PRACTICAL NUMERIC AND IT SKILLS MATHS COMPONENT SUMMARY NOTES: A CONTENT ANALYSIS

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Abstract: *This research was conducted to examine the contents of the Practical Numeric and IT Skills Maths Component Summary Notes which has served as the main text used by the lecturers of the Faculty of Foundation Studies. The researcher endeavored to examine the text as regards its learning objectives, mathematical concepts, processes, symbols and errors. Results show that the text consists of 12 units with a total of 43 learning objectives out of which 19 or 44.19% are stated in the "to understand" form and 24 or 55.81% are based on Bloom's Taxonomy. Further analysis discloses that out of the 24 objectives based on Bloom's Taxonomy, 14 or 58.33% are redundantly expressed hence only 10 objectives or 41.67% are explicitly stated. The mathematical concepts which are not fully explained are percentages, variables, numerical and literal coefficients of algebraic expressions, derivations of formulae, and parabolas. The processes which are to be given focus are using the number line in adding and subtracting integers; and making algebraic expressions using variables and not letters. Mathematical symbols such as ( ) and · can simplify working with algebraic expressions. The errors committed in the text are on BODMAS Rule, changing improper fraction to mixed number, finding the value of algebraic expression using substitution, simplifying algebraic expression, and finding the gradient of a line.*

Keywords: *content analysis, Bloom's Revised Taxonomy, learning objectives, mathematics concepts, processes, symbols, errors*

INTRODUCTION

Mathematics is a major component of the General Foundation Programme of the Sultanate of Oman. The Ministry of Higher Education has set standards that focus on the achievement of the students learning outcomes (SLOs). To meet the standards, Gulf College through its Faculty of Foundation has worked painstakingly for the attainment of the SLOs by its multilinguistic and multicultural students. However, the researcher has encountered challenges in teaching both Pure Mathematics to the students of the Faculty of Computing Studies and Applied Mathematics to the students of the Faculty of Business and

Administration Studies. With this she has embarked to set sail in the realm of content analysis to explore its full potential in the sciences.

RESEARCH OBJECTIVES

Generally, the study aimed to analyse the Practical Numeric and IT Skills Maths Component Summary Notes as regards its learning objectives, mathematical concepts, processes, symbols and errors committed. Specifically the research answered the following questions:

1. What percentage of the learning objectives of the text is based on Bloom's Taxonomy?
2. What mathematical concepts are not fully presented?
3. What processes are to be given focus?
4. What symbols can simplify working with algebraic expressions?
5. What errors are committed?

LITERATURE REVIEW

Content Analysis

Terry College of Business of the University of Georgia (TCB-UG) defines content analysis as a research technique used to make replicable and valid inferences by interpreting and coding textual material. By systematically evaluating texts e.g. documents, oral communication, and graphics, qualitative data can be converted into quantitative data. Although the method has been used frequently in the social sciences, only recently has it become more prevalent among organizational scholars.

Content analysis is valuable in organizational research because it allows researchers to recover and examine the nuances of organizational behaviors, stakeholder perceptions, and societal trends. It is also an important bridge between purely quantitative and purely qualitative research methods. In one regard, content analysis allows researchers to analyze socio-cognitive and perceptual constructs that are difficult to study via traditional quantitative archival methods. At the same time, it allows researchers to gather large samples that may be difficult to employ in purely qualitative studies.

Although content analysis is increasingly used by management researchers as a tool to analyse text and qualitative data, many researchers are unfamiliar with the various content analysis techniques and how to deal with challenges inherent in its application. These challenges include finding adequate measures, developing proxy dictionaries and coding

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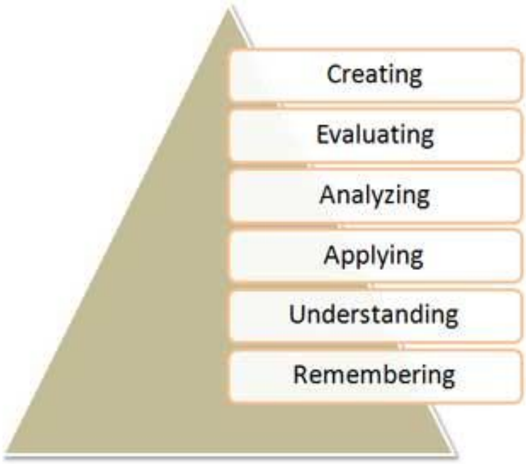
schemes, working with texts from various sources, ensuring reliability and validity, and conducting manual versus computer-aided content analysis (TCB-UG, 2012).

