **N=60**

Type of Error category	Frequency
Reading	13 (22%)
Comprehension	27 (45%)
Transforming	35 (58%)
Process or Skill (Application)	46 (77%)
Encoding (Presentation)	51 (85%)

Findings show that the majority of computation errors by masters students start from the transformation (58%) (knowing how to find the answer), through the process (77%) to encoding (85%). When compared to Clements (1980) who found that 50% of Grade 5 to 7 pupils' errors in Papua New Guinea occurred at the reading, comprehension and transformation levels, one can conclude that age and students' experiences account for the differences. Findings by Lankford (1994) which shows that nurses had errors at the comprehension and transformation level suggest that adult learners show errors at higher levels hence remedial activities focused on procedural method are appropriate for adult learners.

Implications for Andragogy

This study suggests that tutors can reduce computation errors for measures of central tendency by: implementing these:

1. Structuring introductory exercises covering basic mathematics concepts such as
   (a)Operation priority order brackets, of, multiplication, division, addition and subtraction (BOMDAS)
   (b)Fractions
   (c)Use of brackets from New General Mathematics, Book 2
   (d)Decimals and percentages
2. Involving students in the collection of data whose mean, mode and median they will calculate, interpret and present during group reporting.
3. Linking graphical presentation for measures of central tendency to the formula.
4. Asking students to exchange and mark each other's notes, during the teaching learning process
5. Encouraging students to explain the procedure as they work out the solution.
6. Teaching for understanding by explaining the rationale for the manipulation of figures and awarding method marks for correct method logically presented.
7. Examples presented on power-point can be complemented by photocopies of the solution given to students as handouts.

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