**JOURNAL OF EDUCATION AND RESEARCH 3: 11-42, 2015**

# DESIGNING CURRICULA OF MATHEMATICS, WHICH PRODUCE LEADER-INTEGRATOR OF TOMORROW

**PROF. DR. SYED ARIF KAMAL***
*Departments of Mathematics and Education*
*University of Karachi, Karachi 75270, Pakistan.*
*sakamal@uok.edu.pk*

## Abstract

This paper initiates discussion and critique of mathematics-curriculum designing in the Pakistani setting. The curriculum and the associated pedagogical techniques should cultivate habits of creative thinking and critical analysis and create a mindset to be able to resolve conflicts. Various aspects of curriculum development — philosophy, contents and pedagogical techniques — should be integrated. Philosophical basis of the education system should make the student to become a *manager* of resources of the universe (not a *thief*). The curriculum should, not only, *train*, but also, *educate* student. Emphasis is placed on concept building and technique developing. The curricula developed should give equal importance to moral upbringing, intellectual upbringing and physical upbringing. There should be a system of follow through and follow up through feedback from students, lecture/tutorial/problem-solving-session observation by senior teachers and videotaped lecture/tutorial/problem-solving-session evaluation by experts. The curricula should, not only, increase IQ, but also, develop emotional intelligence (EQ) and ability to portray vision as well as communication and networking skills. The students should be trained in the *sound* style of leadership (*commit* and *contribute*), making the incumbent realize the 3 components of an organization — structure, culture and development. Curricula of the final year of each certificate or degree program should have components, which help the graduates seek jobs, by training them, not only, in the technical (subject) skills, but also, in the performance (managerial) skills as well as the innovative (out-of-the-box thinking) skills through behavior-based interviewing techniques. Revised curricula of Department of Mathematics, University of Karachi for MA/MSc, MPhil and PhD are presented.

*Ex-Convener, National Curriculum Revision Committee (Mathematics), Higher Education Commission; Ex-Convener, Subject Committee (Mathematics), National Testing Service Pakistan; Ex-Convener, Sub-Committee (Academics), the Education Committee, Transparency International Pakistan, Ex-Member, Expert Panel (Mathematics), National Curriculum Council, Ministry of Education, Government of Pakistan; *homepage*: http://ngds-ku.org/kamal

**Keywords:** Creative thinking, critical analysis, conflict resolution, curriculum design, leadership styles, behavior-based interviewing, concept building, technique developing.

**List of Abbreviations**

**HEC:** Higher Education Commission, Government of Pakistan http://www.hec.gov.pk

**NCC:** National Curriculum Council, Ministry of Education, Government of Pakistan

**NCRC:** National Curriculum Revision Committee, Higher Education Commission

**NTS:** National Testing Service Pakistan http://www.nts.org.pk

**TIP:** Transparency International Pakistan

**UOK:** University of Karachi http://www.uok.edu.pk

## Introduction

Sixty-six years have passed since the formation of Pakistan, but we have not been able to adopt and implement an education system, which cultivates self-esteem, scholarship, and pride in our heritage, at the same time preparing the students to meet challenges of the third millennium. Part of the problem lies in corruption, which prevails in our educational sector (Kamal, 2011*b*), compounded by lack of commitment by stakeholders. Educational-policy makers need to formulate vibrant and dynamic curricula, which can produce leaders in research and development. According to Daniel Tanner and Laurel N. Tanner (Curriculum Development**:** Theory into Practice), curriculum of a subject is 'the planned and the organized learning experiences, formulated through the systematic reconstruction of knowledge and experience, under the auspices of the institution, for the learner's continuous and willful growth in personal-social competence'.

Curriculum design and development is one of the very important tasks in nation building. However, very little work in this area is found in on-line resources. Pratt (1980) wrote a monograph on the subject. Sharma (2005) dealt with curriculum design in physical education. Finch and Crunkilton (1999) presented principles of curriculum development in the context of vocational and technical education. Beauchamp (1968) surveyed the literature, dealing with practices and concepts pertaining to theory development in behavioral disciplines, related to

education to understand curriculum theory. Brubacher (1950) presented a comparative study of the contemporary philosophies of education.

This paper attempts to differentiate among teaching at school, college and university levels, making a distinction between training and education. Various aspects of curriculum design and development are highlighted in the context of *Quranic Philosophy of Education*. Pre-university, undergraduate and graduate curricula of mathematics developed for Ministry of Education, Government of Pakistan, Higher Education Commission (HEC) and Department of Mathematics, University of Karachi (UOK) are discussed, with newly proposed revisions given in appendices. A complete section is devoted to elaborate how these curricula could produce leader-integrators in research and teaching.

**Teaching at School, College and University Levels**

'What to learn' is the main factor in *training*. A trained person 'knows' the techniques, which can be repeated under standard situations. 'How to learn' is the essence of *education*. An educated person 'knows', 'can explain' and 'can apply' the concepts and the techniques. 'Why to learn' is the challenge for *education-policy maker*.

Teaching at school establishes the base for lifelong education by creating essential concepts and equipping the student with necessary techniques (using developmentally-appropriate activities), pertaining to literacy (ability to read and write) and numeracy (ability to interpret numbers, tables, graphs, bar charts and pie charts). Simple health-related activities, like measurements of heights, masses (weights) and mid-upper-arm circumferences of students may be used to illustrate and link concepts in various disciplines, *e. g.*, biology, chemistry, engineering, health and safety, mathematics and physics — some examples can be found in (Kamal, 2006).

Teaching at college enhances the existing concepts (assimilation in the existing directory, in the context of computer architecture) and introduces new concepts (addition of a new directory), through the processes of concept mapping (looking at concepts from different disciplines, *e. g.*, similarity in mathematical expression of electrical and gravitational potentials, similarity of processes of fast freeze in structural biology and fertilizer production) and concept building — acquisition, formation, development and application (Kamal, 2008*b*). Training at college level should take the student from concept building to problem-solving skills (Kamal, 2003).

Teaching at university is broad-based, challenging the student to critically analyze the different ideas and develop one's own school of thought. University

teaching should emphasize concept building (through debates, discussion sessions, activities) and technique developing (smart approaches to problem solving).

**The Components of Curriculum Design and Development**

Curricula should be developed (concepts should be built and reinforced; techniques should be enriched) giving due consideration to *breadth* (without duplicating topics from allied disciplines) and *depth* (content-outline chart needs to prepared for various topics included in the curriculum, which shows the level, the concept, the activity/the experiment to strengthen the concept, the reference and the philosophy behind introducing this concept). Precedence and influence graphs should be used to represent pre-requisites (depth) and co-requisites (breadth) for different courses. The curriculum should, not only, develop IQ, but also, EQ (emotional intelligence), so that the students can make informed, independent decisions, under stressful situations. It should develop creative thinking and critical analysis (Kamal and Siddiqui, 1986).

There is a need to integrate different aspects of curriculum development ('why to teach' – *philosophy*; 'what to teach' – *contents*, 'how to teach' – *pedagogical techniques*). Figure 1 gives the three ingredients of curriculum designing — philosophy, contents and pedagogical skills (Kamal, 2008*b*). Philosophical basis of the *Pakistani Education System*, based on 'Quranic teachings' (Kamal, 2009), should be such that the student is educated to become a *manager* of resources of the universe (not a *thief*) and knows connection with Allah, self and environment

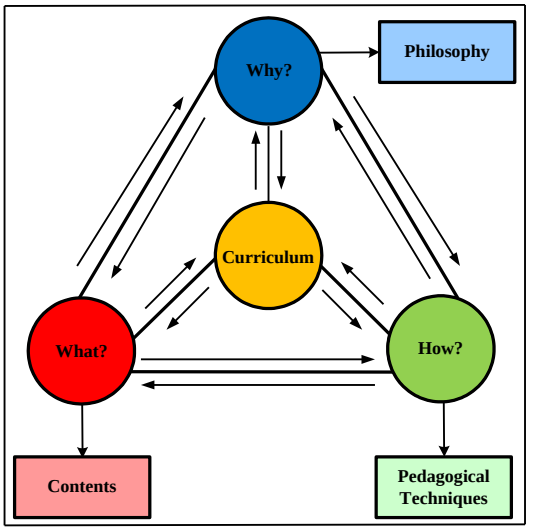


Fig. 1. The three ingredients of curriculum designing

(universe is subdued for man), in contrast to 'logical positivism' (anything, which exists must be observable and verifiable, resulting in materialistic approach — all actions of a person are performed to make this life better with no preparation for life after death), which forms the basis of *Western Education System* (man is a part of the universe).

Developmentally-appropriate contents (Van De Wallie, 1990), consistent with philosophy, having no conflict in terms of depth and breadth of the topics taught, should be prepared with the help of precedence graphs. Pedagogical techniques should be designed, conforming to cultural values and inviting student participation by suggesting activities, which could be conducted in local environment. A donut may not be understood by a rural Pakistani child, but a tire may be used to give the concept of curl — rotation at a point (Siddiqui and Kamal, 1986).