Content analysis is a class of research methods at the intersection of the qualitative and quantitative traditions. It is promising for rigorous exploration of many important but difficult-to-study issues of interest to organizational researchers in areas as diverse as business policy and strategy, managerial and organizational cognition, organizational behavior, human resources, social-issues management, technology and innovation management, international management, and organizational theory (Duriau, Reger, & Pfarrer, 2007).

BLOOM'S TAXONOMY OF LEARNING DOMAINS



Bloom's Taxonomy was created in 1956 under the leadership of educational psychologist Dr Benjamin Bloom in order to promote higher forms of thinking in education, such as analyzing and evaluating concepts, processes, procedures, and principles, rather than just remembering facts is rote learning. It is most often used when designing educational, training, and learning processes (Clark, 2015).

The committee identified three *domains* of educational activities or learning (Bloom, et al. 1956). Cognitive domain refers to mental skills (*knowledge*). Affective pertains to the growth in feelings or emotional areas (*attitude or self*). Psychomotor refers to manual or physical skills (*skills*)

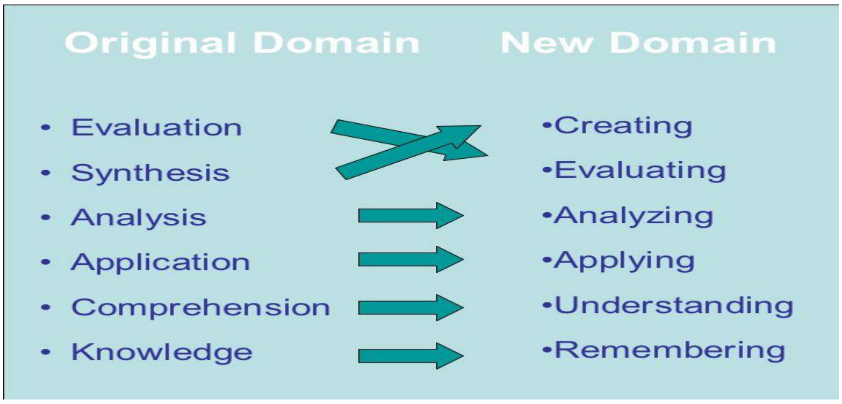
Since the work was produced by higher education, the words tend to be a little bigger than normally used. Domains may be thought of as categories. Instructional designers, trainers, and educators often refer to these three categories as KSA (Knowledge [cognitive], Skills [psychomotor], and Attitudes [affective]). This taxonomy of learning behaviors may be thought of as "the goals of the learning process." That is, after a learning episode, the learner should have acquired a new skill, knowledge, and attitude.

While the committee produced an elaborate compilation for the cognitive and affective domains, they omitted the psychomotor domain. Their explanation for this oversight was that they have little experience in teaching manual skills within the college level. However, there have been at least three psychomotor models created by other researchers.

Their compilation divides the three domains into subdivisions, starting from the simplest cognitive process or behavior to the most complex. The divisions outlined are not absolutes and there are other systems or hierarchies that have been devised, such as the Structure of Observed Learning Outcome (SOLO). However, Bloom's taxonomy is easily understood and is probably the most widely applied one in use today.

Lorin Anderson, a former student of Bloom, and David Krathwohl revisited the cognitive domain in the mid-nineties and made some changes, with the three most prominent ones such as changing the names in the six categories from nouns to verb forms, rearranging them as shown in the chart, and creating a processes and levels of knowledge matrix (Anderson, Krathwohl, Airasian, Cruikshank, Mayer, Pintrich, Raths, Wittrock, 2000).

