

The Concept of Knowledge in Islam and the Principles of Mathematical Sciences

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The theme of this Symposium is *Islamization of knowledge*. The word 'Islamization' is used here as a technical term, and, like every term, it has a certain connotation which is determined by definition. The term is understood here to mean that the concept, principles and methodology that are needed to organize and develop the system of knowledge should be in conformity with the spirit of Islam and the epistemology derived from the Qur'ān.

I think that in the present era, Muḥammad Iqbal of Pakistan, the great Poet of the East and the renowned Muslim philosopher, put forward this idea of *Islamization of knowledge* for the first time in his Persian Mathnavi, "Musafir" in the early (1350/1930's): The actual words used by Iqbal are as follows:

جون عرب اندر اروپا برکشاد علم و حکمت را بنا دیکر نهاد
دانه آن صحرا نشینان کاشتند حاصلش افرنکیان برداشتند
خوشر آن باشد «مسلمانان کنی» کشتیه شمشیر قرآنش کنی
این پری از شیشه اسلاف ماست باز صیدش کن که او از قاف ماست

When the Arabs spread their wings in Europe
Knowledge & Science were given a new foundation
One fruit of the seed that these desert dwellers had planted was
plucked out by Europeans
Happy are those who Islamize it
This fairy is from the bottle of our ancestors
Capture it again because it comes from our mountains.

Thus the object of Islamization should be to capture the 'fairy' of *ilm* and *hikmah*, i.e., science and technology, to make it our own, to master it and make great advance in it, and to apply it for the benefit of humanity (بما ینفع الناس) through the conquest of Nature, so that the declaration in the Qur'ānic verse below may be realized by the human race:

﴿ألم تروا ان الله سخر لكم ما في السموات وما في الأرض﴾ لقمان (٢٠:٣١)

Do you not see that Allah has subjected to your use all things in the heavens and on earth . . .” Qur’ān (31:20)

This means that the re-orientation and re-organization of knowledge should be such that the acquisition and creation of new knowledge which is the *sine qua non* for the conquest of the forces of Nature is not lost to the human race. Let us therefore examine what are the Islamic concepts and principles of acquiring and creating knowledge.

There are three degrees of knowledge, viz.:

- (1) علم اليقين , *Ilm al Yaqīn*, i.e., knowledge by inference. This depends either on the truth of its assumptions (postulates) as in *deduction*, or on probabilities as in *induction*.
- (2) عين اليقين , *Ayn al Yaqīn* i.e., knowledge by perception and observation. This is based on the actual experience of phenomena.

Scientific knowledge is of the above mentioned two kinds and is acquired from the study of natural phenomena which are signs of Allah (آيات الله), *Āyāt Allah* and symbols of ultimate Reality. The study of Nature, of the Heavens and the Earth, and their contemplation is enlightening for men of understanding. They learn the ways of Allah—سنة الله—*Sunnah Allah*, i.e., Law of Nature and subjugate the forces of the physical world.

- (3) The third category of knowledge is حق اليقين *Haqq al Yaqīn*. Allah reveals His signs not only in the observation and contemplation of the outer world (آفاق), *Afāq*, but also through the inner experience of the mind (أنفس) *Anfus*. This Divine guidance comes to God’s creatures in the first instance from this inner experience by means of:
 - (a) Instinct, i.e. جيلة *Jibillah*
 - (b) Intuition, i.e. وجدان *Wijdān*
 - (c) Inspiration, i.e. الهام *Ilhām*
 - (d) Revelation, i.e. وحى *Wahy*

Knowledge and wisdom are two of the Attributes of Allah Who is علم *Alīm* and حكيم *Hakīm*—Omniscient and All-Wise. He knows what is in the Heavens and the Earth: يعلم ما في السموات والأرض

On the other hand, man does not know anything except what has been taught to him by Allah: علم الانسان ما لم يعلم. The first Revelation to the Prophet of Islam (SAAS) ﷺ dealt with reading and learning, and the Prophet (SAAS) ﷺ then pronounced the categorical injunction that it is the sacred duty of every believer—man and woman—to acquire knowledge!

طلب العلم فريضة على كل مسلم ومسلمة

The Qur’an further explains that those believers to whom knowledge has been vouchsafed occupy higher ranks and exalted positions: (Qur’an 58:11)

﴿يرفع الله الذين آمنوا والذين أوتوا العلم درجات﴾ المجادلة (١١:٥٨)

and that those who know and those who do not know cannot be equal:
(Qur'an 39:9)

﴿قل هل يستوي الذين يعلمون والذين لا يعلمون﴾ الزمر (٩:٣٩)

Islam thus sanctified knowledge, and created a keenness for it among the believers. The impetus of this injunction of Islam about learning and its emphasis on acquiring knowledge was such that the spirit of enquiry spread rapidly throughout the Muslim world.