Syllabi should be developed to implement the above curriculum. Course supervisor should break the syllabus into 14 units, each unit to be covered within a week. Such a unit, consisting of 2 to 3 lectures is to be followed by *tutorial session* (concepts taught are reinforced through examples, alternate derivations and explanations, proofs and in-depth discussions) as well as *problem-solving session* (problem formulation, qualitative analysis and determining solutions). Each of these sessions is to be conducted, separately, by a teaching assistant. To help weaker students, *review session* should be scheduled prior to each hourly (monthly test of one-hour duration) and *comprehensive review* before the final examination, all of these to be conducted by the course supervisor. A *continuous-evaluation report* (progress report after each hourly) assigns a tentative grade (cumulative grade based on all hourlies, quizzes, problem sets and assignments taken to date), attendance record as well as qualitative description of student's weaknesses, indicating areas needing special attention. This report is discussed with the student as well as student's parents, in case it is unsatisfactory. First of these reports should be made available to student (first hourly should be scheduled, accordingly) before the deadline for withdrawal from a course, so that any student, performing very poorly, may be able to make withdrawal decision to protect GPA.

Curricula of the final year of an undergraduate program should have components, which develop soft skills in the graduates, to help them seek jobs. There should be résumé-preparing workshops and mock behavior-based interview-sessions to help ease transition from the academic to the practical life. The students should be trained, not only, in the technical (subject) skills (horizontal or $x$ axis) — needed for a *worker*, but also, in the performance (managerial) skills (vertical or $y$ axis) — needed for a *manager*, as well as the

Table 1. Components of behavior-based interview,
for challenging jobs in a competitive market

| *Skill* | *Representation* | *Illustration (from a mathematician's perspective)* |
|---|---|---|
| Technical (subject) | *x* axis (horizontal) | Formulating equation<br>Interpreting graph |
| Performance (managerial) | *y* axis (vertical) | Tackling smart students<br>Handling trouble-making students |
| **Innovative (out-of-the-box thinking)** | ***z* axis (normal)** | **Presenting a new mathematical model**<br>**Applying an existing model to a different branch of knowledge**<br>**Introducing a new branch of mathematics**[∃] |

[∃]The following branches of mathematics have been put forward in Department of Mathematics, University of Karachi during 2010-2013**:**

- *Anthromathematics* on March 22, 2010
  http://www.ngds-ku.org/Presentations/Firdous.pdf
- *Astromathematics* on October 8, 2012
  http://www.ngds-ku.org/Presentations/ISPA.pdf
- *Anthrotopology* on December 27, 2012
  http://www.ngds-ku.org/Presentations/BZU1.pdf
- *Condensed-Matter Mathematics* on December 28, 2012
  http://www.ngds-ku.org/Presentations/BZU.pdf
- *Anthroalgebra* on April 10, 2013
  http://www.ngds-ku.org/Presentations/AMTM.pdf
- *Anthrogeometry* on April 10, 2013
  http://www.ngds-ku.org/Presentations/AMTM.pdf
- *Anthrodynamics* on April 10, 2013
  http://www.ngds-ku.org/Presentations/AMTM.pdf
- *Anthroimaging* on September 3, 2013
  http://www.ngds-ku.org/Presentations/Scan.pdf

**innovative (out-of-the-box thinking) skills (normal or *z* axis)** — needed for a *leader*. (Table 1). A template for behavior-based structured interview (after introducing panel, rapport-building question followed by open-ended question, then moving on to specific examples supporting claims of technical and performance skills listed in résumé, allowing silence/maintaining control, and then ascertaining the skills through contrary evidence followed by a proper conclusion), focusing on attitude (willingness to learn and innovate), knowledge

and skills (ability to learn and innovate) to induct teaching assistants for Department of Mathematics, University of Karachi (UOK) is available as Additional File (http://www.ngds-ku.org/Papers/J39/Additional_File.pdf) and, also, given in Table 2.

## The Integrated Education System

An education plan, to be effective, should possess the following characteristics**:**

Table 2. Interview format for inducting teaching assistants in mathematics

| Job Announced | TEACHING ASSISTANT (MATHEMATICS) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Date & Time of Interview[y] | | | | | | | | |
| Venue | Office of the Chairman, Department of Mathematics, University of Karachi | | | | | | | |
| Name of Candidate[#] | | | | | | | | |
| | Technical Skills | | | Performance Skills | | | Innovative Skills | |
| Interview Structure | (Subject) | Résumé | Actual | (Managerial) | Résumé | Actual | (Out-of-the-Box Thinking) | |
| Introduce Panel | Horizontal (x) axis | | | Vertical (y) axis | | | Normal (z) axis[k] | |
| Rapport-Building Question[f] | Right Concepts | | | Concept Building | | | | |
| Open-Ended Question[§] | Numeracy | | | Concept Mapping | | | | |
| Specific Examples[¶] | Problem Formulation | | | Generating Questions | | | | |
| Allow Silence/Maintain Control | Problem Solving | | | Handling Questions | | | | |
| Contrary Evidence[@] | Creative Thinking | | | Handling Large Class | | | | |
| Proper Conclusion[&] | Critical Analysis | | | Handling Smart Students | | | | |
| | Equation Formulation | | | | | | | |
| Knowledge | Interpretation of Graphs | | | Handling Trouble-Making Students | | | | |
| MPhil candidate in Mathematics | Time Management | | | | | | | |
| (course work completed with 3 GPA) | Chalkboard Organization | | | Motivating Students | | | | |
| | Lecture Planning | | | Creating Leaders | | | | |
| Attitude | Lecture Organization | | | Guiding (Academic) | | | | |
| Grooming/Tidiness | Covering Entire Syllabus | | | Guiding (Career) | | | | |
| Punctuality | Continuous Assessment | | | Character Building | | | | |
| Confidence/Posture/Gait | Classroom Layout | | | Cultivating Emo-tional Intelligence | | | | |
| Positive/Negative Thinker | Oral Communication | | | | | | | |
| Determination | Research Methodology | | | Cultivating Relation-ship Strategies | | | | |
| Perseverance | Project Management | | | | | | | |

[y]**Basic Principle: Past behavior is the best indicator of future performance.** **Marks out of 100 ____ Marks out of 100 ____ Marks out of 100 ____**

[#]**All names must be written in BLOCK LETTERS.**

[f]**To make the candidate comfortable**

[§]**Generalities** **Member Member Member**

[¶]**Past examples** **Recommended/Not Recommended**

[@]**Learn to interpret the answers**

[&]**Plenty of questions**

[k]**Innovative skills, normal (z) axis, are open-ended** **Chairman of the Interview Board**

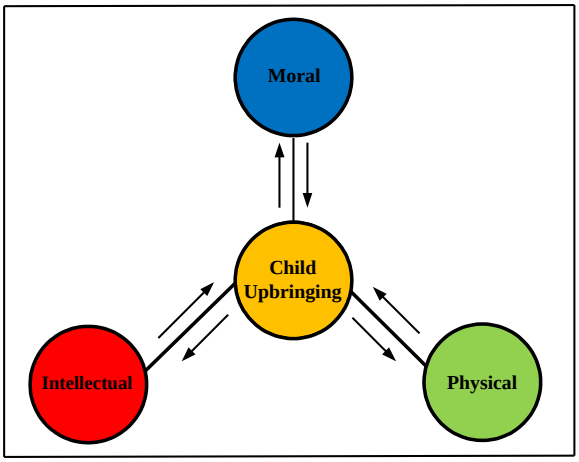


Fig. 2. The curriculum should give equal emphasis to moral, intellectual and physical upbringing of a child

*a)* It should be interesting.
*b)* It should develop observational and thinking abilities in a child.
*c)* It should give equal importance to moral (ethical and spiritual), intellectual (mental) and physical upbringing of a child (Figure 2).
*d)* It should make the child a better Muslim.

In order to make the child a better Muslim, the *Quranic Philosophy of Education* should be implemented, based on the following paradigms**:**

*i)* Education of *Tawheed* (Oneness of Allah) must start at the moment a child is born and reinforced with the education of alphabet. Any education of *Tawheed*, which does not start with the education of alphabet, is 'too late**'**.
*ii)* Any education of *Tawheed*, which is limited to Islamic Studies, is 'too little**'**.
*iii)* The education of a person must affect one's relationship with Allah, self and environment.
*iv)* The education must clarify life before this life, this life and its place in the universe as well as life after this life.
*v)* The order of subjects to be included in the curriculum should be according to prioritization given in the Holy Quran (*Al-Quran* **88:** 18-20 — *Sura-tul Ghashiya*). The number before colon refers to chapter (*surah*) and the number range after colon denotes verse (*ayah*).

