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Measurement of Essential Skills in Mathematics: A Comparative Analysis of SSC (Grade-X) and GCE (O-Level) Exam Papers

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Abstract

The major focus of school education is the intellectual development of students and mathematics is a very effective subject in this regard, if taught and assessed properly. For this study, papers of SSC (Grade-10) for the years 2014 and 2015 set by the Board of Secondary Education, Karachi were scrutinized to know if the items of these papers had measured essential mathematical skills or not. These items were then compared with the items set by General Certificate of Education (GCE: O-Level), University of Cambridge Local Examinations Syndicate (UCLES) for mathematics papers, serving as a benchmark for this study to highlight the shortcomings. The results revealed that the items of SSC papers were highly biased towards 'Factual Knowledge' and 'Routine Procedures'. The study concluded that these items assess knowledge of facts and algorithms only and do not measure essential mathematical skills (involvement of higher levels of thinking processes) of students. The study recommends to improve the items of papers so that essential mathematical skills can be measured rather than the capacity of memorization because with this practice, thinking habits cannot be inculcated among students.

Keywords: assessment items, cognitive demands, essential skills, intellectual development

Introduction

One of the fundamental aims of mathematics education is the development of cognitive faculties of the students (Sidhu, 2008; Taneja, 1990). The development of inner intellectual faculties (Bruhlmeier, 2010) and mathematisation of the thought processes of growing children (NCERT, 2006) is the key concern of modern education systems. The assessment items of these systems are very carefully constructed (Hargreaves, Earl, & Schmidt, 2002). These items not only measure the basic computational skills of mathematics, but also the higher order thinking skills and the level of the thinking process applied by the students in solving a certain problem (D'Souza & Wood, 2003; Sullivan, 2011).

It is a fact that students study to succeed in the examination with the highest possible grade and prepare for their exams in accordance with the assessment scheme prevalent in that system (Lianghuo, 2004). They prepare in the light of past examination papers to get the idea of types and level of questions coming in the papers. Through examination items, the examiner, in fact sends a message to the teachers and students that what is of value and what should be taught or studied to perform well in the exams. In response, the teaching-learning activities of the schools are planned and executed (Race, 2005; Struyven, Duchy, Janssen, 2005). Hence, the shortcomings in assessment items can adversely affect the whole teaching-learning process and can obstruct in attaining the real aims (development of cognitive faculties and higher order thinking skills) of mathematics education.

Unfortunately, in Pakistan the items of mathematics assessment are not carefully constructed in Secondary School Certificate (SSC) Examinations. Textbook questions which demand recalling of the memorized factual and procedural knowledge are focused on. They do not assess higher mental functions like individual thinking, creative thinking, problem solving, critical thinking and logical reasoning (Das, 2006). As students find the same textbook content in previous year exam papers, they memorize the content through reiteration and get good scores. Since the items do not demand application to a novel and practical situation, the use of higher order thinking skills are not required (Tayyaba, 2010). The knowledge of correct formula or proper algorithm is enough to solve these problems correctly. As a result, students and teachers fail to go beyond a mechanical reiteration of textbook questions in mathematics (Amirali & Halai, 2010). This damages the impact on the standards of mathematics education in schools. According to Tahir

(2005), deploying higher order thinking skills which is the core aim of mathematical processes at school level, has been adversely affected due to this practice.

Das (2006) highlights that the achievement level of students in mathematics is quite low as compared to other subjects. Arif (2010) concludes that the students perform well in the questions where routine procedures are to be employed and their performance is poor if they are given questions that require higher order cognitive skills. Mustafa (2011) states that students can pass the exams, even with high grades by merely memorizing factual and procedural information and without having truly understood the concepts. As the exam-items demand a vast amount of facts and procedures to be retrieved from memory instantly, it also induces stress and anxiety in students that result in fear for mathematics and is one the reasons for poor performance and high dropout rates.

