Development of Core Mathematics Courses in light of CCP Key Performance Indicators (KPI's).

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Abstract:

Mathematics is a mental activity interested in patterns, proof, problem posing and solving, logical and critical thinking, to understand the world in which we live and to make use of that understanding in our daily life situations. Programme for International Student Assessment (PISA, 2009, 85) indicated, "Mathematics is concerned with the ability of students to analyze reason and communicate ideas effectively as they pose, formulate, solve and interpret mathematical problems in a variety of life situations". Therefore, "since mathematics have both utilitarian and intrinsic value, all students have a right of access to its benefits which provide powerful numeric, spatial, temporal, symbolic, communicative and other conceptual tools, skills, knowledge, attitudes and values to analyze; make and justify critical decisions; and take transformative action" (Paulsen,2006, 44). Students in modern societies, such as USA and UK, master general and basic information of mathematics with the enough level required for mathematical literate life. They also master skills of mathematical literacy and can apply mathematical rules in their common daily life situations.

Problem of the Study

The problem of the study was stated in the following questions:

1. What are the differences between major mathematics courses and core mathematics courses related to main focus of the course, applications of course, content of course, and Learners of the course ?.
2. What are the core mathematics components, which every QU university student should educate before graduation?
3. To what extent, core mathematics courses can help QU students to acquire :
    1. Core mathematical outcomes,
    2. Core mathematical ideas and topics,

3. Core mathematical skills and competencies, and
4. Core mathematical contexts and situations.

4. To what extent, core mathematics courses meet the CCP quality education.
5. What are the major improvements and modification of core mathematics courses?
6. How to develop a new alternative core mathematics course to acquire QU students of core mathematics components effectively?

Aims of the study

The study aimed to:

1. Allocate the major Differences between major mathematics courses and core mathematics courses.
2. Identify the core mathematics components and requirements, which every QU university student should educate before graduation.
3. Examine the extent to which core mathematics courses acquire QU students of core mathematical outcomes, core mathematics topics, core mathematical processes, core mathematical skills, and core mathematical contexts and situations.
4. Develop a new alternative core mathematics course to acquire QU students the core mathematics requirements effectively.

Importance of Study

Since the early embarking of the 21st century, Steen (2001) confirmed, "there is an urgent need for learners to have access to courses focused on mathematical literacy so that they are better equipped to function effectively in economic, political, cultural and personal capacities".

Thus, "Mathematical literacy has received increasing attention partly driven by concerns that too many students leave universities unable to function mathematically at the level needed in the modern daily life. Further, it is increasingly

recognized that people can only tackle many of the challenges of modern life effectively if they are mathematically literate in key areas" (Steen, 2014, 285).

Programme for International Student Assessment (PISA, 2009, 85) pointed, "Citizens in every country are increasingly confronted with a myriad of tasks involving quantitative, spatial, probabilistic and other mathematical concepts. Such situations include shopping, travelling, cooking, dealing with personal finances, judging political issues, etc."

The main word of the International Summit in Education was "Computational thinking is seen as a skill set that every student in the university needs to develop. It is related with a number of other 21st century competencies such as problem solving, critical thinking, productivity, and creativity" (Dede, 2013).

Today and in the future, "every country needs mathematically literate citizens to deal with a very complex and rapidly changing society. … Failure to use mathematical notions can result in confused personal decisions, an increased susceptibility to pseudo-sciences, and poorly informed decision-making in professional and public life" (PISA, 2009, 87).

Organization for Economic Co-operation and Development (OECD, 2004) indicated, "Mathematical literacy is concerned with the capacity of an individual to draw upon their mathematical competencies to analyses, reason and communicate ideas effectively by posing, formulating and solving mathematical problems in a variety of domains and situations".

A quantitative literate citizen is one of the required outcomes of Qatar University and the modern Qatar society as a whole today and in the future. To sum up, attention in modern societies moves from traditional teaching of mathematics courses to mathematical literacy which is more understandable, applicable, and preferable by non- specialist students.

Literature Review

The underlying intention of the mathematics education developers is that "Mathematical literacy plays a vital role in the improvement of the quality of learners' lives". (Paulsen, 2006,45).

Colleges and universities in USA have a course of Quantitative Reasoning under different titles but the same objectives, contents and learning outcomes. Such titles are Numeracy, Mathematical literacy, Matheracy, Stem mathematics, Ethnomathematics, Social mathematics, functional mathematics, and mathematics for non-specialists.

In Great Britain, "there is an increasing interest being paid to how students might be better prepared to use mathematics to make sense of situations when there is increasing access to quantitative data. UK is not alone in focusing on this problem. Similar concerns about inadequacies of current mathematics courses have been raised in many countries; there is perhaps some convergence of mathematics curricula because of the international comparative studies that measure students' performance in mathematics and the resulting pressure on nations to improve their position in international league tables" (Wake, 2005, 2).

In South Africa, "a new mathematical literacy course begins to implement in the academic year 2006 for all learners who do not take the subject mathematics, much discussion about what exactly is mathematical literacy, and issues about how it can be realized have emerged" (Vithal and Bishop, 2006, 2).

Moreover, several professional bodies and think tanks in the US, UK, and the Netherlands have called for more attention to mathematical literacy. EDU summit 2013, focused on "the core components of computational thinking, its relation with and distinction from other 21st century competences, and its place in the university core curriculum".

Association of American Colleges and Universities (AAC&U, 2015) identified "Quantitative Reasoning as one of the top

learning outcomes priorities in the American colleges and university and in the same time it is one of Liberal education and American's promise (LEAP) assessment of major employer priorities for most important college learning outcomes" (Hart Research Associates, 2015).

Terms of the Study

Mathematical literacy term is used in a variety of ways and under different names such as mathematical literacy, numeracy, functional mathematics, quantitative reasoning. For example, "the term numeracy is used in the UK while qualitative literacy appears in the USA" (Brown, 2003).