*The Integrated Education System*, possessing the characteristics *a-d*, runs from pre-primary to higher secondary (intermediate) level (Kamal, 2009). Salient features of this system are**:**

- Concentration on spoken and written English to make the children express themselves
- An yearly updated integrated sciences, liberal arts and health curriculum to keep pace with the current developments — monthly updates available through net to incorporate important breakthroughs
- Bulky school bags replaced by one monthly textbook cum workbook — "heavy school bags, if worn improperly, do not contribute to scholarship, but curvatures of spinal column" (Kamal *et al.*, 1998)
- Lessons made interesting through educational toys, videos and interactive computer programs
- Projects, presentations, extempore debates and field trips during semester breaks
- Examinations to test analytic abilities, not serve as memory checks
- Preparation of students in science, mathematics and English to enable them to enter a renowned university abroad

Evaluation and appraisal of this system is based on specially designed developmental examinations of the child (Kamal, 2002), written examinations, projects, quizzes, parental comments, teachers' suggestions and expert review of recorded lessons. The curriculum, itself, is divided into the following three disciplines**:**

*a)* *Sciences*, which include mathematical sciences (mathematics, statistics and computer science), physical and biological sciences (physics, chemistry and biology), engineering and technology (modeling and simulation, experiment design and control theory) — introducing the basics of these topics in a simplified manner during the higher secondary years

*b)* *Liberal Arts*, consisting of Quranic studies (teaching of Arabic should be part of these studies), English communication (oral and written), local language and sociology

*c)* *Health and Growth*, comprising of health and safety education, which should include physical examinations of students, incorporating scoliosis screening using moiré fringe topography (Kamal, 1997) as well as height- and weight-monitoring to generate 'Growth-and-Obesity Roadmaps' (Kamal, Ansari and Jamil, 2015); gymnastics (Kamal and Khan 2013; 2014), swimming and sports

In addition to curriculum outline (to link with knowledge obtained in other disciplines and a systematic planning of gradual building-up of concepts and problem-solving skills, the chart contains the level, the concept, the activity/the experiment to reinforce this concept, the reference and the philosophy behind teaching this concept), textbooks, workbooks and lab manuals, there should be

study aids, which should include study guides, video lecture and demonstration series, interactive software series, followed by a structured testing and evaluation system. Participation in in-service training and refresher courses should be mandatory for all teachers, who handle this curriculum. No education plan, however effective, can work unless the parents are involved. A monthly parents' link magazine shall discuss the topics to be taught and goals to be achieved during the month. The magazine shall, also, contain two articles of interest to parents as well as a comment form for the parent to be filled out. In addition, parents shall be asked to attend orientation course at the time of admission of their child and one child guidance course every year.

**Pre-University Curricula**

Siddiqui and Kamal (1987), critically, evaluated pre-university curricula of physics and suggested remedial measures for the shortcomings. The author visited different schools and designed training workshops on concept building, conduct of quizzes, tests and examinations as well as problem-solving techniques, which were conducted in local schools during 2000-2008. He was chosen as a team member to develop mathematics curricula for Grades I-XII as part of the project of Ministry of Education, Government of Pakistan during 2006-2008 (Tahir *et al.*, 2006; Tahir and Yousaf, 2007; 2008) as well as develop and apply criteria for review of textbooks needed for these curricula.

**Undergraduate Curricula of Mathematics**

The students opting mathematics as major field of study should be trained in analysis, algebra, geometry, mechanics, number theory and topology, as the minimum requirements. In addition, they should be taught methods of mathematical physics, probability theory, measure theory, set theory and logic as well as modeling and simulation. They should be able to see the bridge leading them from mathematics to technology, passing through physics and engineering (Kamal, 2008*b*).

The mathematics-curriculum developers should, not only, focus on grooming the students who opt mathematics as their major field of study, but also, develop mathematics curricula, which are studied as minor (subsidiary) subjects by students of biology, chemistry, linguistics, physics and social sciences (Kamal, 2008*b*).

Mathematics curricula should prepare students for problem solving in the classroom (breaking problem into data, objective, solvability, strategy to solve the problem, setting-up of the problem, solution of the problem and results — to be reported to proper significant figures, using language describing the data and

the objective, without mentioning symbols and figures introduced in setting-up of problem), which trains them for problem solving in the laboratory (as research assistant) and, ultimately, in the industry (as production manager). Courses in *Operational Research* and *Mathematical Statistics*, taught in Department of Mathematics, UOK, prepare students to take up industrial challenges. The author has, also, written an article to give an overview of industrial-problem solving (Kamal, 2008*d*).

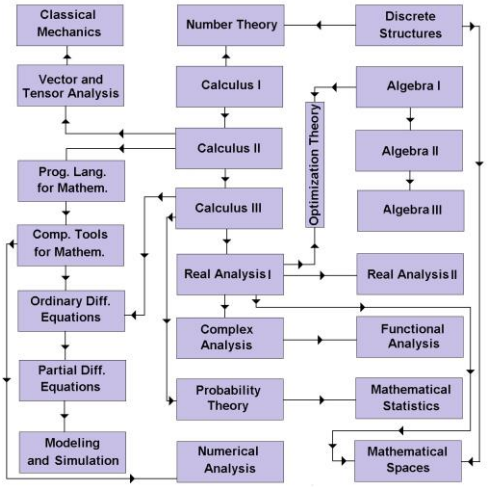


Fig. 3. Precedence and influence graphs representing pre-requisites and co-requisites for BS courses

Undergraduate curriculum (BS) of mathematics was developed as part of HEC project during 2004-2005, when the BS Program was first introduced, nationally (Kamal, 2005). BS curriculum was prepared after conducting extensive discussions and deliberations with mathematicians in the country (Kamal, 2004) and scrutinizing every aspect in National Curriculum Revision Committee (NCRC) for Mathematics. A major overhaul was conducted 3 years later (Kamal, 2008*a*). It would be interesting to note that that the first suggestion to introduce BS and MS came from the author 15 years before HEC took up this project (Kamal and Siddiqui, 1989). Salient features of this curriculum are**:**

- Prioritization of the core courses into 3 categories**:**

*a) Discipline-Specific-Foundation Courses (must know)*
Algebra, Calculus, Complex Analysis, Ordinary-Differential Equations, Real Analysis

*b) Major Courses (should know)*
Classical Mechanics, Discrete Structures, Functional Analysis, Mathematical Modeling and Simulation, Mathematical Spaces, Mathematical Statistics, Number Theory, Numerical Analysis, Numerical Computing, Optimization Theory, Partial-Differential Equation, Vector and Tensor Analyses

*c) Electives or Optional Courses (nice to know)*

- Precedence (representing pre-requisites**:** depth) and influence (representing co-requisites**:** breadth) graphs for BS courses, respectively (Figure 3). Figure 3 is reproduced from HEC document (Kamal, 2008*a*).
- Learning outcomes at the end of each year

To handle such a demanding curriculum, college and university teachers should be trained to teach all core courses through refresher and special courses. They should maintain office hours to assist students in course-related problems as well as guide and counsel them (Strang, 1947). Teachers should improve teaching of basic theory, imparting education of scientific methodology as analogy, contrast, imitation and induction. This can be possible if the vision of college teachers is enhanced (Ara *et al.*, 2005) and they have solid concepts of mathematics and logic (Kamal *et al.*, 2009). A balanced teaching load is needed so that teacher can take out time to do research. Class size should be limited to 25 students; senior instructor provided 2 teaching assistants, one each for problem grading and tutorial session. In courses, which have laboratory, an additional teaching assistant is required to conduct laboratory. Textbooks need to be prepared, which are made available to students at cheaper prices. They should be supplemented with solution manuals for instructors, study guides for students as well as on-line help (interactive software, PowerPoint presentations, demonstrations and 3-D models).

As Chairman of Department of Mathematics, the author led Board of Studies of Mathematics to initiate restructuring mathematics curricula in 2013. In the first phase, MA/MSc curricula are prepared in Mathematics, Anthromathematics, Sport Mathematics and Mathematics-Teacher Education, which are given in Appendix A.

**Graduate Curricula of Mathematics**

Graduate curricula (MS and PhD) of mathematics were, also, formulated as part of the HEC project during 2004-2005 (Kamal, 2005), after extensive deliberations and discussions in NCRC (Mathematics), taking into account opinions of senior mathematicians of the country.

As Chairman of Department of Mathematics, the author gave Board of Studies of Mathematics the task to prepare MPhil and PhD curricula in Mathematics, Anthromathematics and Sport Mathematics (Kamal, 2008*c*) as well as Mathematics-Teacher Education, which are given in Appendices B and C.