General Certificate of Education (GCE) is another education system running parallel with SSC system in Pakistan. The students of this system are far ahead in their mathematical skills than the SSC system, which is due to their good examination system. The items of mathematics exams under this system demands higher level of thinking processes and application of concepts in real-life situations. Thus, producing students whose intellectual abilities are fairly good and who are quite competitive with the requirements of the modern mathematics education. SSC and GCE systems are creating a clear discrimination between students in regard to mathematical skills development, which is not good for the country. Due to the seriousness of the issue and reasons cited above, it is quite pertinent to take a deeper comparative look into the assessment schemes of SSC and GCE exams.

Since the intent of contemporary mathematics instruction is to promote the acquisition of mathematical thinking, intellectual curiosity and reasoning skills, it is imperative to ensure that assessment items in mathematics papers are measurable. This study scrutinizes 2014-2015 exam papers of both SSC and GCE examination boards and aims to examine the cognitive demands the items of these papers have made on students. The main objective of the study was to derive a set of essential mathematical skills needed to be assessed at school by comparing the items of exam-papers of the two systems.

Research Questions

1. How far are the mathematics papers of SSC system comparable with GCE papers in terms of measuring the essential mathematical skills?

    i. What are the levels of cognitive demands the items of mathematics papers (BSE Karachi, Grade-10) and GCE (UK system) mathematics papers made on students?

    ii. How far the papers of these systems different in measuring higher order thinking skills within their common content domains.

Methodology

The quantitative research approach was adopted for this study. The study compared the items of mathematics papers of SSC (Grade-X) and GCE (O-Level) for the years 2014 and 2015. A set of assessment standards derived from the review of the literature, particularly the MATH taxonomy was used to study the patterns of the items in these question papers and document the cognitive demands they made on students.

Sample

Two mathematics papers (2014 & 2015) from each of the two examination boards were selected as a sample to use in this study. (i) The GCE (O-Level) mathematics papers (4024/12/M/J/14 & 4024/22/M/J/14) set by the University of Cambridge Local Examinations Syndicate (UCLES) served as the benchmark. (ii) The SSC (Grade-X) papers set by the Board of Secondary Education, Karachi (BSEK) were included in the materials to be investigated.

Research Instrument

The instrument used to examine and compare the cognitive demands of the test items in this study was the model of MATH Taxonomy (Smith et al., 1996) given in Tables 1 and 2. This is a modified version of the Bloom's taxonomy of Cognitive Domain (Bloom, Englehart, Furst, Hill, & Krathwohl, 1956). This taxonomy was developed to help mathematics teachers, who were facing difficulty in interpreting the thinking skills in Bloom's taxonomy and in creating test items for higher-order thinking abilities (Thompson, 2008) and also for the structuring of

assessment tasks. It includes eight categories of mathematical knowledge and skills and were arranged in three groups A, B and C. The eight categories given in Table 2 are ordered by nature, not by the difficulty level of the activity required to complete a task successfully (Smith, et al., 1996).

Table 1

The MATH (Mathematical Assessment Task Hierarchy) Taxonomy

Group A	**Group B**	**Group C**
(A1) Factual Knowledge	(B1) Information Transfer	(C1) Justifying and Interpreting
(A2) Comprehension	(B2) Application to New Situation	(C2) Implications, Conjectures & Comparisons
(A3) Routine Procedures		(C3) Evaluation

From MATH Taxonomy (Smith et al., 1996)