The chart shows below compares the original taxonomy with the revised one:



Bloom's Revised Taxonomy not only improved the usability of it by using action words, but added a cognitive and knowledge matrix. While Bloom's original cognitive taxonomy did mention three levels of knowledge or products that could be processed, they were not discussed very much and remained one-dimensional. The factual level includes the basic elements that the students must know to be acquainted with a discipline or solve problems. The conceptual level covers the interrelationships among the basic elements within a larger structure that enable them to function together. The procedural level shows how to do something, methods of inquiry, and criteria for using skills, algorithms, techniques, and methods.

In Krathwohl and Anderson's revised version, the authors combine the cognitive processes with the above three levels of knowledge to form a matrix. In addition, they added another level of knowledge – metacognition. Metacognitive level covers the knowledge of cognition in general, as well as awareness and knowledge of one's own cognition.

However, others have identified five contents or artifacts (Clark, Chopeta, 2004; Clark, Mayer, 2007): Facts refer to specific and unique data or instance. Concepts are items, words, or ideas that are known by a common name, include multiple specific examples, shares common features. There are two types of concepts: concrete and abstract. Processes pertain to the flows of events or activities that describe how things work rather than how to do things. There are normally two types: business processes that describe work flows and technical processes that describe how things work in equipment or nature. They may be thought of as the big picture, of how something works. Procedures are series of step-by-step actions and decisions that result in the achievement of a task. There are two types of actions: linear and branched. Principles refer to the guidelines, rules, and parameters that govern. It includes not only what should be done, but also what should not be done. Principles allow one to make predictions and draw implications. Given an effect, one can infer the cause of a phenomenon. Principles are the basic building blocks of causal models or theoretical models.

Smith (2012) suggests that when lecturers begin creating a course, they want to design with the end in mind. The best way to approach this is to start by writing measurable, learning objectives. Effective learning objectives use action verbs to describe what they want their students to be able to do by the end of the course or unit. Aligning assessments with course expectations is much easier when they have written measurable objectives from the beginning.

Here are some examples of learning objectives seen and how they are revised:

Course Level Outcome Examples

Original version: *Understand the American criminal justice system.*

Revised version: *Describe the history of the American criminal justice system.*

Understand is not a measurable verb, however the intent of the lecturer is to have the students be able to describe, which is measurable.

Original version: *Describe and create a social media plan for your organization.*

Revised version: *Create a social media plan for your organization.*

Describe and create are two different levels of learning, and it is strongly suggested that lecturers avoid having more than one action verb. Create is a higher level of learning than describe, therefore it can be assumed that they will be able to describe the process prior to applying it.

Unit Level Examples

Original version: *Understand elements of editing.*

Revised version: *Identify elements of editing, including composition, setting and lighting.*

Understand is not a measurable verb, and it is too broad for a unit level objective. Therefore, the focus has to be narrowed down. (Co-written with fellow Quality Matters expert, Steven Crawford.)

The Number Line in Mathematics

The number line is not just a school object. It is as much a mathematical idea as functions. Unlike the Number Line Hotel, hundreds charts, Cuisenaire rods, and base ten blocks, the number line is not just a pedagogical aid used only to help students learn; mathematicians refer to it, too.

The number line is a geometric “model” of all real numbers -- including 0 1, 2, 25, 374 trillion, and -5, but also 1/2, –17.359, 0.0000000000000001, and pi/6. Unlike counters, which model only counting, the number line models measurement, which is why it must start with zero. When people count, the first object they touch is called "one." When they measure using a ruler, they line one end of the object they are measuring against the zero mark on the ruler. (Education Development Center, Inc. 2016).