Steen defined mathematical literacy as "the capacity to make effective use of mathematical knowledge and understanding in meeting challenges in everyday life" (Steen, 2001, 1).

In South Africa 2006, Mathematical literacy is defined as follows "Mathematical literacy provides learners with an awareness and understanding of the role that mathematics plays in the modern world. Mathematical literacy is a subject driven by life-related applications of mathematics". (DOE, 2003: 9; Vithal and Bishop, 2006, 3).

PISA(2009,85) defines mathematical literacy as "an individual's capacity to identify and understand the role that mathematics plays in the world, to make well-founded judgments and to use and engage with mathematics in ways that meet the needs of that individual's life as a constructive, concerned and reflective citizen".

Association of American Colleges & Universities (AAC&U, 2015) defined Mathematical literacy as "a habit of mind competency, and comfort in working with numerical data. Individuals with strong ML skills possess the ability to reason and solve quantitative problems from a wide array of authentic contexts and everyday life situations".

To rape up, the above definitions focus on two important ideas. First, QL is much more than arithmetic or basic skills. Second, QL requires something quite different from traditional school mathematics.

Differences between major mathematics courses and core mathematics courses:

The first question of the research is, what are the differences between major mathematics courses and core mathematics courses related to focus of the course, applications of course, content of course, and Learners of the course?

To answer this question, Huston (2014,22) indicated that "mathematical literacy course differs from traditional mathematics courses in that its aim is not to solve problems of an abstract and theoretical nature, using conceptual mathematical understanding and to master sophisticated techniques and tools".

The following table summarizes the main differences between major mathematics and mathematical literacy.

As the above table shows, "mathematical literacy is less formal and more intuitive, less abstract and contextual, less symbolic and more concrete. QL also focuses more attention and emphasis on reasoning, thinking and interpreting as well as on other very mathematical competencies" (de Lange, 2001).

Finally, Mathematical literacy is much more than the ability to carry out and understand calculations. It would help to prepare Qatar university students to meet the demands of the daily life situations by developing skills such as understanding and interpreting different types of data.

Core Mathematics:

The second question of the research is what are the core mathematics, which every QU university student should educate before graduation? To answer this question, the core mathematics components were identified through surveying the previous literature as follows:

Table (1) Differences between major mathematics and mathematical literacy (De Lange, 2001)

Differences	Major Mathematics	Mathematical Literacy
Main focus of the course	**Mathematics focuses on the discipline of Mathematics, incorporating abstract and hypothetical thinking.**	**Mathematical literacy focuses on the role of mathematics in the real world using relevant examples in day-to-day life.**
Applications of course	**Applications are most important, not necessarily in real life contexts. Content is also mphasized.**	**The contexts chosen are employment based being current and relevant.**
Content of course	**Content is expanded on as the learner's progress annually.**	**The contexts become more advanced as the learner's progress annually.**
Learners of the course	**Mathematics is designed for those wish to pursue careers in the natural sciences or engineering.**	**Mathematical literacy is designed for learners wanting to pursue tertiary qualifications in the social and life sciences, e.g. law, education, sharia etc., or entrepreneurs who wish to start their own businesses**

Mathematics American Association (MAA, 2004, 1-2) "posed the question: what mathematics should all college students know? Students must possess strong critical and logical thinking skills; have a strong number sense and be proficient at estimation, unit conversions, and the uses of percentages; be able to read a statistical study – or at least a summary – and evaluate it critically; possess the mathematical tools needed to make basic financial decisions; and understand exponential growth and know that it governs everything from populations and prices to tumors and drugs in the blood".

What mathematical literacy requirements should be established for all students who receive a bachelor's degree? Over the years, the Mathematical Association of America (MAA, 2016) "has approached this question in various ways. Colleges and universities should treat mathematical literacy as a thoroughly legitimate and even necessary goal for baccalaureate graduates, expect every college graduate to be able to apply simple mathematical methods to the solution of real-world problems, devise and establish mathematical literacy programs

each consisting of foundation experience and a continuation experience, and mathematics departments should provide leadership in the development of such programs, accept responsibility for overseeing their mathematical literacy programs through regular assessments".

De Lange (2001) points to "the four phenomenological categories used to organize the Organization for Economic Co-operation and Development (OECD) Programme for International Student Assessment (PISA) study (OECD, 2002): 'quantity'; 'space and shape'; 'change and relationships'; and 'uncertainty'".

Around the same areas, Vithal and Bishop (2006, 5) identified "the QL four mathematical literacy areas as, numeracy, algebra, geometry and statistics. Through number and operations in context, functional relationships and the ability to solve problems in real and simulated contexts, space, shape and measurement, data handling and the ability to apply knowledge of statistics and probability to communicate, justify, predict and critically interrogate findings and draw conclusions".

Wake (2005, 11) assessed the "QL content components in terms of four overarching topics: Quantity; space and shape; change and relationships; and uncertainty, process defined in terms of general mathematical competencies (including use of mathematical language, modelling and problem solving skills), situations in which mathematics is used ".

PISA (2009, 95-103) indicated, "Mathematical literacy has been logically organized around content strands (e.g., arithmetic, algebra, geometry) and their detailed topics. The overarching ideas coverage of mathematics are space and shape, change and relationships, quantity, uncertainty".

Recently, Bennett and Briggs (2015) in their valuable book "Using and Understanding Mathematics: A Quantitative Reasoning Approach", identified "areas of core mathematics course as follows: logic and problem solving, thinking critically, approaches to problem solving, quantitative information in

everyday life. Also, it involves numbers in the real world, managing money, probability and statistics, Statistical reasoning, putting statistics to work, probability: living with the odds, modeling, exponential astonishment, modeling our world, modeling with geometry, further applications ,mathematics and the arts, mathematics and politics".

