A Comparative Analysis of the Effectiveness of Mathematics Curriculum Taught at GCE (O-Level) and SSC Systems of Schools in Karachi

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ABSTRACT

This study compares the mathematics curricula of General Certificate of Education (GCE: O-Level) and Secondary School Certificate (SSC: Matriculation) courses of studies. The purpose of this comparison was to trace out the factors accountable for the shortcomings in instructional objectives, contents, approaches, methods of teaching and patterns of assessment in the local (SSC) system of education. The population of study was all teachers, students and textbooks of SSC and GCE systems in Pakistan. The overall size of the sample was of 300 teachers, 200 students and 20 subject experts. The data were collected through questionnaires, interviews and document/ record analysis. The quantitative data were analyzed by using t-test. A comparative content analysis was made for the textbooks and question papers of both SSC and GCE examination boards. The study concluded that the implementation of GCE (O-Level) mathematics curriculum is relatively more effective than SSC curriculum although no significant difference was been found in the methods of teaching in two systems. The major factor for the difference was the structure of examination in both systems. The other key factor traced out as major contributor in this difference of effectiveness was the approaches of teachers and students. The study recommended a radical change in the internal school examinations as well as the pattern of assessment of Board of Secondary Education Karachi (BSEK). It has also been strongly recommended to convert the approaches of teachers and students of SSC from accumulation of content and procedural knowledge towards the construction (problem solving) and application of knowledge.

Keywords: GCE (O-Level), SSC (Matriculation), mathematics curriculum, approaches, methods, contents, assessments

INTRODUCTION

It is a well-known fact that school education, especially secondary education is a key for success in overall educational attainment because it is where students can either "make it or break it" (World Bank, 2013; OECD, 2011) and the most significant subject in the secondary school curriculum is mathematics (Sullivan, 2011; Rani, 2008; Sharan and Sharma, 2008; Sidhu, 2008; Kaur, 2004; Becker et al., 1990). It helps to attain a number of expected educational outcomes (Bruhlmeier, 2010; Sidhu, 2008; Sharma 2008; Ediger & Rao, 2000; Cockroft, 1982).

The worth of this subject has been recognized by different authorities at different times (NCERT, 2006; Cockcroft, 1982; Sharif Commission, 1959). Zakir Hussain Committee in the subcontinent in 1937, the Secondary Education Commission India in 1952 & Kothari Commission India in 1964, all put a special emphasis on mathematics education at school level (Rani, 2008; Sharan and Sharma, 2008; Sidhu, 2008).

The common feature of the school education in the Asian countries, especially the East Asian countries, is a special emphasis and focus on mathematics (Tu, 2010; Soh, 2008; Lim, 2007; Ginsberg et al., 2005; Kaur, 2004; Mastrul, 2002; Skiba, 2001). The other interesting thing common which is an obvious output of this special attention is the outstanding results of the

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students of these countries in the successive international studies conducted during last 20 years (TIMSS, 2011; TIMSS, 2007; TIMSS, 2003; TIMSS, 1999 & TIMSS, 1995; PISA, 2012; PISA, 2009). Another noticeable interesting common feature is the boost in the economic growth of these countries during the first decade of this century (ISR, 2011, p.54).

The General Certificate of Education (GCE: O-Level) is a UK based prestigious and internationally recognized qualification while its equivalent in local system of Pakistan is the Secondary School Certificate (SSC: Matriculation). Both systems are running side by side (Umbreen, 2008). Karachi is the largest city of Pakistan and due to a high cultural and ethnic diversity in its population; it is often called as mini-Pakistan. In Pakistan GCE program is being offered since 1959.There are many institutions which offer GCE (O-Level) to the students but the number of recognized institutions in the British Council is 432 and out of which 130 are located in Karachi (British Council, 2012).

The studies conducted in Pakistan reveal that, in our schools running under local (SSC) system, the subject of mathematics is not taught as its nature demands, it is taught in a traditional lecture method where mostly the content and procedural knowledge is dispensed (Amirali & Halai, 2010; Tayyaba, 2010; Das, 2006; Tahir, 2005; Warick & Reimers, 1995).In the neighboring Asian countries like China, Singapore and Japan equal focus on the process of doing mathematics (problem solving) and learning the contents of mathematics using both intrinsic and extrinsic motivation of students is given (Tu & Shen, 2010; Lee, 2008; Lim, 2007; Zhang.et al., 2004). Special emphasis on mathematics is the salient feature of school education in these Asian countries (Yoshikawa, 2008; Soh, 2008; Lesh & Zawojewski, 2007; Stacey, 2005; Kaur, 2004; Mastrul, 2002; Skiba, 2001; Becker et al., 1990).