RESEARCH METHODOLOGY

Content analysis as a research technique was used in the study. The researcher utilised it based on Terry College of Business of the University of Georgia (TCB-UG) definition that content analysis as a research technique used to make replicable and valid inferences by interpreting and coding textual material. By systematically evaluating texts e.g. documents, oral communication, and graphics, qualitative data can be converted into quantitative data. This study has converted qualitative data on learning objectives into quantitative data. Duriau, Reger, and Pfarrer, (2007) believe that content analysis is a class of research methods at the intersection of the qualitative and quantitative traditions. It is promising for rigorous exploration of many important but difficult-to-study issues of interest.

RESULTS AND DISCUSSIONS

Table 1. Content Analysis on Learning Objectives

Unit	Number of Learning Objectives	Number of "To understand" Objectives	Objectives Based on Bloom's Taxonomy
1	5	5	0
2	2	2	0
3	3	0	3
4	5	2	3
5	3	1	2
6	3	0	3
7	5	1	4
8	5	1	4
9	4	1	3
10	3	2	1
11	3	2	1
12	2	2	0
Total	**43**	**19**	**24**
Percentage	**100%**	**44.19%**	**55.81%**

Table 1 reveals that the text consists of 12 units with a total of 43 learning objectives out of which 19 or 44.19% are stated in the "to understand" form and 24 or 55.81% are based on Bloom's Taxonomy. Smith (2012) opines that *understand* is not a measurable verb, and it is too broad for a unit level objective.

Table 2. Content Analysis on Redundancy

Unit	Objectives Based on Bloom's Taxonomy	Number of Redundant Verbs	Number of Learning Objectives without Redundant Verbs
1	0	0	0
2	0	0	0
3	3	0	3
4	3	0	3
5	2	2	0
6	3	3	0
7	4	4	0
8	4	2	2
9	3	3	0
10	1	0	1
11	1	0	1
12	0	0	0
Total	**24**	**14**	**10**
Percentage	**55.81%**	**58.33%**	**41.67%**

Further analysis discloses that out of the 24 objectives based on Bloom's Taxonomy, 14 or 58.33% are redundantly expressed hence only 10 objectives or 41.67% are explicitly stated. Table 2 shows that in Unit 5, there is redundancy in the two objectives which are *Factorise an algebraic expression by taking out a common factor and by grouping terms;* and *Factorise quadratic expressions.* In Unit 6, the three redundant verbs used are *Solve simple linear equations; solve simple linear equations with brackets; and Solve simple inequalities.* Four objectives in Unit 7 are similarly stated and these are *Transpose formulae where terms are multiplied; Transpose formulae containing fractions; Transpose formulae containing powers and roots; and Transpose formulae whose terms are joined by a plus or minus sign*. In Unit 8, the verb *Find* is repeated as in the given objectives: *Find the gradient and intercept of a straight line;* and *Find the equation of a straight line from its graph.* The repeated verb in Unit 9 is *Solve* as shown by the three objectives: *Solve quadratic equations by factorising; Solve quadratic equations by using the formula;* and *Solve problems which lead to quadratic equations.*

Content Analysis on Mathematical Concepts Presented

The statement *A percentage indicates a proportion* in Unit 1 on page 14 poses confusion among the students as a percentage or percent can be expressed as a ratio which is the relationship of two quantities whereas a proportion is the statement that two ratios are equal. The use of *letter* instead of variable in the discussion on Basic Algebra in Unit 3 on page 25 creates inconsistency in the teaching of this branch of Mathematics as the students are fully knowledgeable of variables even in the secondary level. Coefficient as discussed in Unit 4 on page 41 is not fully explained. Students' learning on coefficients needs to be reinforced by explaining fully the numerical and literal coefficients of a term of any algebraic expressions. Transposing formulae in Unit 7 on page 63 duplicates the transposition in solving for the unknown values. Derivation of formulae as used by other mathematicians seems more appropriate as the learners really have to derive other formulae from a given formula. The smooth *curve* presented in Unit 8 on page 75 is the parabola which the students in Mathematics must know technically. Parabolas are introduced in high school hence there must be continuity in their learning at the tertiary level.