Association of American Colleges and University (AAC &U, 2015) identified "the following mathematical literacy skills to set up a rubric to student learning outcomes in the American colleges and universities: interpretation, representation, application / analysis, assumptions, communication ".

All of the above skills are of utmost importance for the university students not only during the study of their majors on the short run but also for using and understanding mathematical situations in their daily life on the long run.

Courses sample of the study:

CCP Package of natural sciences and mathematics includes three courses related to mathematics to help students think critically and use quantitative reasoning skills in real life situations, thereby expanding the diversity of their knowledge beyond the boundaries of their disciplinary home... In addition, CCP general skills package includes one statistics course. (Core curriculum program, 2016) Therefore, the courses sample of the study consisted of four courses as follows:

1. Calculus 1
2. Statistics1
3. Intermediate Algebra
4. Basic Geometry and measures.

Data Collection Tools of the study:

The study data was collected through:

1. The core mathematics courses files.
2. List of core mathematics requirements.
3. Core survey Checklist.

Procedures of the study

The study was carried out through the following procedures:

1. Survey of the previous literature related to the core mathematics requirements.
2. Examine a sample of the core mathematics courses teached in USA universities (25 courses).
3. Collect the core mathematics courses files teached by CAS mathematics faculty (4 courses).
4. Review CCP mathematics teaching plan with focus on CCP objectives, courses and outcomes.
5. Construct a list of the CPP core mathematics components and requirements, which every QU university student should educate before graduation.
6. Build a survey checklist to assess the CCP core mathematics courses teached by CAS faculty.
7. Identify the major differences between CAS major mathematics courses and CCP core mathematics courses.
8. Analyze the CAS mathematics courses files using survey checklist in light of CCP core mathematical outcomes, core mathematics topics, core mathematical processes, core mathematical skills, and core mathematical contexts and situations.
9. Treat the data obtained statistically using frequencies and percentages.
10. Suggest an outline of a new alternative core mathematics course to acquire QU students the CCP core mathematics requirements effectively.
11. Set up the study recommendations.

Study Results

During the survey of the previous literature, the study first and second questions had been qualitatively answered. The rest four questions of the study will be answered in the following pages:

Quantitative Quality Indicators of CCP Mathematics Courses:

To answer the 3rd question of the study, the extent to which core mathematics courses can help QU students to acquire Core mathematical outcomes, Core mathematics topics, Core mathematical processes, Core mathematical skills, and Core mathematical contexts and situations can be shown through the following tables:

Table (2) Mathematical core courses

Mathematical core courses	Math101 Calculus1		Math 103 Intermediate algebra		Math 104 Basic Geometry		Stat 101 statistics1		Total	
	A	NA	A	NA	A	NA	A	NA	F	%
Numeracy.	✓								1	
Algebra			✓						1`	
Geometry					✓				1	
Statistics							✓		1	
Probabilityth eory							✓		1	
Total	✓		✓		✓		✓✓		5	100%

Table (2) shows that the four core mathematics courses teached by core faculty to specialist students covers 100% of the mathematics strands which can help QU students to acquire the essential components of the mathematical literacy.

Frequencies and percentage in table (3) reveals that core mathematics courses in CAS College cover content core ideas and topics in a range from 20% for change and relationship to 64% for quantity and magnitudes. In between, comes chance, uncertainty, space, and shape with 57%. This range of ideas and topics is medium and indicates that syllabus of core mathematics courses needs revision and modification.

Table (3) Content core ideas and topics

Content core ideas and topics	Math101 Calculus1		Math 103 Intermediate algebra		Math 104 Basic Geometry		Stat 101 statistics1		Total	
	A	NA	A	NA	A	NA	A	NA	F	%
Space and shape										
Recognizing shapes and patterns in shapes					✓				1	
Describing, encoding and decoding visual information						✓			0	
Understanding dynamic changes to shapes					✓				1	
Identifying similarities and differences					✓				1	
Identifying relative positions						✓			0	
Interpreting two-dimensional and three-dimensional representations and the relations between them					✓				1	
Navigation through space.						✓			0	57 %
Change and relationships										
Representing changes in a comprehensible form	✓								1	
Understanding the fundamental types of change	✓								1	
Recognizing particular types of change when they occur		✓							0	
Applying these techniques to the outside world		✓							0	
Controlling a changing universe to the best advantage.		✓							0	20 %
Quantity and magnitudes										
Understanding of relative size			✓						1	
Recognition of			✓						1	

numerical patterns										
Use of numbers			✓						**1**	
Processing and understanding of numbers			✓						**1**	
Quantitative reasoning				✓					**0**	
Number sense				✓					**0**	
Representing numbers in various ways			✓						**1**	
Understanding the meaning of operations			✓						**1**	
Having a feel for the magnitude of numbers			✓						**1**	
Mathematically elegant computations				✓					**0**	
Mental arithmetic and estimating.				✓					**0**	**64 %**
Chance and Uncertainty										
Data and chance							✓		**1**	
Producing data								✓	**0**	
Simple random samples							✓		**1**	
Statistical thinking								✓	**0**	
Omnipresence of variation in processes;								✓	**0**	
Need for data about processes;								✓	**0**	
Design of data production with variation in mind;								✓	**0**	
Quantification of variation;							✓		**1**	
Reasoning from uncertain empirical data								✓	**0**	
Explanation of variation.							✓		**1**	
Data analysis							✓		**1**	
Datadisplay/visualization							✓		**1**	
Probability							✓		**1**	
Inference							✓		**1**	**57 %**