Comparative studies provide opportunities to share the experiences and to learn from each other (Mundy & Schmidt, 2005). A number of comparative studies have been conducted in different areas of teaching and learning worldwide. In Pakistan comparative studies have been conducted in some subjects (Naeem, 2011; Naeemullah, 2007; Kayani,2002) but no significant research work has been carried out to make the comparison of the GCE (O-level) and the SSC education with a special reference to mathematics (Arif, 2011).

This comparative study has been conducted on mathematics curricula in schools offering SSC / GCE or both systems of education in Karachi to probe the issue at large.

RESEARCH QUESTION

How the components of GCE (O-Level) mathematics curriculum work in making it more effective than the SSC curriculum?

Subsidiary Research Questions

1. How are the learning experiences of the students different in both systems?
2. What is the difference in the approaches/methods of teachers in both systems?
3. How far students are different in taking examinations in both the systems?
4. How far contents of both the courses are different?
5. What are the study patterns of students in both systems?

METHODOLOGY

The overall study was conducted adopting a survey methodology.

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Strategy of Research

The research was aimed to make a comparative study of the Secondary School Certificate (SSC: Matriculation) and the General Certificate of Education (GCE: O-level) mathematics Courses in Karachi. The strategy of research was a mixed research approach (both quantitative and qualitative).

The population of the study was comprised of teachers, students, prescribed text books of mathematics taught at SSC and GCE (O- Level) and the question papers of Board of Secondary Education Karachi (BSEK) and Cambridge International Examination (CIE) Board.

Stratified random sampling design along with purposive sampling design was adopted and a sample of total 300 teachers (SSC: 180& GCE: 120), 200 students (SSC: 120&GCE: 80) and 20 subject experts (SSC: 10&GCE: 10).A benchmark of 15 years or above of mathematics teaching (SSC/GC) was adopted for subject experts in this study. Data were collected from 250 schools (SSC: 180 & GCE: 70) located in five districts (District East, District West, District South, District Central and District Malir).

Research Instruments

Questionnaires were developed on the basis of objectives of study in the light of related literature and the works of previous researchers (Kiyani (2002, p.291; Naeemullah, 2007, p.175; Umbreen 2008, p.185 & Naeem, 2011, p.226). A questionnaire comprising up of 100 items was used to collect data from teachers of both the systems. The opinions of students of both systems were collected through a questionnaire containing 80 items. A structured interview process containing 14 open-ended items was designed and administered from the Subject Experts of the both systems.

Data Collection and Analysis

Data through questionnaires and interviews were collected by visiting the sample schools. Collected data were converted into numerical scores and tabulated on MS Excel 2010. The analysis and interpretation for the comparison of the responses of the two groups was done by t-test. A comparative analysis of the contents of textbooks used in both systems was conducted. In addition to this, a critical comparison of the contents of exam-papers was done through personal investigation of the records of previous 20 years of question papers of both Board of Secondary Education Karachi (BSEK) and Cambridge International Examinations (CIE) for SSC and GCE mathematics course respectively.

FINDINGS AND DISCUSSION

The research findings of this study are divided into two sections. The first section is based on the responses of teachers and students against the items of questionnaires given to them. The responses of subject experts derived from the interviews are also included in this section, while the second section discusses the issues, derived from the contents of the textbooks and question papers of the examination boards (BSEK/CIE) of both systems (SSC/GCE).

Section I

The items of questionnaire for teachers were analyzed on by using t-test. The items were analyzed at five-point rating scale (SA, A, U, DA & SDA). For convenience to infer the 'Strongly Agree' and 'Agree' are collapsed in *'Agreed'* while 'Strongly Disagree' and Disagree' are collapsed in *'Disagreed'*. The following table shows some results out of 100 items of teachers' responses.

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Table 1. Showing some results of teachers' responses

Item Nos.	Items	t-value	H_0 Accepted / Rejected	A* (%)		DA* (%)	
				SSC	GCE	SSC	GCE
3.	Mathematics is important because it trains the mind**.**	0.729	Accepted	90.8%	96.3%	0.8%	2.55
11.	Objectives of mathematics education are clearly transmitted to teachers.	2.261	Rejected	57.8%	76.7%	29%	15%
24.	The contents contain a suitable proportion of sums on the application of mathematics in real life situations.	3.275	Rejected	54.4%	73.3%	29%	12%
40.	Additional material is usually used for rigorous drill of learned material.	0.088	Accepted	73.4%	68.4%	16%	15%
44.	Past papers are solved because questions from previous papers often repeat in successive years.	2.313	Rejected	67.2%	41.4%	25%	48%
93.	Questions are taken from the textbooks in (SSC/GCE) papers.	7.259	Rejected	60%	23.3%	34%	65%
96.	On the basis of previous papers some questions can be predicted in the coming paper.	5.547	Rejected	80%	53.3%	17%	35%

*A = (SA + A) of the measurement scale. *DA = (SDA + DA) of the measurement scale.