Content Analysis on Processes Undertaken

In using the number line to add and subtract integers, the basic rule is to start at zero and not on a particular number as explained in *Example 1.2.1.1* and *Example 1.2.1.2* of Unit 1 on page 6 which instruct students to start at 2 and 5 respectively. They need to start at zero then move to the right if the integer is positive and to the left if it is negative. Subtracting from an integer means adding the opposite of the subtrahend to the addend. In making algebraic expressions in Unit 3 on page 25, the students must be guided to use variables from a to z in Mathematics and not *letters* from a to z of the English Alphabet as a *letter* stands for itself but not a variable that stands for a lot of values. An introduction on the parts or components of an algebraic expression is necessary to recall lessons learnt in the secondary level. This can be enriched with a simple discussion on monomial, binomial and polynomial by showing the number of terms which boosts collegiate minds.

Content Analysis on Symbols Used

The operational symbol × to mean multiplication can be used with whole numbers but not with algebraic expressions as the symbol will appear like variable x which can cause confusion. In Unit 3 on page 25, it is stated that *the dot is low and not in the middle* which actually must be at the middle so as not to confuse it with a decimal point. In *Example 3.1.1* five times a number can be represented by 5x or 5(x) or $5 \cdot x$ and not 5.x or $5 \times x$. In finding the value of ed^2 in Example 3.2.3.1 item d instead of $e \times d \times d = 5 \times (-4) \times (-4)$ resulting to $(-20) \times (-4) = 80$ it has be as simple as $e(d)(d) = 5(-4)(-4)$ producing $-20(-4) = 80$.

Content Analysis on Errors Committed

Results reveal that there are five errors made in the text. In Exercise 1.1 of Unit 1 item j on page 6 which is $3^2 \times 5$, the answer must be 45 but the given answer on page 17 is 54. On page 12, *Example 1.3.4.3* it is explained that *18 ÷ 5 is an improper fraction, but it can be written as a mixed number as 3 and 2/5. This is found by doing the division 18 ÷ 5 = 3 remainder 2.* The correct answer must be 3 and 3/5 by doing the division 18 ÷ 5 = 3 remainder 3. An error is committed in Unit 3 particularly in *Exercise 3.2B* item g where p = 2, q = 3, r = 4, and s = 5. The value of $2q^2 + 3p^2$ must be 30 and not 48 as the given answer on page 32. In Unit 4, item l of *Exercise 4.3C* which is *7b(3a – b) – 4a(5a – 7b)* the answer must be $-20a^2 + 49ab - 7b^2$ and not $-20a^2 + 49a - 7b^2$ which is the given answer on page 43. A typographical error is found in Unit 8 on page 78 in Example 8.4.1 with the problem, *Find* *the gradient of AB, where A is (1, 3) and B is (2, 11).* Point B must be (5, 11) as explained on page 79. Mathematical errors are mistakes in computation, calculation, estimation, and presentation. This is supported by Dawkins (2017) of Lamar University who has pointed common mathematical errors such as general errors, algebra errors, trigonometric errors, common errors and calculus errors.

CONCLUSION

The percentage of the learning objectives which are based on Bloom's Taxonomy is 55.81% which means 24 out of 43 objectives are measurable. The "to understand" objectives comprising 19 objectives are not measurable hence they need to be revised accordingly. Among the measurable objectives, 41.67% or 10 of them are explicitly stated and 58.33% or 14 are redundantly expressed thus there is a need to recast the latter. The mathematical concepts which are not fully explained are percentages, variables, numerical and literal coefficients of algebraic expressions, derivations of formulae, and parabolas. The processes which are to be given focus are using the number line in adding and subtracting integers; and making algebraic expressions using variables and not letters. Mathematical symbols such as ( ) and · can simplify working with algebraic expressions. The errors committed in the text are on BODMAS Rule, changing improper fraction to mixed number, finding the value of algebraic expression using substitution, simplifying algebraic expression, and finding the gradient of a line.

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