Let us see how this knowledge, whose acquisition has been made obligatory on every individual, is obtained.

Going back to the early period of the human race, it is found that man accepted things at their face value. As time passed and his consciousness developed, he acquired knowledge by experience. His knowledge, which consisted of a catalogue of events, was quite sketchy and haphazard. He had no concept of drawing inference or making predictions. Systematization began much later with the Babylonians and Egyptians.

The Qur'an, on the other hand, appealed constantly to reason and observation, and thus showed that knowledge was based on both experiment and theory. According to Islam, contemplation is only one source of human knowledge. There are two other sources, viz., history and nature. By tapping these sources the spirit of Islam is seen at its best.

The observable aspect of Reality is emphasized by the Qur'an in several verses such as:

﴿إِنَّ فِي خَلْقِ السَّمَاوَاتِ وَالْأَرْضِ وَاخْتِلَافِ اللَّيْلِ وَالنَّهَارِ وَالْفَلَكَ الَّتِي تَجْرِي فِي الْبَحْرِ بِمَا يَنْفَع النَّاسَ وَمَا أَنْزَلَ مِنَ السَّمَاءِ مِنْ مَاءٍ فَأَحْيَا بِهِ الْأَرْضَ بَعْدَ مَوْتِهَا وَبَثَّ فِيهَا مِنْ كُلِّ دَابَّةٍ وَتَصْرِيفِ الرِّيَّاحِ وَالسَّحَابِ الْمُسَخَّرِ بَيْنَ السَّمَاءِ وَالْأَرْضِ لآيَاتٍ لِقَوْمٍ يَعْقِلُونَ﴾ البقرة (٢:١٦٤)

The Qur'an sees signs of the ultimate Reality in the sun, the moon, the stars—in fact in the whole of Nature as revealed to the perception of man. And a Muslim's duty is to reflect on these signs, and not to pass by them as if he is "deaf and blind". (Qur'an 2:164) Do you not see?; do you not think?, is the theme constantly recurring in the Qur'an. Repeatedly does the Book lay stress on the phenomena of this world as a sure means of knowledge. The Book awakened the empirical spirit in the Muslims, and made them the founders of modern science. The appeal to the concrete was first made by the Prophet (SAAS ﷺ) who prayed constantly for the knowledge of the ultimate Nature of Things: رب أرني حقائق الأشياء كما هي

The Muslim savants acted on these guide-lines laid down by the Qur'an and the *Sunnah*, and developed the new methods of enquiry, observation, experiment and measurement on which modern science is based. They never lost sight however, of the fact that the Omniscient Allah has clearly pointed out that man has been given only a little knowledge. (Qur'an 17:85):

﴿وما أوتيتم من العلم إلا قليلاً﴾ الاسراء (٨٥:١٧)

The final cause, the total explanation, and the real nature of things are transcendental, and belong to the unseen world, (عالم الغيب), the knowledge of which cannot be obtained by human senses and perception, and are, therefore, not amenable to the method of science. According to the Qur'an, the invisible is known only to Allah: (Qur'an 27:65)

﴿قل لا يعلم من في السموات والأرض الغيب إلا الله﴾ النمل (٦٥:٢٧)

Belief in the Unseen (الإيمان بالغيب) is one of the cardinal principles of faith in Islam. On the other hand, the quest for the knowledge of the unseen is inborn in the nature of man:

﴿فطرة الله التي فطر الناس عليها﴾ الروم (٣٠:٣٠)

In such a situation, Allah who is sole possessor of the knowledge of the Unseen reveals it to whom so ever he wills from among his messengers (Qur'an 3:179)

﴿وما كان الله ليطلعكم على الغيب ولكن الله يجتبي من رسله من يشاء﴾ آل عمران (١٧٩:٣)

It is thus obvious that when man cannot know the unseen directly through his own perceptive faculties or reason, and when this knowledge can be imparted to him by the chosen Apostle, to whom it is revealed by Allah, the only way for man to attain this knowledge of the unseen is to believe in Allah and his Apostles.

In the light of these basic principles of knowledge derived from the teachings of Islam, we have to evaluate the various branches of science, and see whether, and how far, they violate any of these principles, and how the re-orientation can be brought about.

Naturally there can be many difficulties, when one sets about this task. The *Ummah* should, however, face this challenge, and competent scholars who combine in themselves expert knowledge of the scientific discipline as well as of the Islamic principles, should devote themselves to the task of re-organizing and re-constructing the major disciplines, taking care that the advances and development (a great deal of which have been contributed by the

Muslims themselves), and on the basis of which the conquest of nature can be effected, are preserved as far as possible.

Of course, if any of the modern developments are demonstrably against the spirit of Islam, they should be discarded by all means. However, the subject should be so developed on Islamic foundations, that its proven parts about which there can be no objections are not lost entirely to the Muslim people and the *Ummah* is not deprived of beneficial applications of that knowledge. No doubt we have to make sure that there is nothing in the various branches of knowledge repugnant to the Qur'an and the *Sunnah*. We have also to remember: الحكمة ضالة المؤمن that "wisdom is that which the muslim searches for."

Turning now to the Mathematical Sciences, we have to analyze their foundations as well as the structures erected on these foundations.

Mathematics is the development of Logic, dealing with the laws of thought and of deriving valid inferences from the fundamental axioms. It deals with numbers and their generalizations and mutual correspondence and relationships.

The foundations of many branches of mathematics were essentially laid by the Muslims themselves, and essentially these foundations were not influenced by any political or social beliefs. Hence there would probably not be much scope for re-organizing them to any appreciable extent. Let us consider this in some detail. I am discussing here only a few fundamental and epoch-making ideas which revolutionized the different branches of mathematics. The overall contributions of Muslims, as we know, are innumerable, verified as by George Sarton (*Introduction to the History of Science*), Moritz Cantor (*Geschichte der Mathematik*), Heinrich Suter and a host of other writers. I have also given my account in the *History of Muslim Philosophy*, edited by M. M. Sharif.

As pointed out earlier, mathematics can be described as the science of numbers, their generalizations and relationships. First of all, let us consider the numbers themselves. Prior to the work of Muhammad ibn Mūsā al-Khawārizmī, numbers were depicted by the letters of the Alphabets; thus 'i' stood for one, 'v' for five, 'x' for ten, and so on. In the very beginning, the Arabs also used their alphabets . . . د، ب، ج، ا etc., for denoting numbers. With this kind of arithmetic mankind could not have made much headway. It is said that the Chinese and the Indians had some conception of the numerals but systematically the numerals were introduced and employed by the Arabs who spread them throughout the world. They have been generally known as "Arab Numerals" ever since.

These Arab numerals however, would not have been sufficient for the development of mathematics, and consequently of modern science. Two things were still missing. One was the number 'zero'. This numeral called 'sifr' (صفر) in Arabic, which means 'empty', was essential and indispensable to make the

system of enumeration complete.

The second missing was the positional value of a numeral, viz., its value when it occupies the first, second, third or other position in the row. These positions signify the units tens, hundreds, thousands and so on.

These three important and vital ideas about numbers were given by al-Khawārizmī in his book on arithmetic which systematized the knowledge of the subject known up to that time.

Al Khawārizmī went much further than this and made great strides. Prior to him, the mathematicians, including the Greeks, considered the number to be a pure magnitude. It was only when Al Khawārizmī conceived of the number as a relation in the modern sense, that the science of algebra became possible. The development of algebra is one of the greatest achievements of the Muslims, and it was cultivated so much that the symbolical process which it idealizes is still called "Algorithm" in modern mathematics. Al Khawārizmī himself formulated and solved the algebraic equations of the first and second degree, and discovered his elegant geometrical method of finding the solutions of such equations. He thus laid the foundations of geometrical algebra, which was developed a great deal by the later Muslim scholars.

Like the other Muslim scholars and scientists, the great Al Khawārizmī was a staunch believer in Islam, and has invariably recorded 'Praise' (حمد) to Allah and *Ṣalāh* (صلاة) to the Holy Prophet (SAAS ﷺ) at the very beginning of his writings. By way of illustration I am quoting here from the first paragraph of his famous *book of algebra* كتاب الجبر والمقابلة:

بسم الله الرحمن الرحيم
 "هذا كتاب وضعه محمد بن موسى الخوارزمي افتتحه بأن قال الحمد لله على نعمه بما هو
 أهله من محامده التي بأداء ما افترض منها علي من يعبده من خلقه يقع اسم الشكر ويستوجب
 المزيد وتؤمن من الغر إقراراً بربوبيته وتذلللاً لعزته وخشوعاً لعظمته.
 بعث محمداً ﷺ بالنبوة على حين فترة من الرسل وتذكر من الحق ودروس من الهدى
 فبصر به من العمى واستنقذ به من الهلكة وكثر به بعد القلة وألف به بعد الشتات.
 تبارك الله ربنا وتعالى جده وتقدسست أسماؤه ولا إله غيره، وصلى الله على محمد النبي
 وآله وسلم".

The great al Bīrūnī introduced the idea of a "function" which describes the correspondence of two numbers and the dependence of one number on the other. This concept of function has become a most important idea in mathematics.