SA = Strongly Agree, A = Agree, SDA = Strongly Disagree, DA = Disagree, [A* = Agreed and DA*= Disagreed].

The analyzed results of teachers' responses collected through questionnaire and the responses acquired through administering interviews of the subject experts are presented precisely in the following table.

Table 2. Summary of the findings obtained on the basis of teachers' and subject experts' responses

Domains	SSC	GCE
Aims/ Objectives	• Teachers' were less aware about the expected aims and objectives of their curriculum.	• Teachers' were relatively more aware about the expected aims and objectives of their curriculum.
Approaches/ Methods	• The approach of selecting and sequencing the contents for teaching was found based on different content areas (arithmetic, algebra & geometry). (Linear Topical Approach) • The approach of teaching was Content-focused with an emphasis on performance through replication. • The approach of predicting and teaching selected contents, leaving	• The approach of selection and sequencing the contents for teaching was found based on internal coherence but with a regular revision. (Concentric Approach) • The approach of teaching was Content-focused with an emphasis on performance through discernment. • The approach of teaching all the contents comprehensively without

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	some topics untaught for SSC examination. • Lecture Method of teaching.	leaving the topics for GCE examination. • Lecture Method of teaching.
Assessments	• The assessment of learning (summative) has been largely adopted. • The more focus on product than the process. • The replica of procedures taught to handle different content areas of the textbook are assessed. • Use of past paper questions in the internal school assessments. • A common observation was found on the use of unfair means during examinations.	• The assessment for learning (formative) with summative assessment. • Equal focus on process with the product. • Application of taught mathematical concepts in a new situation, different from, given in the textbook. • Use of past paper questions in the internal school assessments. • Examinations were found to be held under strict vigilance.

The items of questionnaire for students were analyzed by using t-test at five-point rating scale as well. The following table shows some results out of 80 items of students' responses.

Table 3. Some results of students' responses

Item Nos.	Items	t-value	H_0 Accepted / Rejected	A* (%)		DA* (%)	
				SSC	GCE	SSC	GCE
10	School gives a special emphasis on mathematics than the other subjects.	0.682	Accepted	67%	65%	25%	8.8%
20	All the topics in the textbooks are taught completely for the preparation of final examination.	5.238	Rejected	59.2%	83.8%	29%	7.5%
33	Doing important topics is better than doing all the topics for getting good marks.	5.673	Rejected	62.5%	27.5%	31%	64%
53	Homework is assigned and checked regularly by the teachers.	9.438	Rejected	68.3%	18.8%	24%	75%
58	Activities of mathematics class are largely doing a repetition of similar sums.	0.279	Accepted	69.2%	72.5%	21%	19%
72	Questions in (GCE/SSC) papers are given according to a fixed pattern.	7.688	Rejected	86.6%	40%	8.3%	49%
74	Questions are taken from past papers in (GCE/SSC) paper.	8.282	Rejected	76.6%	30%	14%	60%

*A = (SA + A) of the measurement scale. *DA = (SDA + DA) of the measurement scale.

SA = Strongly Agree, A = Agree, SDA = Strongly Disagree, DA = Disagree, [A* = Agreed and DA* = Disagreed].

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The analyzed results of students' responses collected through questionnaire are presented precisely in the following table.