As per recommendations of NCRC (Kamal, 2008*a*), credits are assigned to Mathematics-Undergraduate Teaching as well as Mathematics-Graduate Teaching, as there are indications that students take more seriously the subjects, in which they are graded (Toriola, 2010). Each course taught earns practical-experience credits. Grades are given according to the following criteria of evaluation**:**

*a)* Feedback from students
*b)* Lecture/Tutorial/Problem-solving-session observation by senior professors of the discipline
*c)* Recorded lecture/tutorial/problem-solving-session evaluation by educational experts

**Leader-Integrators in Mathematics Research and Teaching**

Mathematics curricula, taught by visionary teachers (to be produced by Program in Mathematics-Teacher Education), should bring back the glory of mathematical research and innovation as per traditions set by our forefathers, *Al-Khawazarmi* and others. Algebra (dealing with mathematical structures) emanated from *Jabr-o-Qadr*, which is, now, an established branch of mathematics. Geometry (dealing with distances through the concept of metric) arose out of necessity to know the dimensions of earth for Muslim naval expeditions, which is, now, a part of mathematical landscape. The Pakistani mathematicians should be motivated and trained to win *Field Medal* and *Abel Prize*, contribute in international journals and hold vibrant conferences. Department of Mathematics, University of Karachi holds 2 conferences every year, *Conference on Mathematical Sciences* (during third week of March) and *Conference on Anthromathematics and Sport Mathematics* (during first week of September).

According to Ghani (2012), the social innovation, going on in today's organizations, is shaped through behavioral science, personality and philosophy. Whenever an individual tries to introduce innovative concepts and techniques through out-of-the-box thinking, the *organizational inertia* (Kelly and Amburgey, 1991) resists change-for-better. In order to bring out a sustainable change, one needs to understand structure, culture and development of an educational organization (Figure 4).

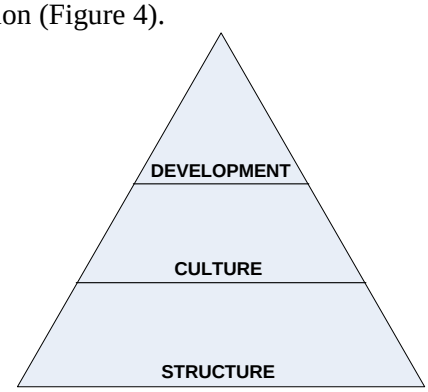


Fig. 4. Structure, culture and development — the three components of an organization of the 21st century

To spot and groom leaders, there is a need to study individuals, working solo and as members of teams, to determine their levels of understanding, commitment, networking, communication and persuasion skills as well as ability to portray vision. The leader-integrator should know the *team dynamics* (when forces inducing the change are prominent) as well as *team kinematics* (when change induced by the forces is evident) — the term 'team kinematics' was first used by Frencken and Lemmink (2007; 2008) in the context of soccer games. The future leader should be motivated through mentoring and empowered through delegation (Figure 5). The mentoring process shall bring out a leader-integrator, capable to manage or resolve conflicts (Kamal, 2011*a*; 2014*a*), through procedure-oriented (owl) administrative style — *indirect* and *controlling* (Figure 6). Figure 6 first appeared in (Kamal, 2011*a*). Such a leader should run an educational institution in the *sound* style (commit and contribute)

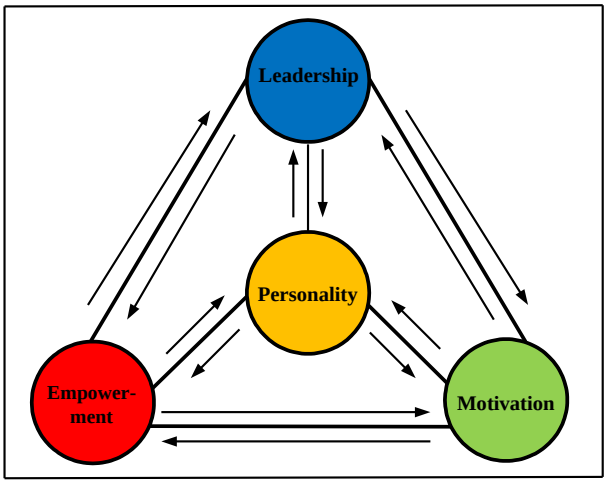


Fig. 5. Motivation, empowerment and leadership — the ladder to become leader-integrator of the 21st century

| | |
|---|---|
| **DOVE**<br>*Indirect & Supporting*<br>**(People-Oriented)**<br>*Seeks Acceptance*<br>Int. Motivator**:** Involvement<br>**Consultative Decisions**<br>**CONFLICT TRANSFORMATION** | **PEACOCK**<br>*Direct & Supporting*<br>**(Idea-Oriented)**<br>*Seeks Recognition*<br>Int. Motivator**:** The Chase<br>**Spontaneous Decisions**<br>**CONFLICT MANAGEMENT** |
| **OWL**<br>*Indirect & Controlling*<br>**(Procedure-Oriented)**<br>*Seeks Accuracy*<br>Int. Motivator**:** The Process<br>**Deliberate Decisions**<br>**CONFLICT RESOLUTION** | **EAGLE**<br>*Direct & Controlling*<br>**(Result-Oriented)**<br>*Seeks Productivity*<br>Int. Motivator**:** Winning<br>**Decisive Decisions**<br>**CONFLICT GENERATION** |

Fig. 6. Conflict transformation, conflict management, conflict resolution and leadership styles

Table 3. Behavioral leadership styles, shaping the organizational culture

| *Leadership Style* | *Characteristics* | *Consequences* |
|---|---|---|
| Indifferent | Evade and elude | Produces impoverishment |
| Accommodating | Yield and comply | Produces low productivity |
| Autocratic | Direct and dominate | Stifles creativity and innovation |
| Status Quo | Balance and compromise | Provides sub-optimal returns |
| Opportunistic | Exploit and manipulate | Undermines the organization |
| Paternalistic | Prescribe and guide | Limits creativity and thinking |
| **Sound** | **Contribute and commit** | **Begets synergy and sustained teamwork — establishes robust and fruitful relation-ships, characterized by trust, respect and frankness** |

of leadership, as opposed to indifferent (evade and elude), accommodating (yield and comply), autocratic (direct and dominate), status quo (balance and compromise), opportu-nistic (exploit and manipulate) and paternalistic (prescribe and guide) styles (Table 3).

Although, every leader is a manager, it is not true the other way around. Leader-ship of tomorrow is in the hands of teacher of today, who has the power to make the student a visionary or a myopic extremist (Kamal, 2013).

**Conclusion**

Imagine a teacher, a class full of students and a chalkboard, but no communication and, hence, no transfer of knowledge. Therefore, the focal point of any exposition of educational philosophy must result in some act of learning. The character and the outcome of this process vary with the curriculum and the associated pedagogical techniques, influenced by the political and the economic theories subscribed by the society. This is the consideration in introducing the MPhil Course 'Mathematics and Society' in our curricula, which should include topics of *mathematical art* and *mathematical fiction*. In fact, mathematics (symbolism related to quantity and space) is the subject, which has the potential to transcend cultural, ethnic, national and religious boundaries. The two powers of mathematics (generalization and application) make it the language of all sciences,

Table A1. MA/MSc (Previous) Scheme of Studies
(common for all disciplines)

**First Semester**

| *Course No.* | *Course Title* | *Cr. Hr.* |
|---|---|---|
| MATH 511 | Real Analysis | 3 + 0 |
| MATH 513 | Linear Algebra & Discrete Mathematics | 3 + 0 |
| MATH 515 | Numerical Analysis | 2 + 1 |
| MATH 517 | Classical Dynamics | 3 + 0 |
| MATH 519 | Applicable Physical Mathematics | 3 + 0 |
| MATH 500.1 | Introduction to Social Sciences | 3 + 0 |
| | **Total** | **17 + 1** |

**Second Semester**

| *Course No.* | *Course Title* | *Cr. Hr.* |
|---|---|---|
| MATH 512 | Complex Analysis | 3 + 0 |
| MATH 514 | Topology | 3 + 0 |
| MATH 516 | Abstract and Modern Algebra | 3 + 0 |
| MATH 518 | Continuum Mechanics | 3 + 0 |
| MATH 520 | Applicable Differential Geometry | 3 + 0 |
| MATH 500.2 | Communication Skills | 2 + 1 |
| | **Total** | **17 + 1** |

training the student to think and to reason with precision. The challenge for a mathematician-statistician of today is to develop a precision understanding of reality (Barankin, 1964). According to Izetbegovic (1993), there are three integral views of the world — the religious, the materialistic and the Islamic (the concept of *deen*, a complete way of life, as opposed to the limited concept of religion, as manifested in Christianity), reflecting three elemental possibilities, namely, conscience, nature and man. The deductive nature of both mathematics and *shariah* (juridical rules of Islam) should make the mathematician realize the reality of realities — "Verily, when He (Allah) intends a thing, His Command is 'Be', and it is!" (*Al-Quran* **36:** 82 — *Sura-tul-Yasin*, translation of Abdullah Yusuf Ali), a reality, which renowned mathematician, Stephen Hawking, Lucasian Professor at Cambridge University, England (1980-2009), could not grasp, while he was trying, unsuccessfully, to develop an equation of the Universe.