Table 2

Description of Categories in MATH Taxonomy

Categories	**Code**	**Description of Behavior**
Factual Knowledge	A1	• Recall of learned facts e.g. a formula or a definition. • Replication of the solution of questions.
Comprehension	A2	• The ability to examine, understand and draw relative information from the given situation. • The competence to translate the obtained meanings to problem solving. • The capacity to extrapolate.
Routine Procedures	A3	• Carrying out all the steps precisely to solve a sum.
Information Transfer	B1	• Transformation of data from one form to another, e.g. numerical to graphical. • Recognition of the appropriateness of a formula in a situation. • Recognition of the unsuitability of a formula in specific situations. • Elaboration of mathematical ideas in non-technical terms. • Construction of a mathematical argument from a verbal outline. • Explanation of the relationships between the elements of a mathematical content. • Explanation of the mathematical processes. • Reconstruction of a mathematical argument in a logical order.
Application to New Situations	B2	• Application of suitable methods or knowledge to new situations. • Solution of an unseen question for the first time.
Justifying and Interpreting	C1	• Justification and/or interpretation of a given result. • Finding inaccuracies in reasoning, recognizing computational limits and sources of error. • Discussing the significance of examples and counter examples.
Implications, Conjectures and Comparisons	C2	• Drawing implications for using certain steps or procedures in a particular problem. • Making conjectures astutely, and proving them accurately. • Analysis of data by comparing and contrasting.
Evaluation	C3	• Use of set criteria to assess the value of data for specific purposes such as drawing conclusions; selecting the relevant material or procedure; reviewing the usefulness of an algorithm; use of organizational skills in restructuring given material to view it in a different perspective. • Thinking creatively (individual thinking).

Adapted from MATH Taxonomy (Smith et al., 1996)

Data Collection and Analysis

To compare the items, four content domains were selected from their common contents, namely Numbers and Operations (N & O), Algebra (A), Measurements and Geometry (M & G) and Information Handling (IH). SSC papers of last 20 years (1996-2015) were reviewed to find out the source of items and their possible reiteration during these years.

Table 3

Common Content Areas of SSC and GCE***

(i) Numbers and Operations (N & O)

- Real numbers, irrational numbers & use of number line.
- Addition, subtraction, multiplication, determinants and inverse of 2-by-2 matrices.
- The solution of two simultaneous linear equations using matrices.
- Set, complement, union, intersection and Venn diagrams.
- Basic operations on surds of second order.
- Ratio, rate & proportions.

(ii) Algebra (A)

- Factorization of algebraic expressions.
- Finding of HCF, LCM and square root of algebraic expressions.
- The solution of two linear equations by algebraic methods.
- The solution of linear inequalities.
- The solution of quadratic equations.
- Analyzing attributes & forming of quadratic equations.

(iii) Measurement and Geometry (M & G)

- Use of trigonometric identities to verify relationships between trigonometric ratios.
- Properties of angles, triangles, parallelograms and circles.
- The solution of a right triangle.
- Basic concepts of circle (circumference, chord, secant, tangent).
- Construction of triangles, right bisectors of sides & angle bisectors.

(iv) Information Handling (IH)

- Definition of key terms, types of variables, types of data.
- Collection and presentation of data.
- Frequency distribution, graphs (histogram and frequency polygon).
- Bar graphs, pie diagrams.
- Mean, median & mode their merits & demerits.

SSC = Secondary School Certificate Examination (syllabus of mathematics for grade X)

**GCE = General Certificate of Education (syllabus-D-4024 for O-Level)

The inter-coder reliability of the instrument was calculated using the model adopted by Fong and Kaur (2015). The two authors of this study independently reviewed and ranked the items of papers against each category of MATH taxonomy. They categorized the items of both SSC and GCE papers one by one and the results

were compared to arrive at a consensus and finally checked the reliability of coding. Out of 44 questions/part questions, the codes for 41 were matched with SSC papers. Similarly, out of 121 questions/part questions, the codes for 106 items coincided. The 3 items from SSC papers and 15 items from GCE paper that had different coding were discussed and arrived at agreement.

Hence the inter-coder reliability for SSC papers was 93.2% [(41÷44) ×100% = 93.2%] and for GCE papers it was 87.6 %[(106÷121) ×100% = 87.6%].

Findings

For this study, the researchers examined items of question papers of mathematics against the different categories of MATH Taxonomy (Smith et al., 1996). The researchers selected two year's (2014/2015) papers of SSC mathematics, set by Board of Secondary Education Karachi (class X) and measured the level of intellectual demand these items have made on students. The same year's papers of General Certificate of Education (GCE: O-Level), set by the University of Cambridge Local Examinations Syndicate (UCLES) were also examined and compared with SSC papers. GCE papers served as benchmark papers in order to highlight the shortcomings in the SSC items in comparison to GCE.

The following table presents the results of the review of papers, conducted to distribute items of these papers in regard to the level of intellectual demand they made on students.

Table 4

Distribution of Items in the Categories of Cognitive Demand

Category	*Percentage(%),by weight-age of marks allotted to questions/part question*			
	SSC Annual (2014)	**SSC Annual (2015)**	**GCE 4024(12&22) (M/J/2014)**	**GCE 4024(12&22) (M/J/2015)**
A1	57.24	60.69	P1(04.50) & P2(01.79)	P1(03.25) & P2(03.57)
A2	03.75	02.68	P1(20.50) & P2(21.43)	P1(19.25) & P2(17.86)
A3	39.01	36.63	P1(41.25) & P2(25.89)	P1(43.50) & P2(28.57)
B1	---	---	P1(12.50) & P2(17.86)	P1(10.00) & P2(16.96)
B2	---	---	P1(11.25) & P2(23.32)	P1(12.50) & P2(21.43)
C1	---	---	P1(01.25) & P2(05.36)	P1(05.00) & P2(06.25)
C2	---	---	P1(05.00) & P2(01.67)	P1(03.75) & P2(03.57)
C3	---	---	P1(03.75) & P2(02.68)	P1(02.75) & P2(01.79)

Note. A1 = Factual Knowledge; A2 = Comprehension; A3 = Routine Procedures; B1 = Information Transfer; B2 = Application to new situation C1 = Justifying and Interpreting; C2 = Implications, Conjectures and Comparisons; C3 = Evaluation; P1 = (M/J/12/2014); P2 = (M/J/22/2014).

The above table shows that items of SSC papers have a clear bias towards the assessment of factual knowledge A1 [2014 (57.24%) & 2015 (60.69%)] and to the application of routine procedures A3 [2014 (39.01%) & 2015 (36.63%)]. No item of SSC papers was found in B1/B2 or C1/C2/C3 categories. On the other side, GCE paper-I was also inclined towards A3 [2014(41.25%) & 2015(43.50%)], but, GCE papers were balanced in a way that they contained items falling in each category of MATH taxonomy. A suitable number of items of GCE papers were found challenging, demanding a variety of higher cognitive skills. These findings are aligned with the aims of teaching mathematics at school level (NCERT, 2006).

Items of SSC papers were scrutinized to get a deeper insight about their source, nature, pattern and level of cognitive demand. As there was a difference in the course contents of the two systems, the common content areas of the two syllabi were selected and divided into four domains, that is, Numbers and Operations (N&O); Algebra (A); Measurement and Geometry (M&G) and Information Handling (IH) for comparison. Contents of the SSC papers in each domain were analyzed and compared with GCE (O-Level) contents, which are taken as a benchmark in this study. The results of content analysis of SSC papers are given in the following tables.

Table 5a

Items of SSC Papers from 'Numbers and Operations'

Year/Q. #	Domain	Questions	Category
2014 (Q2)	Numbers and Operations (N&O)	If U= {1,2,3,4,5,6,7}, A= {1,3,5,7} and B= {3,4,5,6}; prove that A′ ∪ B′= (A∩B)′	
2015 (Q2)		If A= {a,b,c} and B= {x,y}, find only two binary relations in A×B.	
2014 (Q3)		Simplify $\left(\frac{(125)^2 \times 8}{(64)^2}\right)^{\frac{1}{3}}$	
2015 (Q3)		Simplif $\sqrt{\frac{(216)^{\frac{2}{3}} \times (25)^{\frac{1}{2}}}{\frac{1}{25}^{-\frac{3}{2}}}}$	
2014 (Q7)		Solve the following equations with the help of matrices: 5x – 2y =1 & 2x – y = 0	
2015 (Q8)		If $A=\begin{bmatrix}3 & 2\\ 5 & 4\end{bmatrix}$; find A^{-1} and verify that $AA^{-1}=I$	
Total Questions.	2014 (3)		A1(2) A3(1)
	2015 (3)		A1(2) A3(1)