Table 4. Summary of the results obtained from students' responses

Domains	SSC	GCE
Learning Experiences	1. Lecture method is used for teaching. 2. Contents of textbooks and past papers are used for teaching. 3. Home work is regularly given and properly checked. 4. Emphasis on neatness along with accuracy is given. 5. A sense of unease was found towards the solution of problems on application of mathematical concepts in real life situations.	1. Lecture method is used for teaching. 2. Contents of textbooks, workbooks, reference books and past papers are used for teaching. 3. Home work is given but not properly checked. 4. Emphasis on accuracy is given but not on the neatness. 5. A sense of self-assurance was found towards the solution of problems on application of mathematical concepts in real life situations.
Approaches & Methods	1. The approach of selected study and prediction for the examination 2. The approach of rote memorization especially for some specific content-areas. 3. Preparing for the examination by solving previous year's papers. 4. The approach of students to solve most of problems was usually recognizing the problem by linking it with the textbook where they had previously solved it, retrieving from memory the method and/or formula and by using it finding the solution. 5. An approach of diffidence towards the solution of problems involving graphs.	1. The approach of comprehensive study for the examination. 2. The approach of studying through rigorous exercise on all topics. 3. Preparing for the examination by solving previous year's papers. 4. The approach having the following steps during the solution of most of problems: comprehending the problem, analyzing and evaluating the given situation, selecting a method of its solution, retrieving the procedure and/or formula from memory same or similar to given situation, applying it and finding its solution. 5. An approach of assertiveness towards the solution of problems involving graphs.
Assessment Experiences	1. Textbook questions are given in the assessment. 2. Past paper-questions are given during internal examinations. 3. Class tests are taken regularly. 4. Regular assessments help in confidence building. 5. Examinations (SSC) are not conducted under strict vigilance.	1. Textbook questions are not given in the assessments. 2. Past-paper questions are given during internal examinations. 3. Class tests are taken regularly. 4. Regular assessments help in confidence building. 5. Examinations (GCE) are conducted under strict vigilance.

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Section II

This section discusses the issues, derived from the content analysis of the textbooks used in both systems i.e. textbook of SSC published by Sindh Textbook Board Jamshoro for IX-X and a set of 4 textbooks (Book 1-Book4) published by Oxford University Press Karachi. The issues derived from the content analysis of question papers of the examination boards i.e. Board of Secondary Education Karachi (BSEK) and Cambridge International Examinations (CIE) are also the part of this section. The following table presents the results of this content analysis.

Table 5. Summary of Content Analysis

Contents	SSC	GCE
Textbooks	1. Black & white appearance with discernible use of mathematical language. 2. Contents on everyday mathematics (percentage, rate, sale, purchase, interest, money etc.) were missing. 3. Contents were logically sequenced. 4. Problems on practical life situations (word problems) were found scarcely. 5. Contents to develop problem solving skill were missing. 6. Contents reinforce the provision of mathematical knowledge of procedures and operations. 7. Contents were found largely meeting the requirements of factual knowledge of the syllabus.	1. Colorful appearance with indiscernible use of mathematical language. 2. A proper proportion of these topics were included. 3. Contents were logically sequenced. 4. Problems on practical life situations (word problems) were found in profusion. 5. Contents to develop problem solving skill were found. 6. Contents were clearly inclined towards the application of mathematical procedures and operations in everyday problems. 7. Contents on further exploration and enquiry beyond the limits of syllabus were also found.
Q. Papers	1. Mostly exact same, textbook questions were found. 2. A clear pattern of repetition of questions in successive papers was identified. 3. Predictable to large extent, due to a fixed design and repetition of questions. 4. Questions from certain chapters were found always in specific sections with a consistent choice. 5. Not much flexible 6. Pattern of paper stimulates a narrow down approach and selected material-study habit. 7. No question was found on logical reasoning.	1. Exactly same textbook questions were not found. 2. No pattern of repetition of questions was found. 3. Papers were neither easily predictable nor to that extent. 4. Questions from all topics were found mixed. 5. Highly flexible 6. Pattern promotes a comprehensive study habit. 7. Questions found on logical reasoning.

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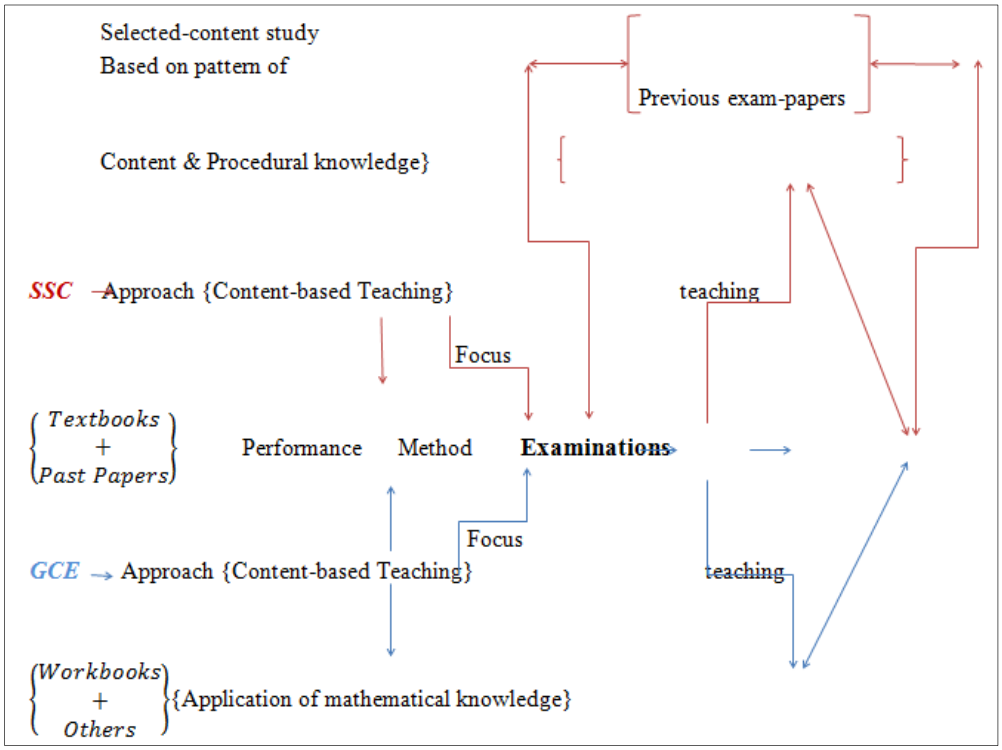

Diagram 1: Showing the comparison of mathematics teaching in two schemes of studies

The above diagram indicates that performance in examination is the focus of both systems but there is only one rout to go for it and perform in GCE system and it is through comprehensive study and rigorous practice. The SSC system also goes for examinations through normal route but a short cut rout of selected-content study has been found very common in this system. The content is selected on the basis of previous papers of examination. The fixed design, incessant repetition of questions and exactly same textbook questions in papers promote this short cut approach for attaining high scores. In the diagram this reversible process is shown by lines with arrow-heads on both sides. Therefore the core of difference between the two systems is the examination system that drives the whole process of teaching and learning.

CONCLUSIONS AND RECOMMENDATIONS

On the basis of analysis of data and findings of the study, it is concluded that the edge of GCE curriculum over SSC in effectiveness in implementation is due to some key factors such as the clarity of aims and objectives to teachers; contents of teaching aligned with the expected aims and objectives; well-balanced textbooks according to different domains of knowledge furthering problem solving, critical thinking and reasoning skills among students.

Another prime factor is the difference approaches of teachers and students of two systems and the difference in focus during teaching and assessment. Although methods of teaching are not much different but methods of assessment are entirely different, which is the most important factor of difference in the effectiveness between theses curricula?

The most damaging difference is one year's pause of mathematics education in SSC system. This one year's suspension has been found another negative contributor because after such a long interruption, students who fail to recall their previous knowledge, prerequisite for furthering on that topic, suffer problems in concept building because they cannot attach the new information with their previously learned knowledge. No such discontinuation of

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mathematics at school level in has been found in GCE system which is another contributor in making curriculum more effective.

In the light of drawn conclusions, it is recommended that the expected aims and objectives of teaching mathematics at SSC level are transmitted to teachers. There is an urgent need to divert the focus of our schools towards producing thinking skills among students. These thinking skills can be produced through proper teaching of mathematics. For this school heads can be guided and counseled through a campaign to focus on students' thinking skills in their schools. They may be directed to make sure teaching of mathematics according to the expected aims and objectives of SSC curriculum, in their institutions. It is recommended to revise the contents of the textbook. Contents on everyday application of mathematics (profit / loss / sale / purchase / hire-purchase / percentage / interest / money etc.) may be incorporated. Topics involving geometrical figures such as mensuration (area and volume of 2D / 3D figures) and trigonometry may be included. Topics to enhance logical reasoning such as number sequence and geometrical patterns may also be included. It is also recommended to increase the coherence within different areas of content by integrating them through word problems. Student's monotonous outlook towards textbook may be changed by including material on the solution of real life problems through mathematical concepts; reducing excessive use of mathematical language with simple language and including colorful pictures and illustrations related to topic may be used to enhance conceptual understanding. It is strongly recommended that approaches of mathematics teachers should be changed. For this there is a dire need of proper training for mathematics teachers. At least basic training of teaching mathematics to attain proper approaches should be provided to all teachers. It is strongly recommended to change the method of assessment in SSC system both in internal school examinations and in BSEK examinations. There is an urgent need of changing the routine of giving same textbook questions in the papers. To solve the problem of rote memorization in mathematics, it is recommended not to include any material in the same framework, as it is given in the textbooks. To discourage the approaches of selective study and prediction of papers, it is recommended that the pattern of sectioning papers on the basis of topics should be changed with minimizing the choice of selection among questions. There is a dire need of continuation of mathematics as a subject at all levels in school curriculum. It is therefore recommended that proper steps should be taken to ensure the continuation of mathematics teaching in all grades during school education.

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