Students would need guidance from experts to choose a suitable combination of

Table A2. MA/MSc (Final) Scheme of Studies — Pure Mathematics

**Third Semester**

| *Course No.* | *Course Title* | *Cr. Hr.* |
|---|---|---|
| MATH 633 | Mathematical Statistics I | 2 + 1 |
| MATH 687 | Functional Analysis | 3 + 0 |
| MATH 689 | Number Theory | 3 + 0 |
| | Optional Course A I | 3 + 0 |
| | Optional Course B I | 3 + 0 |
| | Optional Course C I | 3 + 0 |
| | **Total** | **17 + 1** |

**Fourth Semester**

| *Course No.* | *Course Title* | *Cr. Hr.* |
|---|---|---|
| MATH 634 | Mathematical Statistics II | 2 + 1 |
| MATH 688 | Algebraic Topology | 3 + 0 |
| MATH 690 | Representation Theory | 3 + 0 |
| | Optional Course A II | 3 + 0 |
| | Optional Course B II | 3 + 0 |
| | Optional Course C II | 3 + 0 |
| | **Total** | **17 + 1** |

optional (elective) courses based on interest, future goals and capabilities. The optional courses proposed in the schemes of studies should discover talent, develop insight as well as ability to reason and to visualize secrets of nature in students, at the same time enriching them to deal with humans, who have emotions, aspirations, concerns and reservations; they are not, merely, the numbers in an equation (*e. g.*, equation simulating an atomic explosion) or mathematical representation of images in a technological gadget (*e. g.*, full-body scanner at an airport). *Ethical Mathematics* should be the center of attention of the next century. The curriculum should have a delicate balance between *Hardyism* (noblest and purest form of thought with little practical application) and *Maoism* (pursuing only those aspects of mathematics, which are, socially, useful). It should be, continuously, evolved, keeping in line with the modern trends and requirements. It is, only, through a carefully designed and developed curriculum, with philosophy consistent with the Pakistani ideology, contents conforming to the latest developments and the pedagogical techniques based on

Table A3. MA/MSc (Final) Scheme of Studies — Applied Mathematics

**Third Semester**

| *Course No.* | *Course Title* | *Cr. Hr.* |
|---|---|---|
| MATH 633 | Mathematical Statistics I | 2 + 1 |
| MATH 687 | Functional Analysis | 3 + 0 |
| MATH 691 | Quantum Mechanics | 3 + 0 |
| | Optional Course A I | 3 + 0 |
| | Optional Course B I | 3 + 0 |
| | Optional Course C I | 3 + 0 |
| | **Total** | **17 + 1** |

**Fourth Semester**

| *Course No.* | *Course Title* | *Cr. Hr.* |
|---|---|---|
| MATH 634 | Mathematical Statistics II | 2 + 1 |
| MATH 688 | Algebraic Topology | 3 + 0 |
| MATH 692 | Quantum Field Theory | 3 + 0 |
| | Optional Course A II | 3 + 0 |
| | Optional Course B II | 3 + 0 |
| | Optional Course C II | 3 + 0 |
| | **Total** | **17 + 1** |

indigenous examples, that the dream of Pakistan becoming the leader of third-world countries could be realized.

**Acknowledgments**

The author is indebted to Prof. Dr. Shagufta Shahzadi, Professor of Special Education and Dean, Faculty of Education, UOK for inviting me to give keynote lecture during *the Karachi University Educational Conference* and encouraging me to write this paper as well as Usman Ghani of Grid International for gifting me table calendar of 2012, celebrating the pioneers of management, learning and development (in honor of Mian Abdul Ghani, his father), from which styles of leadership have been adapted for this paper and summarized in Table 2. Ghani and the author studied together in BSc (Hons.), First Year in Department of Physics, UOK during the academic year 1973-1974. Heartfelt thanks are due to Prof. Dr. Muhammed Tahir and his team of curriculum writers for mathematics curricula of classes I-XII (Tahir *et al.*, 2006; Tahir and Yousaf, 2007; 2008) for keeping the author on-board during every aspect of curriculum development and

Table A4. MA/MSc (Final) Scheme of Studies — Anthromathematics

**Third Semester**

| *Course No.* | *Course Title* | *Cr. Hr.* |
|---|---|---|
| MATH 609 | Anthromathematics I | 2 + 1 |
| MATH 633 | Mathematical Statistics I | 2 + 1 |
| MATH 699 | Fluid Dynamics and Blood-Flow Modeling | 3 + 0 |
| Project | Optional Course A I (Project I) | 0 + 3 |
| | Optional Course B I | 3 + 0 |
| | Optional Course C I | 3 + 0 |
| | **Total** | **13 + 5** |

**Fourth Semester**

| *Course No.* | *Course Title* | *Cr. Hr.* |
|---|---|---|
| MATH 600 | Algebraic Topology and Orthopedics | 3 + 0 |
| MATH 610 | Anthromathematics II | 2 + 1 |
| MATH 634 | Mathematical Statistics II | 2 + 1 |
| Project | Optional Course A I (Project II) | 0 + 3 |
| | Optional Course B I | 3 + 0 |
| | Optional Course C I | 3 + 0 |
| | **Total** | **13 + 5** |

review. As member of Expert Panel, National Curriculum Council (NCC), Ministry of Education, Government of Pakistan, the author acted as a member of Team of Advisers of Curriculum Development for the first project (Tahir *et al.*, 2006) and member of National Advisory Committee for the second (Tahir and Yousaf, 2007) as well as the third (Tahir and Yousaf, 2008) project. Dr. Malik Muhammed Yousaf, not only, coöperated in these 3 projects as member of Team of Curriculum Writers, but also, was selected as member of NCRC for Mathematics of HEC, when the author was convener of this committee (2004-2012), which produced BS, MS and PhD curricula of Mathematics (Kamal, 2005; 2008*a*). In addition, he was inducted in Subject Committee for Mathematics, National Testing Service (NTS) Pakistan by the author, who was convener of this committee during 2009-2012, which prepared curricula for national-level tests in mathematics. My deepest appreciation goes to Justice (Retd.) Haziq-ul-Khairi and Prof. Kafil Ahmed of the Education Committee, Transparency International Pakistan (TIP) for inviting me in their seminar (Kamal, 2001*b*) and making me convener of Sub-Committee (Academics) of the Education Committee

Table A5. MA/MSc (Final) Scheme of Studies — Sport Mathematics⊃

**Third Semester**

| *Course No.* | *Course Title* | *Cr. Hr.* |
|---|---|---|
| MATH 633 | Mathematical Statistics I | 2 + 1 |
| MATH 693 | Sport Mathematics I (Sport Kinsiology) | 2 + 1 |
| MATH 697 | Fluid Dynamics and Exercise Physiology | 3 + 0 |
| Project | Optional Course A I (Project I) | 0 + 3 |
| | Optional Course B I | 3 + 0 |
| | Optional Course C I | 3 + 0 |
| | **Total** | **13 + 5** |

**Fourth Semester**

| *Course No.* | *Course Title* | *Cr. Hr.* |
|---|---|---|
| MATH 634 | Mathematical Statistics II | 2 + 1 |
| MATH 694 | Sport Mathematics II (Sport Biomechanics) | 2 + 1 |
| MATH 698 | Anthrotoplogy and Gymnastic-Performance Analysis | 3 + 0 |
| Project | Optional Course A I (Project II) | 0 + 3 |
| | Optional Course B I | 3 + 0 |
| | Optional Course C I | 3 + 0 |
| | **Total** | **13 + 5** |

⊃in collaboration with Department of Health, Physical Education and Sport Sciences, UOK

Committee. The author expresses his gratitude to Mr. Muhammed Obaid, from whom he learnt many concepts of organizational structure and Mr. R. A. Butt for suggesting *the Quranic Philosophy of Education*. Last but not the least, the author would like to acknowledge that he was motivated by Prof. Dr. Sarwar Jahan Abbasi to launch mathematics-teacher-education program. She introduced concepts of mathematical art and mathematical fiction during *the First National Conference on Mathematical Sciences* held in March 2010. This paper is being published to mark the hundredth birth anniversary of author's father and mentor, (Late) Syed Ishtiaq Raza, MA (Alig), BT (Alig) — equivalent of today's BEd, an educationist (born February 2, 1915; died February 7, 1978). No potential conflict of interest is identified for this work.