Table (4) Core Mathematical processes

Core Mathematical processes	Math101 Calculus1		Math 103 Intermediate algebra		Math 104 Basic Geometry		Stat 101 statistics1		Total	
	A	NA	A	NA	A	NA	A	NA	F	%
Mathematical problem Representation	✓		✓			✓		✓	2	50%
Mathematical language Understanding			✓		✓				2	50%
Finding regularities, relations and patterns.		✓	✓			✓		✓	1	25%
Recognizing aspects that are isomorphic with known problems.		✓		✓		✓		✓	0	0%
Translating the problem into mathematics	✓		✓		✓			✓	3	75%
Using and switching between different representations.	✓		✓			✓	✓		3	75%
Using symbolic, formal and technical language and operations.		✓	✓		✓			✓	2	50%
Mathematical Models Refining and adjusting.		✓		✓		✓		✓	0	0%
Argumentation.		✓		✓		✓		✓	0	0%
Generalization.	✓		✓		✓		✓		4	100%
Mathematical Concept Understanding	✓		✓		✓		✓		4	100%
Mathematical Reflection and justification		✓		✓		✓		✓	0	0%
Communicating the process and solution.	✓		✓		✓		✓		4	100%
Analyzing the model and its limits.	✓			✓		✓		✓	1	25%

Frequencies and percentage in table (4) reveals that core mathematics courses in CAS College can help QU students to practice some mathematical processes and skills with high percentage 75-100% such as translation problems into mathematics, Using and switching between different representations, Generalization, Mathematical Concept Understanding, Communicating the process and solution. The

data in the above table also revealed that core mathematics courses in CAS could not help QU students to learn some vital skills and processes such as Finding regularities, relations and patterns. Recognizing aspects that are isomorphic with known problems. Mathematical Models Refining and adjusting, Argumentation, Mathematical Reflection and justification, analyzing the model and its limits within percentage ranged from 0-25%. This results means that core mathematics course are information based courses but not skills bases courses.

Table (5) Core Mathematical Situations and contexts

Core Mathematical Situations and context	Math101 Calculus1		Math 103 Intermediate algebra		Math 104 Basic Geometry		Stat 101 statistics1		Total	
	A	NA	A	NA	A	NA	A	NA	F	%
Personal Situations and context		✓		✓		✓	✓		1 A	25%
Educational/occupational Situations and context		✓		✓		✓	✓		1 A	25%
Public Situations and context		✓		✓		✓	✓		1 A	25%
Scientific Situations and context	✓		✓		✓		✓		4 A	100%

Frequencies and percentage in table (5) reveals that core mathematics courses in CAS College can help QU students to learn from Scientific Situations and context with percentage 100%. The Personal Situations and context, Educational/occupational Situations and context, and Public Situations and context were used only in one course 25%.

Frequencies and percentage in table reveals that core mathematics courses in CAS college can help QU students to achieve the three lower levels of learning : Students can execute clearly described procedures, including those that require sequential decisions., Students can interpret and recognize situations in contexts that require no more than direct inference., Students can answer questions involving familiar contexts where all relevant information is present and the questions are clearly defined.

Table (6) Assessment Rubric of core mathematics learning

Assessment Rubric of core mathematics learning	Math101 Calculus1		Math 103 Intermediate algebra		Math 104 Basic Geometry		Stat 101 statistics1		Total	
	A	NA	A	NA	A	NA	A	NA	F	%
Level 6 Students can conceptualize, generalize, and utilize information based on their investigations and modelling of complex problem situations.		✓		✓		✓		✓	4 NA	0%
Level 5 Students can develop and work with models for complex situations, identifying constraints and specifying assumptions. In addition, reasoning.		✓		✓		✓		✓	4 NA	0%
Level 4 Students can work effectively with explicit models for complex concrete situations that may involve constraints or call for making assumptions.		✓		✓		✓		✓	4 NA	0%
Level 3 Students can execute clearly described procedures, including those that require sequential decisions.	✓		✓		✓		✓		4 A	100 %
Level 2 Students can interpret and recognize situations in contexts that require no more than direct inference.	✓		✓		✓		✓		4 A	100 %
Level 1 Students can answer questions involving familiar contexts where all relevant information is present and the questions are clearly defined.	✓		✓		✓		✓		4 A	100 %

The upper three levels of learning cannot be achieved: Students can conceptualize, generalize, and utilize information based on their investigations and modelling of complex problem situations. Students can develop and work with models for complex situations, identifying constraints and specifying assumptions .Students can work effectively with explicit models for complex concrete situations that may involve constraints or call for making assumptions.

Assessment of Core Mathematics Courses:

To answer the 4th question, the extent to which the core mathematics courses meet the CCP quality education requirements was identified through the analysis of the mathematics courses files studied by QU students as follows:

MATH 101 Calculus I

- Prerequisites of the course identified as none despite pre-calculus comes always before calculus1.
- As stated in the course file, it covers Sciences, engineering, and pharmacy students only.
- Course did not cover the other fields and students in colleges of Business, Medicine, Education and Law students, etc.
- There is no refer to the course as a part of CCP mathematics and science package.
- There is a confusion between advanced organizers and flipped learning and another confusion between delivery methods and resources of learning.
- Blended learning did not referred to despite its upmost importance to teaching in QU.
- Learning resources is mixed with delivery methods without differentiation between them.
- Online links for relevant math videos materials and online links of math packages including Mathlab did not refer to in the file.
- Faculty information incomplete.