Note. From "Board of Secondary Education Karachi (BSEK), mathematics paper (Grade: X/Science Group), Annual Exams, 2014/2015".

In Table 5a, Q2/2014 requires proof of De Morgan's law. This question was found consistently in BSEK papers of last 20 years i.e. (2012/Q2); (2008/Q2a); (2007/Q2b); (2006/Q2a); (2005/Q2a); (2004/Q2b); (2003/Q2a); (2002/Q2a); (2001/Q2a); (2000/Q2a); (1999/Q2a); (1998/Q2a); (1997/Q2a). The Q2/2015 (the Cartesian product) has also been found repeatedly in past exam papers i.e. (2013/Q2); (2009/Q2b); (2006/Q2b); (2003/Q2b); (2001/Q2b); (1999/Q2b); (1996/Q2b). These questions are found in a set pattern that demands the application of routine procedures only.

The Q3/2014 & Q3/2015 (table 5a) were taken from the textbook exercises (Ex2.7/Q10 & Ex. 2.7/Q12 respectively). A clear pattern and consistent repetition of questions from Ex.2.7 were found in the past papers. The question on this topic has always been taken from Ex.2.7 (Q6 to Q12) during the years (1998, 1999, 2002, 2004, 2005, 2006, 2009, 2010, 2012, 2013, 2014, and 2015).The Q7/2014 & Q8/2015 (Table 4a) are the worked examples of the textbook (Ex. 7.5/example1 & Ex 7.4/example1 respectively).

Table 5b
Items of SSC papers from 'Algebra'

Year/Q. #	Domain	Questions	Category
2014 (Q6)	Algebra (A)	Factorize: $r^2(s-t)+s^2(t-r)+t^2(r-s)$	A1
2015 (Q6)		Factorize: $4a^2(3b-4c)+9b^2(4c-2a)+16c^2(2a-3b)$	A1
2014 (Q9)		Solve the equation $2b^2-7b+5=0$, using quadratic formula	A3
2015 (Q7)		-6 +|5x-3|=3	A1
2014 Q18)		Find the solution set graphically of the following simultaneous equations: $x-2y=-3$ & $2x+y=14$	A3
2015(Q18)		Find the solution set graphically of the following simultaneous equations: $3x-11=y$ & $-3y=9$	A3
Total Questions.	2014 (5) 2015 (5)		A1(3) A1(4) A3(2) A3(1)

Note. From "Board of Secondary Education Karachi (BSEK), mathematics paper (Grade: X/Science Group), Annual Exams, 2014/2015".

The Q6/2014 & Q6/2015 (table 5b) are from the textbook (Ex5.6/Q2 & Ex 5.6/Q7 respectively). One question from this exercise can be seen in the last five year's papers (2013/Q6; (2012/Q2); (2011/Q1); (2010/Q1). The Q9/2014 (application of quadratic formula) was taken from Ex 6.8/Q5. One question has been taken from Ex 6.8 during (2013/example1; 2012/Q5; 2011/Q1; 2010/2013/example1). The Q18/2014 & Q18/2015 (table 4b) were taken from the textbook (Ex6.2/example3 & Ex 6.2/Q1 respectively). A question of 10 marks from this exercise is present in the papers of the last 20 years.

Items of the papers from this domain (Algebra) were also textbook questions. Thus, the cognitive demand made by these items was mainly of factual knowledge belonging to A1 category of MATH taxonomy and it never went beyond employing routine procedures (A3).

Table 5c
Items of SSC papers from 'Measurement & Geometry'

Year/Q. #	Domain	Questions	Category
2014(Q15)	Measurement & Geometry (M&G)	Prove that the sum of angles of a triangle is always 180°	A1
2015 (Q9)		If a side of a triangle is extended the exterior angle so formed is, in a measure, greater than the either of the two interior opposite angles, prove it.	A1
2014(Q16)		Find the values of the trigonometric ratios of the angle 30°	A1
2015(Q12)		If sin θ=3/5, find the remaining trigonometric ratios, using trigonometric identities	A2
2014(Q21)		Draw direct common tangents to a the circle	A1
2015(Q21)		Construct a triangle and draw in circle	A1
Total	2014 (5)		A1(5) A2(0)
Questions.	2015 (6)		A1(5) A2(1)

Note. From "Board of Secondary Education Karachi (BSEK), mathematics paper (Grade: X/Science Group), Annual Exams, 2014/2015".

In this domain (Table 5c) proofs of those theorems of geometry were required that are already proved in the textbook. Students learn these theorems by heart and replicate them in the exams. Questions have never been given where arguments and their logical reasoning are required to prove (Ex12.1 – Ex12.17 & Ex13.1 – Ex13.7) during the last 20 year's papers. Moreover, drawing of the inscribed/circumscribed

circle of a triangle or direct/transverse common tangents to a circle was always required in practical geometry. In this way, items from this content domain always fall in factual knowledge (A1) category of the MATH taxonomy.

Table 5d
Items of SSC papers from 'Information Handling'

Year/Q. #	Domain	Questions	Category
2014(Q20)	Information Handling (IH)	Find the variance from the following information $\overline{x}$ = 19.5, n=10, $\sum x^2$ = 5555	A1
2015(Q20)		A set of data contains the values as 148, 145, 160, 157, 156, 160, 160, 165, show that the *mode >median>mean*	A1
Total Questions	2014 (1) 2015 (1)		A1(1) A1(1)

Note. From "Board of Secondary Education Karachi (BSEK), mathematics paper (Grade: X/Science Group), Annual Exams, 2014/2015".

The items of the papers in this domain (Table 5d) were also taken from the textbook. Questions on mean/median/mode were mostly given with a fixed design. Items of SSC paper in this domain were always found related to A1 and/or A3 category. Being textbook questions, these items are not novel for students, they would have been solved several times as a practice and preparation for paper, so, these items would fall in the factual knowledge (A1) category.

The results of the distribution of the items in different categories, on the basis of the divisions of MATH taxonomy is presented in Table 6.

Table 6

Comparison of Cognitive Demand of SSC and GCE Items Within Their Common Content Domains

	Percentage(%), by weight-age of marks allotted to questions/part questions	
	SSC	**GCE**
Domains	**Annual-2014/15**	**M/J-2014/15**
(N&O)		
A1	66.67	00.00
A2	00.00	09.82
A3	33.33	58.43
B1	---	20.11
B2	---	01.50
C1	---	07.42
C2	---	01.88
C3	---	00.84
(A)		
A1	70.00	01.35
A2	00.00	08.50
A3	30.00	62.40
B1	---	18.74
B2	---	01.73
C1	---	02.48
C2	---	01.82
C3	---	01.98
(M&G)		
A1	90.91	02.45
A2	09.10	20.72
A3	---	35.24
B1	---	07.60
B2	---	01.28
C1	---	28.76
C2	---	03.35
C3	---	00.60
(IH)		
A1	100	03.32
A2	---	16.49
A3	---	59.67
B1	---	03.40
B2	---	01.85
C1	---	01.25
C2	---	12.20
C3	---	0182

Note. N&O = Numbers and Operations; A = Algebra; M&O = Measurement and Geometry; IH = Information Handling

The above results show that there is a significant difference in the percentage of items given in each category of SSC and GCE (O-Level) syllabi. This indicates that items of SSC papers are completely different with respect to their cognitive demand as compared to GCE.

Table 7
Distribution of Groups of Cognitive Demand Across Four Domains

	Percentage(%), by weight-age of marks	
	SSC	**GCE**
Domains	**Annual-2014/15**	**M/J-2014/15**
(N&O)		
A	100	68
B	0	21
C	0	11
(A)		
A1	100	72
A2	0	20
A3	0	8
(M&G)		
A1	100	58
A2	0	8
A3	0	34
(IH)		
A1	100	79
A2	0	5
A3	0	16

Table 7 shows that items of SSC papers are completely focusing on measurement of knowledge objectives (Group-A) in all domains of syllabus without even touching the other groups (B & C). On the other side, GCE items are well distributed in all groups.

Discussion

This study was conducted to examine the items of SSC papers in order to answer the research questions: How far these items are effective in measuring the essential thinking skills of students? How far, these items are fulfilling the underlying core objectives, that is, development of higher levels of cognitive skills, proficiency in problem solving and habits of logical thinking of teaching mathematics. How far do these items comply with the objectives set by the national mathematics

curriculum document (MOE, 2006)? The results of content analysis of the selected papers show that nearly all items of SSC papers lie in Group-A and within this group, the items are mostly inclined towards A1 category [2014(57.24%) & 2015 (60.69%)]. Nearly all the remaining items fall in A3 category [2014(39.01%) & 2015 (36.63%)]. A very low proportion of items [2014(3.75 %) & 2015 (2.68%)] belong to A2 category in this group. Hence, it can be concluded that SSC papers primarily focus on the measurement of knowledge of contents and algorithms.

The results of this study also reveal that the items used in SSC mathematics papers are just a copy of textbook questions. Students have done textbook questions a number of times prior to the exams and become quite familiar with them. As a result, during exams their thinking process starts from recognizing the question where it was previously done, recalling the procedural steps of that question and finally replication of its solution. Consequently, their thinking processes do not go beyond factual and procedural knowledge. Hence, it can be concluded that the use of textbook questions is one of the major weak points in SSC papers. The results of this study are in conformity with the findings of some previous studies conducted by Kiyani (2002), Das (2006), Arif (2010) & Mustafa (2011).

There is a need for paradigm shift in the assessment scheme of SSC Board Exams. Board exams should use novel items construction to assess students' abilities in all areas of MATH taxonomy. Paper setters should focus equally on setting the items (items that measure skills in all areas of the cognitive domain) and on setting the papers (papers that cover all areas of the content domain). Teachers and paper setters should also focus on the process of mathematisation, that is, thinking mathematically rather than simply focusing on content knowledge while teaching and assessing. This change is not only necessary for the intellectual development at student level, but is also required on a national level as the two systems (SSC/GCE) are creating a huge wall of difference in the level of cognitive abilities, application competencies and problem-solving skills between the students of the two systems.

Conclusion and Recommendations

The study concluded that the items of SSC papers by and large fall in Group-A of the MATH taxonomy and are highly biased towards A1 and A3 categories indicating that these items largely assess the lower cognitive skills (recognition, recall and duplication) of memorized facts and/or over-learned

solutions of problems/proofs of theorems and/or imitation of the procedures to construct specific geometrical figures. These items do not demand the application of higher cognitive skills and are not comparable with the items of GCE (O-Level), which is an internationally recognized system of education running parallel to the SSC system; therefore, there is a drastic need to change the assessment style in mathematics in the SSC Examination Board in order to measure the essential mathematical skills of students and achieve the real aims of teaching mathematics.

The study recommends constructing original items for mathematics papers, which are previously unseen to students and should demand employment of skills given all categories (A, B and C) of MATH taxonomy in proper proportion. The study emphasizes to focus on thinking habits among students in mathematics and this cannot be done by assessing the capacity of memorization of mathematical content and procedures, which is the current practice during SSC Board Exams.

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