Table A5. MA (Final) Scheme of Studies — Mathematics-Teacher Education⊂

**Third Semester**

| *Course No.* | *Course Title* | *Cr. Hr.* |
|---|---|---|
| MATH 633 | Mathematical Statistics I | 2 + 1 |
| MATH 687 | Functional Analysis | 3 + 0 |
| MATH 695 | History and Philosophy of Mathematics | 3 + 0 |
| | Optional Course A I | 3 + 0 |
| | Optional Course B I | 3 + 0 |
| | Optional Course C I | 3 + 0 |
| | **Total** | **17 + 1** |

**Fourth Semester**

| *Course No.* | *Course Title* | *Cr. Hr.* |
|---|---|---|
| MATH 634 | Mathematical Statistics II | 2 + 1 |
| MATH 688 | Algebraic Topology | 3 + 0 |
| MATH 696 | Pedagogical Skills for Mathematics Teachers | 2 + 1 |
| | Optional Course A I | 3 + 0 |
| | Optional Course B I | 3 + 0 |
| | Optional Course C I | 3 + 0 |
| | **Total** | **16 + 2** |

⊂in collaboration with Department of Teacher Education, UOK

**Appendix A: MA/MSc Curricula of Department of Mathematics, UOK**

Masters Program is of 2 years (2 semesters in each year). Student is supposed to complete 72 credit hours, equally distributed among 4 semesters. MA/MSc (Previous) Scheme of Studies is common for all disciplines. This scheme consists of basic mathematical concepts, techniques and tools, applicable in different disciplines. MA/MSc Schemes of Studies for *Pure Mathematics*, *Applied Mathematics*, *Anthromathematics*, *Sport Mathematics* and *Mathematics-Teacher Education* are listed in Table A1 (previous year) and Tables A2-6 (final year). Sport-mathematics students have to complete 90-session intensive foundation course (mathematics students in sport sciences and vice versa). A number of optional courses are, already, approved by the Academic Council of University of Karachi courses Karachi and are being offered in the department. New courses are to be introduced keeping in view the current trends in various discip-

Table B1. MPhil (First Year) Scheme of Studies —
Pure and Applied Mathematics

**First Semester**

| *Course No.* | *Course Title* | *Cr. Hr.* |
|---|---|---|
| MATH 701 | Research Methodology I | 2 + 1 |
| | Optional Course D I | 3 + 0 |
| | Optional Course E I | 3 + 0 |
| | Optional Course F I | 3 + 0 |
| MATH 781 | Guest/Students' Seminar I | 0 + 1 |
| MATH 783 | Mathematics-Undergraduate Teaching I | 0 + 3 |
| MATH 785 | Masters-Examination Preparation I | Non-Credit |
| | **Total** | **11 + 5** |

**Second Semester**

| *Course No.* | *Course Title* | *Cr. Hr.* |
|---|---|---|
| MATH 702 | Research Methodology II | 2 + 1 |
| | Optional Course D II | 3 + 0 |
| | Optional Course E II | 3 + 0 |
| | Optional Course F II | 3 + 0 |
| MATH 782 | Guest/Students' Seminar II | 0 + 1 |
| MATH 784 | Mathematics-Undergraduate Teaching II | 0 + 3 |
| MATH 786 | Masters-Examination Preparation II | Non-Credit |
| | **Total** | **11 + 5** |

lines of mathematics. Optional Course C should be different from the student's major field of studies. Some recommendations are given in Box 1.

**Appendix B: MPhil Curricula of Department of Mathematics, UOK**

MPhil program is of 2 years (2 semesters in each year). Candidate is supposed to

Box 1. Choices for Optional Course C

| |
|---|
| Applied-Mathematics Group for *Pure-Mathematics* Students |
| Pure-Mathematics Group for *Applied-Mathematics* Students |
| Pure-Mathematics Group for *Anthromathematics* Students |
| Applied-Mathematics Group for *Sport-Mathematics* Students |
| Applied-Mathematics Group for *Mathematics-Teacher-Education* Students |

Table B2. MPhil (First Year) Scheme of Studies — Sport and Anthromathematics

**First Semester**

| *Course No.* | *Course Title* | *Cr. Hr.* |
|---|---|---|
| MATH 701 | Research Methodology I | 2 + 1 |
| MATH 725 | Advanced Anthromathematics I | 2 + 1 |
| MATH 727 | Advanced Sport Mathematics I | 2 + 1 |
| | Optional Course G I | 3 + 0 |
| MATH 781 | Guest/Students' Seminar I | 0 + 1 |
| MATH 783 | Mathematics-Undergraduate Teaching I | 0 + 3 |
| MATH 785 | Masters-Examination Preparation I | Non-Credit |
| | **Total** | **9 + 7** |

**Second Semester**

| *Course No.* | *Course Title* | *Cr. Hr.* |
|---|---|---|
| MATH 702 | Research Methodology II | 2 + 1 |
| MATH 726 | Advanced Anthromathematics II | 2 + 1 |
| MATH 728 | Advanced Sport Mathematics II | 2 + 1 |
| | Optional Course G II | 3 + 0 |
| MATH 782 | Guest/Students' Seminar II | 0 + 1 |
| MATH 784 | Mathematics-Undergraduate Teaching II | 0 + 3 |
| MATH 786 | Masters-Examination Preparation II | Non-Credit |
| | **Total** | **9 + 7** |

complete 60 credit hours, each semester of first year comprises of 16 credit hours and that of second year 14 credit hours, which include 24 credit hours of 700-level courses (generally, 8 courses, each of 3 hours, 2 of them are Research Methodology) and (10 + 10) hours of thesis research during the second year. Candidates are admitted on the basis of GAT (Subject), with a score of 50 or above. Departmental test is conducted in disciplines, where GAT (Subject) is not available. GAT (Graduate Aptitude Test) is conducted by NTS Pakistan.

By the end of first year candidates have to pass *Masters Examinations* (written and oral) — 2 attempts allowed — and coursework with GPA of 3.0, before being allowed to start work on thesis. MPhil candidates in *Pure and Applied Mathematics* should select Optional Course D from Pure-Mathematics Group and Optional Course E from Applied-Mathematics Group. Optional Course F may

Table B3. MPhil (First Year) Scheme of Studies — Mathematics-Teacher Education

**First Semester**

| *Course No.* | *Course Title* | *Cr. Hr.* |
|---|---|---|
| MATH 701 | Research Methodology I | 2 + 1 |
| MATH 729 | Mathematics and Society I | 2 + 1 |
| MATH 731 | Educational Psychology for Mathematicians I | 2 + 1 |
| | Optional Course H I | 3 + 0 |
| MATH 781 | Guest/Students' Seminar I | 0 + 1 |
| MATH 783 | Mathematics-Undergraduate Teaching I | 0 + 3 |
| MATH 785 | Masters-Examination Preparation I | Non-Credit |
| | **Total** | **9 + 7** |

**Second Semester**

| *Course No.* | *Course Title* | *Cr. Hr.* |
|---|---|---|
| MATH 702 | Research Methodology II | 2 + 1 |
| MATH 730 | Mathematics and Society II | 2 + 1 |
| MATH 732 | Educational Psychology for Mathematicians II | 2 + 1 |
| | Optional Course h II | 3 + 0 |
| MATH 782 | Guest/Students' Seminar II | 0 + 1 |
| MATH 784 | Mathematics-Undergraduate Teaching II | 0 + 3 |
| MATH 786 | Masters-Examination Preparation II | Non-Credit |
| | **Total** | **9 + 7** |

may be from the branch in which the candidate is writing thesis. MPhil candidates in *Sport and Anthromathematics* have to select the Optional Course G from Pure-Mathematics Group. MPhil candidates in *Mathematics-Teacher Education* must select Optional Course H from Applied-Mathematics Group. In Mathematics-Undergraduate Teaching, MPhil Candidate acts as teaching assistant, and helps the course supervisor in grading as well as conducts laboratory and tutorial (problem solving, discussion) sessions of BS, BA/BSc (Honors) and MA/ MSc Courses. Candidate is required to produce one research paper before the award of degree.

Tables B1-4 summarize MPhil (First Year) Scheme of Studies for *Pure and*

Table B4. MPhil (Second Year) Scheme of Studies
(common for all disciplines)

**First Semester**

| *Course No.* | *Course Title* | *Cr. Hr.* |
|---|---|---|
| MATH 787 | Guest/Students' Seminar I | 0 + 1 |
| MATH 789 | Mathematics-Undergraduate Teaching III | 0 + 3 |
| MATH 791 | Thesis Research I | 0 + 10 |
| | **Total** | **0 + 14** |

**Second Semester**

| *Course No.* | *Course Title* | *Cr. Hr.* |
|---|---|---|
| MATH 788 | Guest/Students' Seminar II | 0 + 1 |
| MATH 790 | Mathematics-Undergraduate Teaching IV | 0 + 3 |
| MATH 792 | Thesis Research II | 0 + 10 |
| | **Total** | **0 + 14** |

*Applied Mathematics*, *Sport and Anthromathematics* (Kamal, 2014*b*) and *Mathematics-Teacher Education*, as well as MPhil (Second Year) Scheme of Studies (common for all disciplines), respectively.