- Textbook used covers Calculus for Scientists and Engineers as its title refer to.
- Calculus1 course is not suitable as a CCP course because it must cover all of the other groups of students such as pharmacy, medicine, education, and law students as well.
- Documentation of some references in the course is incomplete.
- Learning resources do not listed at all under this section.
- Course objectives are based on faculty actions not on the student knowledge and learning, as it must be.
- Course objectives are most mathematically and Far away from the CCP objectives.
- Developing student's active investigations and critical thinking skills did not included.
- Student learning outcomes Cover knowledge and understanding outcomes only.
- SLO's do not cover practical, professional, general, and transferable outcomes (which CCP is looking for).
- There is a need for specific remedial math activities in-class or online for the underachiever students and specific enrichment math activities for the talented students.
- Relationship between assessment tools and learning outcomes is not clear.
- 92% of the final grade based upon exams and quizzes while 8% only is given for math activities upon which the students can understand math.
- Cognitive learning outcomes will be measured clearly while affective and general learning outcomes will not be measured properly.
- There is no rubric to measure for critical thinking skills, attitudes towards math.
- Study plan, online math activities, and Mymathlab homework is not graded.
- In-class Quizzes number and dates are not clear.

- Formative feedback tools and procedures of using it to enhance course teaching is not clear.

STAT 101 course:

- Prerequisites of the course are not identified.
- Relation of the course with Core Curriculum program is not identified.
- Lecture Days, Times and Class Room are for fall 2015 not for spring 2016.
- As stated in the file, course covers basic statistical topics except of simple linear correlation, simple linear regression and chi-squared distribution despite reference to it in the course objectives.
- Statistical software used in the course are Excel and Minitab without use of SPSS as the more common, relevant, and easier for the students.
- There is no reference to the course as a part of CCP mathematics and science package.
- Blended learning or flipped learning did not used despite its upmost importance to teaching in QU because of the widely access of Blackboard environment as a learning management system.
- Statistical experiments did not used despite its important role in teaching statistics for the students of negative attitude towards math.
- Carrying out statistical activities and solving statistical problems, using SPSS package is not used despite its importance to develop statistical thinking skills.
- Textbook is only one book covers Introduction to Probability and Statistics.
- References are two statistics books of very old content(9th to 14th edition)
- Reference topics are not named and page numbers are not identified.

- There is no use of any additional learning resources to foster teaching of the course such as online math text tutorials, online videos tutorials, SPSS tutorial, statistics tables of data, statistical manipulatives, etc.
- Course objectives are general and covers statistical knowledge, statistical thinking, and practical statistical skills.
- Developing student's investigational and critical thinking skills is included in the course objectives.
- Student learning outcomes (SLO's) Cover statistical knowledge, statistical thinking, and statistical skills outcomes.
- SLO's do not cover clearly general and transferable outcomes (which CCP is looking for).
- Simple linear regression included in the student learning outcomes but did not include in course description or in course content distribution.
- There is a need for specific remedial math activities in-class or online for the underachiever students and specific enrichment math activities for the talented students.
- Relationship between assessment tools and learning outcomes is not aligned clearly.
- 75% of the final grade based upon exams and quizzes while 25% is given for math activities upon which the students can understand math.
- There is no rubric to measure for critical thinking skills or a scale to measure attitudes towards math.
- Study plan and online math activities is not graded and not calculated in the general grade.
- Number of In-class quizzes are four only as stated the file, which is not enough for good formative assessment because there should be a quiz every week (12-15 quiz).
- Dates of exams and quizzes are not identified in the weekly syllabus distribution.

- Formative feedback tools and procedures to enhance course teaching is not stated clearly in the course file.

Improvements Essential for Core Mathematics Courses:

To answer the 5th question, improving MATH 101 Calculus I course can be done through:

- Refer to pre-calculus course is the prerequisite of calculus1 course a in the course file.
- Refer to Pre-Calculus course in the foundation program.
- Modify course description section to cover Business, Medicine, Education and Law students, etc.
- Modify as follows: MATH 101 is a first course in the calculus of one variable intended for Sciences, engineering, pharmacy, Business, Medicine, Education and Law students, etc.
- State Course as a part of CCP math package clearly in the course description
- refer to http://www.qu.edu.qa/core/
- Use tools of advanced organizers and Math starters before the lesson instead of flipped learning as stated in the file.
- Differentiate between delivery methods and sources of learning under two separate titles to clear the confusion.
- Add a new subtitle under the name of resources of learning or transfer all the sources to next subtitle: References and Resources.
- Emphasis of using blended learning as it is the more suitable method for QU and training math faculty to know how to use it.
- Use of investigational approach and critical thinking approach during the math activities in class and online.
- Refer to:
- http://www.eduplace.com/graphicorganizer/ http://www.dirigoes.org/~mathtoolbox/Math_Toolbox/Advanced_Organizers.html

- http://www.statisticsonline.org/subtangent/30-maths-starters.pdf
- http://www.dreambox.com/blended-learning ,
- http://blog.cue.org/flipped-learning-your-math-class/
- https://www.stem.org.uk/elibrary/resource/30167/investigative-and-problem-solving-approaches-to-mathematics-and-their
- Insert online links for Relevant Math videos materials and Math packages explaining some material including Matlab in the file course.
- Select and use Online Math tutorials, Math problem solvers, and Math review sheets to support the textbook.
- Refer to:
- http://www.mathtutor.ac.uk/
- http://www.learnerstv.com/Free-maths-Video-lectures-ltv095-Page1.htm
- http://www.zweigmedia.com/tuts/tutorial-Index-en.html ,
- http://www.purplemath.com/modules/index.htm ,
- http://softmath.com/math-com-calculator/adding-functions/algebra-made-simple.html
- http://www.cymath.com/.
- Complete the basic information of the faculty teaching the course.
- Replace the textbook used with a more general one to cover all groups of students and colleges such as textbooks of Math made simple or Math for beginners.
- Modify the documentation of the additional references listed.
- Add suitable resources of learning to the textbook used such as text, video, and online tutorials.
- Refer to : http://www-math.mit.edu/=~djk/calculus_beginners/

- Restate the course objectives to be based on the student knowledge and skills instead of faculty actions and skills.
- Such as: To understand and apply the basic concepts found in an introductory calculus course, namely limits, differentiation, and integration.
- Include of CCP objectives and critical thinking skills in the course objectives.
- Refer to: http://www.qu.edu.qa/core/
- Restate student-learning outcomes to include practical, professional, general, and transferable outcomes (which CCP is looking for).
- Such as :
- To develop an interest in calculus, and acquire a positive attitude towards its use and power
- To show a willingness to participate and persevere in the learning of calculus
- To develop confidence in their ability to use calculus effectively
- To appreciate the benefits of using technology in calculus
- To display responsibility for their college, presentation and learning of calculus
- To interact in a constructive and cooperative manner with peers and teachers and respond constructively to advice.
- Use some remedial in-class or online math activities for underachiever students and some enrichment activities for the talented students.
- Referto: http://www.ascd.org/publications/books/104016/chapters/Helping_Underachievers@_Whole-Class_Strategies.aspx
- http://www.ed.gov.nl.ca/edu/k12/studentsupportservices/publications/TeachingStudentsGiftedTalented.pdf
- Match assessment tools with student learning outcomes and the grades given in a three-column table.

- Balance ratio of the final grade between exams and activities with 70% of the grade for the exams and 30% for the activities.
- Use a measurement rubric for critical thinking skills.
- Refer to:
- https://www.nsu.edu/.../irap/assets/qep-p1-cp-REASO…
- http://academic.pgcc.edu/~wpeirce/MCCCTR/Designing rubricsassessingthinking.html
- http://www.aacu.org/value/rubrics/critical-thinking
- Use a questionnaire or attitude scale to measure affective learning and CCP outcomes.
- Refer to:
- http://www.simplypsychology.org/attitude-measurement.html
- http://www.kaputcenter.umassd.edu/downloads/products/technical_reports/tr4_student_attitude.pdf
- Score and add study plan, online math activities, and Mymathlab homework to the general grade.
- In-class Quizzes number and dates must be identified clearly in the course calendar.
- Use formative feedback tools clearly such as reflection paper, one-minute paper, muddiest point paper, pros and cons paper, etc.
- Refer to:
- https://www.nwea.org/blog/2014/33-digital-tools-advancing-formative-assessment-classroom/
- http://www.levy.k12.fl.us/instruction/Instructional_Tools/60FormativeAssessment.pdf

Improving STAT 101 Course Through:

- Identify and refer Prerequisite course of STAT1 to in the course file.
- State relation of STAT1 course with CORE math package clearly.

- Modify lecture Days, Times and Class Room from fall 2015 to spring 2016.
- Identify Prerequisite course of STAT1 as Elementary Algebra (foundation program).
- For CORE math package, refer to http://www.qu.edu.qa/core/
- Modify all the dates from 2015 to 2016.
- Stat1 course is an element of CCP general skills package and this should be stated clearly in the course file.
- Stat1 Course contents should covers linear correlation, regression and chi squared.
- Statistical software used in the course should include SPSS package (statistical programs for social sciences) because of its common use all over the world universities.
- Refer to:
- http://www.qu.edu.qa/core/
- http://www.rowan.edu/colleges/csm/departments/math/syllabi/UND.COURSES/Stat1.html
- http://www.ssc.wisc.edu/sscc/pubs/spss_students1.htm
- http://www.spss-tutorials.com/
- Online advanced organizers and Math starters should be used before the class to bridge the gap of math previous knowledge...
- Blended learning as it is the more suitable method for QU should be used as the main delivery method and training math faculty on how to use it.
- Statistical experimental approach should be used because it is the best way to teach statistics for the students of negative attitude towards statistics.
- Carrying out statistical activities and solving statistical problems using SPSS package should be done because it is a good way to develop the statistical thinking skills.
- Refer to:

- http://www.eduplace.com/graphicorganizer/ http://www.dirigoes.org/~mathtoolbox/Math_Toolbox/ Advanced_Organizers.html
- http://www.statisticsonline.org/subtangent/30-maths-starters.pdf
- http://www.dreambox.com/blended-learning ,
- http://blog.cue.org/flipped-learning-your-math-class/
- https://www.stem.org.uk/elibrary/resource/30167/investigative-and-problem-solving-approaches-to-mathematics-and-their
- http://www.stattrek.com/statistics/statistical-experiment.aspx
- https://www.stat.auckland.ac.nz/~iase/publications/1/9b1_elsa.pdf
- http://www.spss-tutorials.com/
- Textbook used should be changed with a more recent book containing chi square, simple regression, and correlation.
- Sources of learning such as online math text tutorials, online math video tutorials, and tables of daily life problems should be identified and used to support the textbook.
- SPSS package for statistical analysis for social sciences should be used to develop the statistical skills.
- Pages and numbers of statistical problems in the additional reference topics should be identified.
- Refer to:
- Peck, Olsen and Devore; Introduction to Statistics and Data Analysis with CD Rom, 3rd edition, Thomson Brooks/Cole, 2008.
- http://www.rowan.edu/colleges/csm/departments/math/syllabi/UND.COURSES/Stat1.html
- http://www.spss-tutorials.com/
- http://www.datastep.com/SPSSTutorial_1.pdf

- Modifying course objectives to include CCP objectives and critical thinking skills.
- The objectives of this course are:
- To familiarize students with basic statistical terminology and tools for describing data sets.
- Students will also obtain a knowledge of basic concepts in data description, hypothesis testing, statistical inference and obtain a firm basis for further statistical study.
- Students will be exposed to the importance of the basic assumptions underlying all statistical calculations
- Restating of student learning outcomes to include general and transferable outcomes such as critical thinking skills (which CCP is looking for).
- Simple linear regression mentioned in the outcomes should be include in course description and course content distribution or omitted from the learning outcomes.
- Affective student learning outcomes:
- To develop an interest in statistics, and acquire a positive attitude towards its use and power
- To show a willingness to participate and persevere in the learning of statistics
- To develop confidence in their ability to use statistics effectively
- To appreciate the benefits of using technology in statistics
- To display responsibility for their college, presentation and learning of statistics
- To interact in a constructive and cooperative manner with peers and teachers and respond constructively to advice.
- Linear correlation and regression topics:
- Bivariate descriptive statistics
- Interpreting scatterplots and the Pearson coefficient of correlation

Simple Linear Regression Coefficient of determination

- http://statistics.about.com/od/Activities/
- http://www.teachingideas.co.uk/subjects/statistics
- http://serc.carleton.edu/sp/library/experiments/index.html
- http://www.teachmathematics.net/page/2961/statistics-virtual-manipulatives
- http://mei.org.uk/files/statistics/Teaching_Statistics_Ideas.pdf
- Using some remedial in-class or online math activities for underachiever students and some enrichment activities for the talented students.
- Refer to:
- http://www.ascd.org/publications/books/104016/chapters/Helping_Underachievers@_Whole-Class_Strategies.aspx
- http://www.ed.gov.nl.ca/edu/k12/studentsupportservices/publications/TeachingStudentsGiftedTalented.pdf
- Assessment tools must be matched with student learning outcomes and the grades given in a three-column table.
- A rubric to measure critical thinking skills and a questionnaire or an attitude scale to measure affective learning and CCP outcomes should be used.
- Study plan and online statistical activities must be scored and added to the general grade.
- In-class Quizzes and exams number must be increased to 8-12 quiz at least and dates must be identified clearly in the course calendar.
- Refer to:
- https://www.nsu.edu/.../irap/assets/qep-p1-cp-REASO…
- http://www.aacu.org/value/rubrics/critical-thinking
- http://www.kaputcenter.umassd.edu/downloads/products/technical_reports/tr4_student_attitude.pdf

- Formative feedback tools should be used clearly such as reflection paper, one-minute paper, muddiest point paper, pros and cons paper, etc.
- Refer to:
- https://www.nwea.org/blog/2014/33-digital-tools-advancing-formative-assessment-classroom/
- http://www.levy.k12.fl.us/instruction/Instructional_Tools/60FormativeAssessment.pdf
- csc.columbusstate.edu/summers/NOTES/1301/One-Min…
- http://www.cdio.org/files/mudcards.pdf

Need for a New Alternative Core Mathematics Course:

To answer the 6th question, a new alternative core mathematics course to acquire QU students of core mathematics components effectively was developed through the following procedure:

Course Description:

The course is designed to promote quantitative literacy among non-specialist students. It is a non-traditional, application-based course centered on the use of mathematics to model change in the real world, and the effective communication of these mathematical ideas. The course is primarily intended for students who will not take any further mathematics courses at the university such as students in Social, Behavioral, Humanistic, Education, Law, Business, and Sharia and Islamic Studies.

Course Objectives:

The course aims to strengthen students' critical thinking, quantitative skills, and demonstrate the relevance and importance of mathematics in everyday life. This will entail defining problems by means of numeric, graphic, or symbolic representations of real-world phenomena, identifying and pursuing methods of solution, deducing consequences, formulating alternatives, and predicting outcomes.

Student Learning Outcomes:

According to Bennett and Briggs (2015) chosen textbook, upon completion of the course, students should be able to:

1. "Explore common fallacies, or deceptive arguments, and learn how to avoid them.
2. Understand sets, and use Venn diagrams to visualize relationships among sets.
3. Learn to distinguish and evaluate basic inductive and deductive arguments.
4. Apply logic to common situations in everyday life.
5. Learn the basic principles of unit analysis, and review standardized units.
6. Develop experience with unit analysis as a problem-solving technique, including problems involving energy, density, and concentration.
7. Become familiar with subtle uses and abuses of percentages.
8. Understand the types of errors that affect measured numbers and ways of dealing with the inevitable uncertainty of numbers in the daily news.
9. Explore how numbers can be deceiving unless we interpret them carefully.
10. Review the basics of personal budgeting.
11. Explore the basic principles of compound interest.
12. Understand the mathematics of loan payments, including those for student loans, credit cards, and mortgages.
13. Distinguish between linear growth and exponential growth, and explore the remarkable effects of the repeated doublings that characterize exponential growth.
14. Understand how statistical studies are conducted, with emphasis on the importance of sampling.
15. Interpret and explore common types of media graphics.

16. Study fundamentals ideas of geometry, including formulas for finding the perimeter, area, and volume of common objects.
17. Investigate examples that use geometry to solve problems that arise in everyday life.
18. Explore basic concepts of probability and three methods for determining probabilities: theoretical, relative frequency, and subjective.
19. Discover how to solve various scheduling problems such as a house building project, limiting tasks and critical paths, and finding the earliest and latest start and finish times".

Course Textbook:

1. Jeffrey O. Bennett, Bill L Briggs (2015).*Using and Understanding Mathematics: A Quantitative Reasoning Approach* (6th Edition) .Boston: Addison-Wesley Longman Publishing Company.
2. *Using and Understanding Mathematics: A Quantitative Reasoning Approach plus NEW MyMathLab with Pearson e-text* -- Access Card Package, 6/e Bennett & Briggs ©2015 | Pearson | Cloth Bound with Access Card; 768 pp | Available ISBN-10: 0321923219 | ISBN-13: 9780321923219

Course Additional References:

Bennett and Briggs. "Using and Understanding Mathematics Quantitative Reasoning Approach". 5th Edition, Published by Pearson Education, 2010.

Bennett, Briggs, and Triola. "Statistical reasoning for everyday life", 3rd ed., published by Pearson/Addison Wesley, 2007.

Comup: For all Practical Purposes: Mathematical literacy in today's world, 9th ed. 2011.

Hershberger and Ronald. "Mathematical Applications for management, life, and social sciences", 9th Ed. Published by Thomson Brooks, 2008.

Jeffrey O. Bennett, Bill L Briggs (2015).Student's Study Guide and Solutions Manual for Using and Understanding Mathematics: A Quantitative Reasoning Approach, 6th ed., Published by Pearson.

NEW MyMathLab with Pearson e-text -- Instant Access -- for Using and Understanding Mathematics: A Quantitative Reasoning Approach, sixth Edition, Published by Pearson.

Sevilla and Somers. "Quantitative Reasoning: Tools for Today's Informed Citizen". Emeryville, CA: Key College Pub., 2007.

Sobecki, Bluman, Matthews, "Mathematics in Our World", second ed., McGraw-Hill, 2011.

Course Major Parts:

According to Bennett and Briggs (2015) chosen textbook, the main parts of the course are Logic and problem solving, quantitative information in everyday life, probability and statistics, modeling, and futher applications of mathematics in the arts and mathematics in politics.

Course Units and Topics:

According to the content of the textbook chosen (Bennett and Briggs, 2015), the proposed course content consists of:

1. "Thinking Critically

a. Living in the Media Age
b. Propositions and Truth Values
c. Sets and Venn Diagrams
d. Analyzing Arguments
e. Critical Thinking in Everyday Life

2. Approaches to Problem Solving

a. Working with Units
b. Problem-Solving with Units
c. Problem-Solving Guidelines and Hints

3. Numbers in the Real World

a. Uses and Abuses of Percentages
b. Putting Numbers in Perspective
c. Dealing with Uncertainty
d. Index Numbers: The CPI and Beyond
e. How Numbers Can Deceive: Polygraphs, Mammograms, and More

4. Managing Money
a. Taking Control of Your Finances
b. the Power of Compounding
c. Savings Plans and Investments
d. Loan Payments, Credit Cards, and Mortgages
e. Income Taxes
f. Understanding the Federal Budget

5. Statistical Reasoning:

a. Fundamentals of Statistics
b. Should You Believe a Statistical Study?
c. Statistical Tables and Graphs
d. Graphics in the Media
e. Correlation and Causality

6. Putting Statistics to Work:

a. Characterizing Data

b. Measures of Variation
c. the Normal Distribution
d. Statistical Inference

7. Probability: Living with the Odds

a. Fundamentals of Probability
b. Combining Probabilities
c. the Law of Large Numbers
d. Assessing Risk
e. Counting and Probability

8. Exponential Astonishment

a. Growth: Linear versus Exponential
b. Doubling Time and Half-Life
c. Real Population Growth
d. Logarithmic Scales: Earthquakes, Sounds, and Acids

9. Modeling Our World

a. Functions: The Building Blocks of Mathematical Models
b. Linear Modeling
c. Exponential Modeling

10. Modeling with Geometry

a. Fundamentals of Geometry
b. Problem Solving with Geometry
c. Fractal Geometry

11. Mathematics and the Arts

a. Mathematics and Music
b. Perspective and Symmetry
c. Proportion and the Golden Ratio

12. Mathematics and Politics

a. Voting: Does the Majority Always Rule?
b. Theory of Voting
c. Apportionment: The House of Representatives and Beyond

d. Dividing the Political Pie"

Course Teaching and Delivery:

The course will be delivered through a combination of technology based-active learning strategies.

- Flipped Classroom: presentation explaining material posted in Blackboard prior to class
- Blended learning: blackboard and web learning platform-accompanying textbook.
- Face to face learning: actively involving students in learning by asking questions that provoke critical thinking and mathematical communications.
- Collaborative learning through peer and small group project and assignments.

Course Supplementary Materials:

Usage of a scientific calculator is required for this course. Phones, tablets and laptops may not be used, or accessed at any point during exams. Calculator apps or programs on phones, tablets, or laptops may not be used during exams.

In Class Activities:

A wide range of exercises and problem types end each unit, making it easy for instructors to create assignments to fit their course goals. Study and review features in every chapter are designed to help students use their time effectively.

Online Course Activities:

The course will use Blackboard Learn as the primary means of accessing MyLabsPlus (The online homework component of the course). It is designed to work hand-in-hand with the book and offers additional practice and learning aids that improve student learning in measurable ways.

Homework Assignments:

All Homework will be done online (using MyLabsPlus) once a section is finished, students will be allowed eight times to re-do the Homework during and after class until the due date. No homework can be done after the due date.

Quizzes and Formative Feedback:

Students will have weekly in class quizzes when they do not have an exam. These quizzes will be based on the homework problems that announced in class and post on the course website. Quizzes will typically be 15 minutes long and are intended to ensure that students are keeping up with course material, provide them with formative feedback, and help prepare for the exams. The lowest quiz score will not count toward the final grade. Some quizzes will be completed without a calculator.

Exams and Final:

Students will have quizzes throughout the semester and a comprehensive final exam. There will be no makeup exams and alternate dates or times will only be arranged for participants in University sponsored activities that prevent those students from being in class, or extreme extenuating circumstances. Students will be required to complete the exam without the assistance of a calculator.

Authentic Assessment:

There will be homework assignments on each chapter-section. There will be at least ten quizzes. There will be a comprehensive final exam. The assessment of course objectives will be determined based on online homework, lab activities, quizzes, exams, and Course evaluation.

Recommendations of the Study:

1. Reviewing and improving of CCP math four courses studied to specialist students by faculty of math department in CAS College in light of the assessments, improvements and course reports resulted in the current research.
2. Designing a new course of mathematics literacy QL100 to be teached for non -specialist students in the rest colleges of the university.
3. Approval of the proposed new course from the university administration.

4. Piloting of the proposed new course for one semester in one or two groups of students from two different colleges of the university.
5. Holding a one-week training program for the faculty members expected to share in teaching the new course.
6. Planning to generalize teaching of the proposed new course in fall 2017l2018.

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