AbūBakar al Kartūbī wrote a book on algebra called *Al Fakhri*, in which he developed among other important ideas—such as the theory of surds, the

summation of series and the indeterminate quadratic equations—the very important concept of mathematical induction. It is generally recognized that the method of inductive reasoning is one of the greatest contributions of Muslims to modern civilization.

The illustrious ‘Umar al Khayyām, who is considered as one of the greatest mathematicians, made what was for his time an uncommonly great progress by dealing systematically with algebraic equations of the cubic and higher orders, and by classifying them into various groups.

In the subject of geometry, the three sons of Shākir Ibn Mūsā, Muhammad, Aḥmad, and Ḥasan, who are also called the Banū Mūsā, discovered a method of trisecting an angle by the geometry of motion, thus connecting geometry with mechanics. That this problem is not solvable by means of the ruler and compass alone, has been well-known from the time of the Greek mathematicians.

In the fourth century of *Hijrah*, al Kūhī and others founded and successfully developed a branch of Geometry that consists of problems leading to algebraic equations of the third and higher degrees. This correlation of geometry with algebra, and the geometric method of solving algebraic equations introduced by al Khawarizmi, anticipated Descartes’ discovery of analytical geometry in the eleventh century A.H. / seventeenth century A.C.

The crowning achievement of Muslims in the subject of Geometry was, however, connected with the appraisal of Euclid’s postulates. It is well-known that in each science or logical system, the beginning is made with some fundamental concepts and a few assertions called postulates (or axioms) which are accepted without demonstration or proof, and on the basis of which further statements (called theorems) are established. Now it is recognized that some of Euclid’s postulates are quite self-evident. For instance, no one questions the validity of the statement that the whole is greater than a part, or that equals added to equals result in equals. But the same cannot be said about Euclid’s, parallel postulate. Fakhr al Dīn al Rāzī (d.606 AH / 1210 AC) made a preliminary critique of this postulate, but it was Naṣr al Dīn al Ṭūsī (d.673 AH / 1275 AC) who recognized the weakness in Euclid’s theory of the parallels. Since the days of Ptolemy no one had given serious thought to the difficulties of demonstrating the truth of *Euclid’s* parallel postulate on the basis of perceptual space. After the lapse of more than a thousand years, it was Naṣr al Dīn al Ṭūsī who first tackled this problem, and in his efforts to improve the postulate, realized the necessity of abandoning perceptual space. It was only in the thirteenth century AH / nineteenth century AC century that such studies continued by Bolyai, Lobachievsky, Gauss and Reimann resulted in the discovery and development of the various non-Euclidean geometries, culminating in the hyperspace movement and the Theory of Relativity of our own time.

Trigonometry, both plane and spherical, is, for the most part, a creation of the Muslims. Al Khwārizmī himself compiled trigonometric tables that contained not only the sine function as utilized by his predecessors, but also for the first time, the tangent functions. Muhammad ibn Jābir al Baṭṭānī (d. 317 AH / 927 AC) used sines regularly because he was convinced of their superiority over the Greek chords. The previous works contained the full arc, but al Baṭṭānī remarked that it was more advantageous to use the half-arc, which is regarded as a very important advance in mathematics. He completed the introduction of tangents and cotangents in trigonometry, and gave the relation between the sides and angles of a spherical triangle.

Abu al-Wafa al Kūhī was the first to show the generality of the sine theorem relative to the triangles. He introduced the secant and the cosecant in trigonometry, and was aware of the relations between the lines connected with a triangle that are used to define the six trigonometric functions.

After developing trigonometry, and preparing accurate trigonometric tables, the Muslim mathematicians could calculate the heights of mountains, distances of inaccessible places, and breadths of rivers.

Later developments in mathematics have been established on the above mentioned foundations which were laid by the Muslim scholars themselves. It is unlikely, therefore, that there is anything in these developments which is repugnant to the spirit of Islam.

There is, however, one branch of the mathematical sciences, viz., cosmology, for which a detailed review has to be undertaken to see how far the present theories of the origin and evolution of the nebulae, the stars, the planets and other celestial bodies can be harmonized with the account of the creation of the universe given in the Qur'ān.

For instance, Astro-physicists have proposed a theory that initially the primordial matter, consisting of the elementary particles, was spread out uniformly when, all of a sudden, there was a disturbance and a big bang when the process of condensation started and the evolution of nebulae and stars began. The scientists are not in a position to say what this bang was but the believers can say that it was the Divine Order: Be! “ *كن* ”.

Anyway, this is the subject which would have to be considered in depth by competent scholars who possess an expert knowledge of the cosmological discipline and of the origin and creation of the universe contained in the Qur'ān.