**Appendix C: PhD Curricula of Department of Mathematics, UOK**

PhD program is of 2 years (2 semesters in each year). Candidate is supposed to complete 60 credit hours, each semester comprises of 15 credit hours, which include 18 credit hours of 800-level courses (generally, 6 courses, each of 3 hours) and (11 + 11) hours of dissertation research during the second year. Candidates are admitted on the basis of GAT (Subject), with a score of 70 or above. Departmental test is conducted in disciplines, where GAT (Subject) is not available. Tables C1-3 summarize PhD (First Year) Scheme of Studies for *Pure and Applied Mathematics*, *Sport and Anthromathematics* as well as *Mathematics-Teacher Education*, respectively. By the end of first year candidates have to pass *Qualifying Examinations* (written and oral) — 2 attempts allowed — and coursework with a GPA of 3.0, before being allowed to start work on dissertation. PhD (Second Year) Scheme of Studies is common for all disciplines (Table C4). Optional Courses J-N are 800-level courses approved by Department of Mathematics, UOK. It is, strongly, recommended that the

Table C1. PhD (First Year) Scheme of Studies — Pure and Applied Mathematics

**First Semester**

| *Course No.* | *Course Title* | *Cr. Hr.* |
|---|---|---|
| | Optional Course J I | 3 + 0 |
| | Optional Course K I | 3 + 0 |
| | Optional Course L I | 3 + 0 |
| MATH 879 | Independent Study I | 0 + 2 |
| MATH 881 | Guest/Students' Seminar I | 0 + 1 |
| MATH 883 | Mathematics-Graduate Teaching I | 0 + 3 |
| MATH 885 | Qualifying-Examination Preparation I | Non-Credit |
| | **Total** | **9 + 6** |

**Second Semester**

| *Course No.* | *Course Title* | *Cr. Hr.* |
|---|---|---|
| | Optional Course J II | 3 + 0 |
| | Optional Course K II | 3 + 0 |
| | Optional Course L II | 3 + 0 |
| MATH 880 | Independent Study II | 0 + 2 |
| MATH 882 | Guest/Students' Seminar II | 0 + 1 |
| MATH 884 | Mathematics-Graduate Teaching II | 0 + 3 |
| MATH 886 | Qualifying-Examination Preparation II | Non-Credit |
| | **Total** | **9 + 6** |

candidate study one of the optional courses from an allied discipline, *e. g.*, physics or computer science. In Mathematics-Graduate Teaching, PhD Candidate acts as teaching associate (holding at least an MPhil degree), and helps the course supervisor (who is, generally, a PhD-holding Associate Professor or Professor) in grading as well as conducts laboratory sessions of MPhil Courses. Before the award of PhD degree, candidate is required to produce 3 research papers, the first one in an impact-factor journal, the second one in an HEC-recognized journal and the third one in conference proceedings.

## References

1. Ara, J., S. A. Kamal and T. Rahim (2005, December 2-4). Vision of the academic community of science and physics concepts at high school. *The International Conference on Physics for World and Society*, Celebration of World Year of Physics and the Third Annual Session of Rajasthan Physics

Association, University of Rajasthan, Jaipur, India, p. 54, abstract#67**:** http://www.ngds-ku.org/pub/confabst.htm#C65:

2. Barankin, E. W. (1964). Probability and the east. *Annals of the Institute of Mathematics*, **16 (1):** 185-230
3. Beauchamp, G. A. (1968). *Curriculum Theory*. 2nd ed. The Kagg Press, Wilmette, Illinois, United States
4. Brubacher, J. S. (1950). *Modern Philosophies of Education*. McGraw Hill, New York, United States
5. Izetbegovic, A. A. (1993). *Islam Between East and West*. 3rd ed. American Trust Publications, Indianapolis, Indiana, United States
6. Finch, C. R. and J. R. Crunkilton (1999). *Curriculum Development in Vocational and Technical Education***:** *Planning, Content, and Implementation*. 5th ed. Allyn and Bacon, Needham Heights, Massachusetts, United States

Table C2. PhD (First Year) Scheme of Studies — Sport and Anthromathematics

**First Semester**

| *Course No.* | *Course Title* | *Cr. Hr.* |
|---|---|---|
| MATH 803 | Topics in Anthromathematics I | 2 + 1 |
| MATH 807 | Topics in Sport Mathematics I | 2 + 1 |
| | Optional Course M I | 3 + 0 |
| MATH 879 | Independent Study I | 0 + 2 |
| MATH 881 | Guest/Students' Seminar I | 0 + 1 |
| MATH 883 | Mathematics-Graduate Teaching I | 0 + 3 |
| MATH 885 | Qualifying-Examination Preparation I | Non-Credit |
| | **Total** | **8 + 8** |

**Second Semester**

| *Course No.* | *Course Title* | *Cr. Hr.* |
|---|---|---|
| MATH 804 | Topics in Anthromathematics II | 2 + 1 |
| MATH 808 | Topics in Sport Mathematics II | 2 + 1 |
| | Optional Course M II | 3 + 0 |
| MATH 880 | Independent Study II | 0 + 2 |
| MATH 882 | Guest/Students' Seminar II | 0 + 1 |
| MATH 884 | Mathematics-Graduate Teaching II | 0 + 3 |
| MATH 886 | Qualifying-Examination Preparation II | Non-Credit |
| | **Total** | **8 + 8** |

Table C3. PhD (First Year) Scheme of Studies — Mathematics-Teacher Education

**First Semester**

| *Course No.* | *Course Title* | *Cr. Hr.* |
|---|---|---|
| MATH 809 | Mathematics-Curriculum Designing I | 2 + 1 |
| MATH 811 | Educational Philosophy for Mathematicians I | 3 + 0 |
| | Optional Course N I | 3 + 0 |
| MATH 879 | Independent Study I | 0 + 2 |
| MATH 881 | Guest/Students' Seminar I | 0 + 1 |
| MATH 883 | Mathematics-Graduate Teaching I | 0 + 3 |
| MATH 885 | Qualifying-Examination Preparation I | Non-Credit |
| | **Total** | **8 + 8** |

**Second Semester**

| *Course No.* | *Course Title* | *Cr. Hr.* |
|---|---|---|
| MATH 810 | Mathematics-Curriculum Designing II | 2 + 1 |
| MATH 812 | Educational Philosophy for Mathematicians II | 3 + 0 |
| | Optional Course N II | 3 + 0 |
| MATH 880 | Independent Study II | 0 + 2 |
| MATH 882 | Guest/Students' Seminar II | 0 + 1 |
| MATH 884 | Mathematics-Graduate Teaching II | 0 + 3 |
| MATH 886 | Qualifying-Examination Preparation II | Non-Credit |
| | **Total** | **8 + 8** |

7. Frencken, W. G. P. and K. A. P. M. Lemmink (2007, January 16-20). Successful performance in soccer**:** Team kinematics of goal scoring opportunity in small-side soccer games. *The Sixth World Congress on Science and Football*, Antalya, Turkey, abstract#O-024; *Journal of Sports Science and Medicine*, **6** (**Supplement 10):** 19, 20 — (2008). *Science and Football VI (Proceedings)*, edited by T. Reilly and F. Korkusuz, pp. 161-166
8. Ghani, U. (2012, June 13). The twenty-first century impetus for social innovation. *Address*, Grid International Inc. Dinner Program, Hotel Marriott, Karachi, Pakistan
9. Kamal, S. A. (1997, August 11). Moiré fringe topography to detect scoliosis in children. *The News International (Karachi, Pakistan)*, (technotalk page), full text**:** http://www.ngds-ku.org/Articles/A16.pdf

10. Kamal, S. A. (2002, September 23, 24). The Early-Childhood-Integrated-Developmental Examination (ECIDE) for 3-8-year-old children. *The Aga Khan University National Sciences Research Symposium***:** *Early Childhood Care and Development (ECCD 2002)*, Karachi, Pakistan, p. 32, abstract#17**:** http://www.ngds-ku.org/pub/confabst.htm#C54:
11. Kamal, S. A. (2003, February 7-9). The training of a physicist**:** From concept building to problem-solving skills. *The Second International Conference on Physics Education*, Center of Physics Education, National Center for Physics and Department of Physics, University of Karachi, Karachi, Pakistan (concluding talk + recommendations of the conference), full text**:** http://www.ngds-ku.org/Papers/C57.pdf
12. Kamal, S. A. (2004, December 4, 5). Mathematics research and teaching in University of Karachi**:** Challenges and opportunities. *The Winter Conference in Mathematics*, Center for Advanced Studies in Mathematics, LUMS (Lahore University of Management Sciences), Lahore, Pakistan, p. 18, abstract#24**:** http://www.ngds-ku.org/pub/confabst.htm#C62:
13. Kamal, S. A. (2005). *Curriculum of Mathematics (Revised)*. Higher Education Commission**:** Islamabad (editor), full text**:** http://www.ngds-ku.org/HEC/math-booklet-final-2005.pdf

Table C4. PhD (Second Year) Scheme of Studies
(common for all disciplines)

**First Semester**

| *Course No.* | *Course Title* | *Cr. Hr.* |
|---|---|---|
| MATH 887 | Guest/Students' Seminar I | 0 + 1 |
| MATH 889 | Mathematics-Graduate Teaching III | 0 + 3 |
| MATH 891 | Dissertation Research I | 0 + 11 |
| | **Total** | **0 + 15** |

**Second Semester**

| *Course No.* | *Course Title* | *Cr. Hr.* |
|---|---|---|
| MATH 888 | Guest/Students' Seminar II | 0 + 1 |
| MATH 890 | Mathematics-Graduate Teaching IV | 0 + 3 |
| MATH 892 | Dissertation Research II | 0 + 11 |
| | **Total** | **0 + 15** |

14. Kamal, S. A. (2006, May 23). *Manual for Obtaining Anthropometric Measurements.* The-NGDS-Pilot-Project-e-Publication, University of Karachi, Karachi, Pakistan, pp. 11, 12, full text**:** http://www.ngds-ku.org/ngds_folder/M02.pdf
15. Kamal, S. A. (2008*a*). *Curriculum of Mathematics (BS 4-Year)*. Higher Education Commission, Islamabad, Pakistan (editor) , full text**:** http://www.ngds-ku.org/HEC/math-booklet-final-2008.pdf
16. Kamal, S. A. (2008*b*, December 18-20). From mathematics to technology**:** A bridge through physics and engineering. *Proceedings of the International Conference on Physics and the World of Today*, edited by M. A. Jafri and S. M. Naqvi, Department of Physics, University of Karachi, Karachi, Pakistan, pp. 32-39, full text**:** http://www.ngds-ku.org/Papers/C70.pdf
17. Kamal, S. A. (2008*c*, December 20-23). Role of mathematics in sports sciences and technologies. *The Thirty-Fifth All Pakistan Science Conference (Genomics for Health and Prosperity)*, University of Karachi, Karachi, Pakistan, p. 75, abstract#72**:** http://www.ngds-ku.org/Presentations/Sports.pdf
18. Kamal, S. A. (2008*d*). Handling industrial projects. *RAWISH (Magazine of Government Degree College, Malir Cantonment, Karachi, Pakistan)*, pp. 47-49, full text**:** http://www.ngds-ku.org/Articles/A20.pdf
19. Kamal, S. A. (2009, January 15). The integrated-educational system**:** A pre-university educational system for the third millennium. *The Sindh Educational Conference*, the Jamia Millia Government College of Education, Karachi, Pakistan, p. 1 (keynote lecture), abstract#1**:** http://www.ngds-ku.org/Presentations/Education.pdf
20. Kamal S. A. (2011*a*, May 28). Intelligent power, conflict resolution, complexity and international trade. IBA (Institute of Business Administration), Karachi, Pakistan (seminar)**,** abstract**:** http://www.ngds-ku.org/Presentations/IBA.pdf
21. Kamal, S. A. (2011*b*, October 22). Curbing corruption in pre-university education. *Seminar on Curbing Corruption in the Education Sector*, the Education Committee, Transparency International Pakistan, Ambassador III, Hotel Marriott, Karachi, Pakistan, p. 1, abstract**:** http://www.ngds-ku.org/Presentations/TIP.pdf
22. Kamal, S. A. (2013, December 12). Designing curricula, which produce leader-integrator of tomorrow. *The Karachi University Educational Conference*, University of Karachi, Karachi, Pakistan, pp. 3, 4 (keynote lecture), abstract**:** http://www.ngds-ku.org/Presentations/Leader-Integrator.pdf
23. Kamal S. A. (2014*a*, December 3, 4). Small-intelligent power and conflict management at state-level. *The International Conference on Challenges of*

*Transition in Social Sciences (ICCTSS 2014)*, Faculty of Social Sciences, University of Karachi, Karachi, Pakistan, p. 32, academic session, Paper II, abstract**:** http://www.ngds-ku.org/Presentations/Smart-Intelligent.pdf

24. Kamal S. A. (2014*b*, May 17). Sports and anthromathematics. *The Fifty-Fifth Annual Prize Distribution Function*, Government College, Hyderabad, Pakistan (seminar)**,** abstract**:** http://www.ngds-ku.org/Presentations/Sport_Mathematics.pdf
25. Kamal, S. A. and K. A. Siddqui (1986, December 27, 28). How to develop creative thinking and critical analysis? *Proceedings of the Second Workshop on Teaching of Physics*, edited by A. F. Hasnain, Karachi, Pakistan, pp. 51-56, full text**:** http://www.ngds-ku.org/Papers/C24.pdf
26. Kamal, S. A. and K. A. Siddiqui (1989, April-June). Basic requirements to train a physicist. *Physics Education (India)*, 53-61, full text**:** http://www.ngds-ku.org/Papers/J09.pdf
27. Kamal, S. A., K. A. Siddiqui and Naseeruddin (2009). Concept building in the undergraduate mathematics and physics curricula. *Karachi University Journal of Science*, **37 (1&2):** 1-6, full text**:** http://www.ngds-ku.org/Papers/J28.pdf
28. Kamal, S. A., Naseeruddin, M. Wasim and S. Firdous (1998). Physics of scoliosis screening in school-going children. *Karachi University Journal of Science*, **26 (1):** 5-12, full text**:** http://www.ngds-ku.org/Papers/J22.pdf
29. Kamal, S. A., S. A. Ansari and S. S. Jamil (2015). Generating and validating Growth-and-Obesity Roadmaps for the Pakistani children. *International Journal of Biology and Biotechnology*, **12 (1):** 47-61, full text**:** http://www.ngds-ku.org/Papers/J35.pdf
30. Kamal, S. A. and S. A. Khan (2013, September 4, 5). Fitness for primary-school children. *The First Conference on Anthromathematics in the Memory of (Late) Syed Firdous (ANTHROMATHEMATICS 2013)*, Department of Mathematics, University of Karachi, Karachi, Pakistan and Government College, Hyderabad, Pakistan, p. 24, abstract# Anthro13-18**:** http://www.ngds-ku.org/Presentations/Fitness.pdf
31. Kamal, S. A. and S. A. Khan (2014). Primary-physical-education practices in Pakistan and England**:** Health and safety perspectives. *International Journal of Biology and Biotechnology*, **11 (2&3):** 401-419, full text**:** http://www.ngds-ku.org/Papers/J33.pdf
32. Kelly, D. and T. L. Amburgey (1991). Organizational inertia and momentum: A dynamic model of strategic change. *Academy of Management Journal*, **34 (3):** 591-612
33. Pratt, D. (1980). *Curriculum: Design and Development*. Harcourt Brace Jovanovich, New York, United States
34. Siddiqui, K. A. and S. A. Kamal (1986, December 27, 28). Physics makes

the deaf and the dumb equations of mathematics to speak. *Proceedings of the Second Workshop on Teaching of Physics*, edited by A. F. Hasnain, Karachi, Pakistan, pp. 40-49, full text**:**
http://www.ngds-ku.org/Papers/C25.pdf

35. Siddiqui, K. A. and S. A. Kamal (1987, October 14-17). A survey of school and pre-university physics education in Pakistan. *Physics Education in Asia (Proceedings of the Regional Physics Education Symposium and the Aspen General Conference)*, edited by S. B. Aidid, M. Z. Ismail, A. K. Koh and M. M. Singh, Kuala Lumpur, Malaysia, pp. 81-89, full text**:** http://www.ngds-ku.org/Papers/C28.pdf
36. Sharma, J. P. (2005). *Curriculum Design in Physical Education*. Khel Sahitya Kendra, New Delhi, India, 231
37. Strang, R. (1947). *Educational Guidance***:** *Its Principles and Practice*. Macmillan, New York, United States
38. Tahir, M. and M. M. Yousaf (2007). *National Curriculum for General Mathematics — Grades IX-X (Humanities Group)*. Ministry of Education, Government of Pakistan**:** Islamabad, Pakistan
39. Tahir, M. and M. M. Yousaf (2008). *National Curriculum of for General Mathematics — Grades XI-XII (Humanities Group)*. Ministry of Education, Government of Pakistan, Islamabad, Pakistan
40. Tahir, M., M. M. Yousaf, Saleemullah and T. Saqib (2006). *National Curriculum for Mathematics — Grades I-XII*. Ministry of Education, Government of Pakistan, Islamabad, Pakistan
41. Toriola, O. M. (2010). Children's perception of physical education and school sport in Swaziland. *The Shield (International Journal of Physical Education and Sport Science)*, **5 (1):** 96-107
42. Van De Wallie, J. A. (1990). *Elementary School Mathematics, Teaching Developmentally*. Addison-Wesley/Longman, Reading, Massachusetts, United States

*(Accepted for Publication***:** *January 2015)*

*Web address of this document* (*on author's homepage*)**:** http://www.ngds-ku.org/Papers/J39.pdf
*Abstract***:** http://www.ngds-ku.org/pub/jourabstB.htm#J39: