The Reform Project

Progressive, enlightened voices from the Arab Muslim world

Towards a

Model Curriculum

For the reform of the educational syllabus

in the teaching of the humanities

[A] Courses:

The Rise and Nature of Knowledge

Course A1		The Route to Knowledge – The historical rise of the scientific method		
	Module		Units	
	A1.1	**Antiquity – early methodology and the emergence of natural science**	A1.1.1	The culturally diverse origins of scientific endeavour
			A1.1.2	Pre-Socratics and the tussle between myth and reason
			A1.1.3	Atomism - an early but repudiated pre-echo of modern science
			A1.1.4	Epicurus and the pre-figuring of scientific methodology
			A1.1.5	Early controversy on Evolution - Aristotle and Lucretius
			A1.1.6	Aristotle and the triumph over Plato's *Theory of Forms*
			A1.1.7	Aristotle and the ordered categorisation of investigative method
			A1.1.8	The debate on final causation - and its relevance for today
			A1.1.9	The relationship of philosophical thought to the promotion of science
	A1.2	**The Late Antiquity Transition**	A1.2.1	Technological advance and the focus on empiricism
			A1.2.2	Explorations on the concept of a 'soul'
			A1.2.3	Plotinus and 'Neo-Platonism' - its influence on the trajectory of science
			A1.2.4	From 'Unmoved Mover' to creator deity
			A1.2.5	Ptolemy and the structure of the heavens
			A1.2.6	The limitations of ancient science
	A1.3	**The Muslim world**	A1.3.1	Continuity and development of Hellenistic science in the Muslim world
			A1.3.2	The defence of the scientific vision: al-Kindī, Ibn Sīnā and Ibn al-Haytham
			A1.3.3	Cultural tensions associated with the 'interloper' sciences
			A1.3.4	The search for authority: *'Ilm al-kalām* , the Mu'tazila and the *Miḥna*
			A1.3.5	The rise of Ash'arism, Occasionalism and opposition to the logicians
			A1.3.6	The implications of the al-Ghazālī/ibn Rushd debate
			A1.3.7	The waning of Muslim science
	A1.4	**The rise of scientific method in Europe**	A1.4.1	Radical Aristotelianism, Averroists and the development of the 'double truth'
			A1.4.2	The separation of the *magisteria* of faith and 'natural philosophy'
			A1.4.3	The emergence of a consistent scientific method
	A1.5	**The 17th century transformation**	A1.5.1	The relinquishing of the teleological function of science
			A1.5.2	The acceptance and utility of doubt
			A1.5.3	Copernicus, Galileo and the struggle for heliocentrism
			A1.5.4	Descartes and Bacon: the debate between rationalism and empiricism
			A1.5.5	Isaac Newton's mechanical model for the universe
			A1.5.6	The institutionalisation of research, peer review and dissemination

Course A2		The methodology of science		
	Module		Units	
	A2.1	**Preliminaries**	A2.1.1	Developing the scientific attitude
			A2.1.2	Legitimising doubt, questioning and self-examination
	A2.2	**Basic methodological principles**	A2.2.1	Precision in vocabulary and definitions
			A2.2.2	The elimination of bias and the adoption of objectivism
			A2.2.3	The avoidance of relativism
	A2.3	**The methodology of effective argument**	A2.3.1	Constructing questions, collecting data, formulating a thesis
			A2.3.2	Falsifiability, predictive power and repeatability
			A2.3.3	The interpretation of data - the use of inductive and deductive reasoning
			A2.3.4	The structure and sequence of investigation
	A2.4	**Argumentation fallacies and the detection of pseudo-science**	A2.4.1	Key indicators of weak scientific reasoning
			A2.4.2	Key indicators of pseudo-science and deception

Preliminaries on knowledge acquisition

Given that the intellectual, philosophical and analytical mode of thinking is a mentality not fully indigenised to Arab students, who have been schooled by indoctrination and rote learning, the explanation of the structure and method of contemporary approaches to knowledge acquisition must act as a necessary preliminary preparation to the *Model Curriculum* as a whole.

Such a preparation aims to facilitate the absorption of modern methods of knowledge acquisition and evaluation, and inculcate an understanding of the nature of knowledge as an attitude and an approach, rather than a finite body of wisdom to be revealed to the labours of the worthy or the pious. It trains the student to nuance his decisions according to the methodology of evidence-gathering, evaluation and testing, and establishes the propriety of doubt and productive criticism as affirming, rather than enfeebling, the scientific endeavour.

This preliminary groundwork is essential in order to put the students in a receptive mindset, one that does not adopt a confrontational attitude of defending an imagined attack upon Islam, or one that might lead them to consider that they are about to be 'westernised' in some way. Accordingly, the *Model Curriculum* makes the solid case for the cultural neutralism of modern methodologies of accumulating and evaluating knowledge (including the scientific method).

It thus prepares a generation of students capable of distinguishing religious truths inherent in religious faith from scientific truths focusing on the realities of the physical world. By so doing the student will see the irrelevance of 'red lines' and any falsely proposed arenas of 'conflict' between science and faith.

Course A1 - The Route to Knowledge – The historical rise of the scientific method

If the student is to make sense of the route to knowledge, an appreciation of the historical and cultural background of the rise of science is crucial. The educator will therefore need to include a module of comparative history in the programme in order to demonstrate the developmental trajectory of the scientific method. That is, the factors which were conducive to its rise, the reasons for its progressive development in the late medieval period and the acceleration of its development and elaboration in Europe during the Enlightenment period. The lessons learned from that trajectory will then be demonstrated as relevant for the future prospects of a knowledge society in the Arab-Muslim world.

The task for the educator is to extract from historical record those elements that were conducive to inquiry and which developed into the modern scientific methodology. In this process it is important to underline the multi-faceted sources of the reasoning systems that went into these methods, along with an appropriate focus for the Middle Eastern student of the contribution made by Arab-Muslim scholars to that development. With this focus the educator will be able to embed the modern approach to knowledge acquisition as an integral part of *world* heritage rather than as some unilateral imposition of a particular civilisational pattern.

To do this, the *Course A1 - The Route to Knowledge – The historical rise of the scientific method* provides sample readings that illustrate the development of the scientific method as it developed over history and the stages of the advance, from the emergence in Greece and ancient India of rationalist explanations of nature, to the pioneering of the scientific method as it is practised today, passing through the following broad stages:

- Antiquity – early methodology and the emergence of natural science
- The Late Antiquity transition
- The Muslim world
- The rise of the scientific method in Europe
- The 17th century transformation

In order to avoid an extensive course on the history of science, *Course A1* concentrates on those matters during these periods that illustrate the scientific *attitude* or *method*.

- *Module A1.1: Antiquity – early methodology and the emergence of natural science*

The task for the educator is to prioritise those elements in thinking that are experimentally based and which, over history, have allowed for the accumulation of knowledge of the physical world. The module on *Antiquity – early methodology and the emergence of natural science* achieves this by rooting the historical treatment of the rise of the scientific method back in deep antiquity (unit *A1.1.1*), from the role of the Babylonians in evolving the first examples of an observation-based astronomy, ancient Egyptian technology and geometric precision, ancient Chinese Mohist explorations of logic and opposition of fatalism, through the accumulated achievement of structured science that began with the pre-Socratic ancient Greek philosophers in replacing mythical and religious explanations for phenomena (unit *A1.1.2*), the confirmation of physical reality as the appropriate subject of study, the rise of atomism as a foundation for a scientific explanation of phenomena, and the defense of sense perception and experimentation (unit *A1.1.3*).

The module establishes these fundamental building blocks of the early scientific method of investigation by paradigmatically focusing on two authors – Epicurus and Aristotle – in order to set the scene for the operative attitudes to science (unit *A1.1.4*). Their importance for the *Model Curriculum* is that, in very broad terms, Epicurus signified *what* to study, and Aristotle demonstrated *how* to study. The schools of thought focusing on the work of these thinkers furnished the foundational basis for subsequent developments on the route to knowledge.

Since the educational dispute in the present time in the Middle East is most clearly focused on evolutionary theory (as demonstrated in *Part II* above in the section on '*The evolution question'*) the importance of the Greeks' contribution to disentangling mundane scientific from metaphysical theological thinking is highlighted (units *A1.1.5* and *A1.1.6*). This underlines the antiquity of the debate, the decisions made, and the ultimately positive results from this disentangling.

The educator can thus establish for the student how the legacy of the ancient world to science is not merely a matter of antiquarian interest. In reality the period bequeathed substantial advances in factual knowledge across a full range of scientific disciplines, important analyses of scientific problems (especially those related to change and its causes as developed in unit *A1.1.8*), the relationship of philosophical thought to the promotion of scientific knowledge (unit *A1.1.9*), a recognition of the importance of an empirical attitude to investigation and the establishment of a logically coherent and consistent framework for the categorising and understanding of natural phenomena.

- *Module A1.2: The Late Antiquity Transition*

The educator will be able to highlight how, alongside the development towards specialisation in the sciences and the refinement of instrumentation, the Hellenistic period (320 BC ff) and the period of Late Antiquity (c.250 AD to c.650 AD) established the core features of what came to dominate the philosophical and theological world view of the Middle Ages in Europe and the Muslim world.

This period witnessed the transition from a largely material conception to one that included a stronger focus on theological explanations that will be more familiar to the Muslim student. During this period there emerged theories of 'ensouled' or animate creatures and their parts, and the conception of a 'world soul' extending throughout matter, which later developed on from the conception of creation as a force *within* nature, through one of the actions of a *demiurge* ordering the material of nature, and eventually towards an individualised, monotheistic divinity *transcending* the material world (explored in units *A1.2.2* to *A1.2.5*). This development had a theologically productive, but scientifically restricting, influence over the following centuries.

A second, ultimately restricting, development was the establishment of the model of the earth and the universe put forward by Ptolemy which, albeit an improvement on earlier models of earth as a flat disk, bypassed available current geocentric theses and posited a motionless sphere standing at the centre of seven rotating spheres containing the sun, moon and five planets (unit *A1.2.6*). This Ptolemaic system heavily influenced other cultural traditions and remained the canonical explanation in both the Christian and Muslim worlds until it was convincingly refuted by Copernicus in the 16th century.

The educator may also usefully focus on this period, in which the naturalist explanation of phenomena championed by figures of antiquity such as Epicurus lost ground, as an important starting point for the development of the relationship of Arab philosophy and Islamic theology with scientific endeavour in the Middle Ages, a relationship which pitched the empiricist position against the consideration of the workings of unseen entities.

- *Module A1.3: The Muslim world*

The transformations in the route to knowledge that occurred during the period of Muslim cultural efflorescence (a period loosely defined as dating from the 'Abbāsid Caliphate to the destruction of Baghdad by the Mongols) are some of the most interesting and pivotal. They have particular relevance for the student in the Muslim world since they underline a prominent feature that the educator can emphasise: the crucial results that accrue from cultural diversity and from the absence of self-quarantining, and the necessity for reproducing and maintaining this cultural formula.

Here the educator can demonstrate how this period provided the perfect conditions for scientific efflorescence as the opportunities provided by a unifying cultural and linguistic environment facilitated the absorption, development and dissemination of the cultural heritage from the antique and late antique periods. The intellectual environment of this period can be demonstrated by Ibn al-Haytham's famous dictum, that

> the duty of the man who investigates the writings of scientists, if learning the truth is his goal, is to make himself an enemy of all that he reads, and, applying his mind to the core and margins of its content, attack it from every side. He should also suspect himself as he performs his critical examination of it, so that he may avoid falling into either prejudice or leniency.[1]

It is an attitude that perfectly encapsulates the mindset of science and the route to knowledge, and is one of the first of its kind. The educator can thus give strong motivation for the adoption of contemporary scientific methodologies from the evidence of their productive role in the promotion of science and technology in the Muslim 'Golden Age'.

The lesson works not only for the laboratory, but also for social and intellectual progress, and indeed for the perception of religion and its authority and role in society – a feature which the educator can elaborate in the units *A1.3.2* through *A1.3.4.* Here the educator can demonstrate how the rise of *kalām* scholasticism, from early Muslims' observation of the intensive debates among contemporary Christian factions over Christology, opened up the field of debate on the relative authoritativeness of Reason and Scripture and led first to the rationalists gaining the initiative under the *Miḥna*, and later to the rise of the more textually-minded traditionists. The struggle, which is yet to be finally resolved, represents in essence the search for authoritativeness: whether Reason can change or update religious doctrine (and hence preserve its dynamism), or whether it is to be confined solely to inferential techniques (*qiyās*) in the intellectually delimited spectrum or 'closed corpus' of the sacred Texts and accepted precedent (the operative ingredients of *uṣūl al-fiqh*).

The vitality of the debate, and its subtlety, thus has lessons for the student's contemporary environment since the same suspicions on the 'foreignness' of science persist, and in some

[1] Al-Ḥasan Ibn al-Haytham, الشكوك على بطلميوس '(*Doubts Concerning Ptolemy')*, eds. A. I Sabra, and N. al-Shihabi, Dār al-Kutub, 1971, pp.3-4. والوجب على الناظر في كتب العلوم، اذا كان غرضه معرفة الحقائق، أن يجعل نفسه خصما لكل ماينظر فيه، ويجيل فكره في متنه وجميع حواشيه، ويخصمه من جميع جهاته ونواحيه، ويتعم أيضا نفسه عند خصامه فلا يتحامل عليه ولايتسمح فيه.

quarters the same reticence to accept natural causality. The debate during the medieval period has all the hallmarks of today's dispute, from al-Bīrūnī's spirited defense of scientific investigation against the opposition of the clerics who 'feigned wisdom by questioning the utility of the sciences' by arguing that 'the seeker of real truth must study creation in order to know the Creator and his attributes'.

A particularly fecund aspect of the debate is the nuanced critique by al-Ghazāli of the philosophers' theory of natural causation, and Ibn Rushd's equally nuanced defence (unit *A1.3.6*) against the Ashʿarī opposition to inherent movements, infinity, and absolute regularity of the universe, and their argument that the world, and even human actions, were sustained and governed through the direct intervention of a divine primary causation – itself a continuation of the Hellenistic speculations of the Late Antique period. Both positions were markers of the vitality of the debate before the Occasionalist[2] doctrine championed by the Ashʿarīs gained authority and narrowed the parameters of the discussion.

As mentioned earlier, the debates in the Muslim world concerning the challenges posed by the Greek philosophical heritage, and how this was to be harmonised with scriptural revelation, preceded the debates that took place in Christian Europe by roughly a century. The educator may therefore contrast the fecundity of these medieval discussions with the relative levels of reticence today, and encourage students to draw their conclusions on to what extent conservatism and resistance to change affects the vitality of a faith and a culture.

Most importantly, the educator can outline the factors that contributed to the weakening of Muslim scientific endeavour at the tail end of this period, factors that are complex and demand objective reflection. In the unit *A1.3.7* the social, political, and epistemic contexts are examined which narrowed the latitude of the period that had seen both scientific and religions practices in the Muslim world formulating their own rules and methods. The educator can demonstrate how political fragmentation initially positively affected scientific productivity by diversifying patronage, but subsequently hindered progress as political instability and rivalry focused priorities on more practical concerns of daily functioning of the state apparatuses of the bureaucracy, the judiciary, the hospitals and the security of society, and less on methodological debates or groundbreaking discoveries.

In addition, pre-occupations with stability – intellectual and doctrinal stability – in this era led to more standardisation and propagation of certain ideas at the expense of alternative views, a greater uniformity of jurisprudence and the precedence of certain theological standpoints over others. In such an environment funds that previously may have been used to support scientific activity were now diverted to the patronization of religious foundations – in which the curriculum centred around law and jurisprudence, with less interest in the bigger questions that had occupied the intellectual space before.

In the units of module *A1.3* the educator will be able to demonstrate how the Muslim period of scientific efflorescence was an age of *indigenisation of rationalism*, an approach that was not culturally delimited but a process of harmonisation with cultural and religious rooting that yielded the same positive results as it did later in Christian Europe. The exploration of the route to knowledge in this Muslim period demonstrates an important fact: that the rules and methods of both scientific and religious practice – such as the 'scientific method' or textual hermeneutics – are not rigid but evolve in response to developments in the social and intellectual environment. As the one changes, so does the other, to remain relevant and responsive to reality.

As a result, luminaries of the period of Muslim scientific efflorescence such as Ibn Rushd and Ibn Sīnā had a lasting impression on a European world that was itself evolving and opening up to new vistas of intellectual endeavour, and untroubled by the origins of the knowledge. Some Christian theologians, known as the Latin Averroists, actively adopted the work of Ibn Rushd ('Averroes') to promote the concept of the Double Truth, according to which a proposition could

[2] So called from Malebranche's use of the term to describe how certain natural events are 'occasions' for God's creation of certain effects. From this perspective, what people ordinarily call 'causes' or 'natural powers' are to be construed as 'occasional causes'.

be true in philosophy, but not true in theology, or vice versa, thus solving the perennial problem of the conflict of philosophy and theology, of reason and faith by enabling the separation of their respective domains.

The educator can demonstrate here how prominent Muslim intellectuals of the modern period, like the Egyptian philosopher and hermeneutic specialist Ḥasan Ḥanafī and the Moroccan thinker Muḥammad ʿĀbid al-Jābirī adopt Ibn Rushd as a leading symbol in their pleas for a modern Muslim civil society, one which acknowledges its debt to its own Islamic past and heritage, but is, at the same time, open to other cultures and civilisations, in the same way that western Europe combined respect for its own heritage with openness to the achievements of other cultures and civilizations. Evaluation of the separation of the domains of reason and faith promoted by Ibn Rushd marked the beginnings of the acceleration of science on the European continent. At the same time, in the Muslim world, a reverse dynamic appears to have acted to consign the memory, along with the writings, of these luminaries to near oblivion.

The educator's inculcation of the units of module *A1.3* is therefore not merely a historical exercise, but designed to show students the way forward, and at the same time illustrate to them what happens when cultural borders are erected and the indigenisation of rationalism process is undervalued or interrupted.

- *Module A1.4: The rise of scientific method in Europe*

In this next module the educator will be able to show how the potential of the Muslim period in the progress of science were realised and accelerated in medieval Europe, and the reasons for this acceleration. By understanding the factors relating to philosophy as it pertained to the acquisition of knowledge, coupled with the historical and structural factors that established the enterprise of scientific exploration on a firm footing, some important lessons can be learnt for education in the Middle East today.

As the unit *A1.4.1* will demonstrate, Ibn Rushd's conclusions, though ultimately unaccepted in the Muslim world,[3] were taken up and developed by European scholars, the 'Averroists', to lend support to the 'radical Aristotelianism' that was emerging in the thirteenth century. The educator can demonstrate here how the 'double truth' concept was developed from Ibn Rushd's 'one truth' reached in two different ways (the 'literal truth' for the uneducated and the 'metaphorical truth' for those with philosophical training), to 'two entirely separate truths': that is, a 'hard' truth of concrete facts established through science and philosophy, and a 'religious' truth attained through faith.

An important stimulus to the development of scientific methodology was provided by the disentanglement of the religious/metaphysical and mundane spheres of knowledge. The clarification of the separate *magisteria* of faith and what was originally termed 'natural philosophy' is explored in unit *A1.4.2,* where the educator can underline the importance of Thomas Aquinas, particularly in his masterly defeat of Occasionalism by his asserting of the status of natural philosophy as the perfection of Man's understanding of the natural order of the universe. In this conception the natural world is no longer subject to the whim of the deity but operates according to its own rules without the need for divine justification.

The educator can demonstrate how, the medieval European scholars confined the tools of investigation to a methodological naturalism and to a pragmatic explanation of natural phenomena. The efficiency of this method lay in selecting exclusively from the least elaborate explanation of natural causes (a process often termed 'Ockham's Razor'[4] or the 'principle of parsimony' whereby one is to select the explanation with the simplest and fewest assumptions)

[3] In 1195, in the town square of Cordoba, 108 of Ibn Rushd's books were incinerated and the teaching of philosophy was banned. As one of the greatest interpreters of Aristotle, Ibn Rushd had a far greater impact upon Medieval Europe and most of his works survived due to their preservation there in Latin or Hebrew translation.

[4] So named from William of Ockham (c. 1287–1347), who was an English Franciscan friar, scholastic philosopher, and theologian. The preference for simplicity that this formula advocates is based on the falsifiability criterion, aimed at preventing the presentation of ever more elaborate *ad hoc* explanations to prevent the hypothesis from being falsified.

and thus leaving out any unnecessarily complex or *ad hoc* appeals to supernatural agency. The educator can highlight this pivotal turning-point by demonstrating a crucial change: reason is no longer on the defensive but now has primacy, even to the point that theology is now to be justified on rational or philosophical criteria. This turning-point essentially paved the way for a secularization of knowledge and education in the Latin West that in the 14th and 15th centuries was promoted by scholastics such as William of Ockham, and humanist philosophers such as Marsilio Ficino.

Having explained the development of this grounding, in the unit *A1.4.3*: the educator can explain how the scientific endeavour was able to progress, accelerate and accumulate. This will include Robert Grosseteste's development of the 'dual nature' of scientific reasoning elaborated in his proto-'predictions' category, whereby the investigator generalises from particular observations into a universal law, and then back again from universal laws to a prediction of particulars. He can highlight, in addition, the pivotal role played by Roger Bacon (who studied Ibn al-Haytham's and Robert Grosseteste's methodologies in detail) and his elaboration of the earliest systematic theorisation of the scientific method as a set of universally applicable principles. These principles included a repeating cycle of *observation, hypothesis, experimentation*, and the need for *independent verification*. Importantly, Bacon highlighted *the importance of repetition*, recording the manner in which he conducted his experiments in precise detail so that others could independently test his results.

- *Module A1.5: The 17th century transformation*

As a result of the work of Roger Bacon and those who adopted his methodology, the scientific method began to be established as the only credible form of investigation. The educator can demonstrate how the employment of an empirical methodology and quantitative mathematical techniques allowed the later Renaissance's enquirers to challenge the hegemony over thought not just of the ancient writers but more importantly of religious orthodoxy. The purpose of module A1.5 is to demonstrate how, over the course of the 17th century, virtually all the features characterising modern science were established and institutionalised, accounting for what may justly be termed a 'revolution' in scientific knowledge.

The units of this module cover the key elements of this revolution. They include *the relinquishing of the teleological function of science* (unit *A5.1.1*) and the idea of a 'moral purpose' for phenomena, thus separating the 'natural philosophy' domain of the physical world, from the religious domain of the scriptures, whose purpose, as Galileo Galilei famously put it, was "to teach us how to go to heaven, not how heaven goes." The lack of certainty that this separation bequeathed was no longer considered a negative, but as explained in unit *A5.1.2* (*The acceptance and utility of doubt*) was embraced as a motivator for testing and experimentation, even of previously understood certainties. The change in attitude was succinctly expressed by Francis Bacon in his aphorism: "If a man will begin with certainties, he shall end in doubts; but if he will be content to begin with doubts, he shall end in certainties".

The educator can demonstrate in this unit the full *propriety* of doubt, and how it came to be established that the goal of investigation could not be the ultimate demonstration of certainty, but rather the *provisional superiority* of a hypothesis in the face of alternatives and challenges. Once 'science' came to be conceived in this period not primarily as a body of knowledge, but as an *approach* to knowledge or 'a way of thinking', the intensification and acceleration of the scientific enterprise was secured.[5] This period saw important debates on the relative prioritisation of rationalism and empiricism and is marked by the demonstration of heliocentrism (unit *A1.5.3*), an event that illustrated the maturation and emergence of science from the authorities of the ancient world.

[5] As Bertrand Russell put it: "It is not what the man of science believes that distinguishes him, but how and why he believes it. His beliefs are tentative, not dogmatic; they are based on evidence, not on authority or intuition". Bertrand Russell, *The History of Western Philosophy*, Book III, Chapter 6, *The Rise of Science*, p.527.

The investigation of the earth's mechanisms, and its demotion from its centrality, opened mankind's gaze to wider horizons and the possibilities for an understanding of the universe that went beyond metaphysics. On this theme the educator can illustrate the debates of the Age of Reason in establishing new ways of thinking, progressing from deduction from first principles (René Descartes) to induction (Francis Bacon), and culminating in Isaac Newton's defining and mapping this understanding as a set of inexorable physical, mechanical laws expressed in the language of mathematics and working upon the mutual impulsion of particles (units *A1.5.4* and *A1.5.5*).

Finally, the educator in unit *A1.5.6* can emphasise what is perhaps the most important legacy of this period: the systematisation and institutionalisation of scientific research and the establishment of communities of scientific peers ready to critically review, collaborate and disseminate research (over against earlier instincts to hoard knowledge) in scholarly journals. This 17th century innovation defines the profession of science as we know it today.

As can be seen, the modules of *Course A1: The Route to Knowledge – The historical rise of the scientific method* demonstrate the gradual, accumulative progress towards developing those elements of methodology that have led to the triumphs of modern systems of knowledge acquisition. By looking at the history in this way the student can understand the factors that promoted, or hindered, this development in the ancient and medieval worlds and witness the final release of creative energy that began in the Age of Enlightenment and continues today. In this historical treatment the Course highlights the pivotal role played by the Islamic world in this accelerating enterprise, and demonstrates how the Islamic experience is part of a continuum. The educator can thus demonstrate to the student how the scientific vision, founded upon a material conception of reality, is not one that has been specifically designed to counter some putative 'Islamic' epistemology, not some cultural peculiarity of the contemporary West that may be taken or left aside at will, but something that is deeply rooted in mankind's story and in the long record of his speculation as to the nature of things. It is a joint enterprise of humanity on the route to knowledge.

Course A2 – The methodology of science

The aim of this Course is to train the student to gain a better understanding of the nature and construction of knowledge, and apply this understanding to the different areas of knowledge they may be engaged in. To achieve this requires a knowledge of the methodology of research and argumentation, the securing of objective observation, the neutral accumulation and critical evaluation of data and the consistent checking of general perceptions against experience. The development of skills of critical evaluation is a crucial precursor to the development of self-confidence in the student to participate in independent investigation and innovation – a particular deficit in the Middle East where the practice of education by rote-learning has yet to be substantially challenged.

- *Module A2.1 – Preliminaries*

To introduce the modern methodology of knowledge acquisition and the scientific method, the educator may first need to establish for Muslim students not only the requirement to understand and practice science 'properly and in a manner that is faithful to its methodology and tradition' but also its propriety as something 'critical to the creation of a productive scientific environment and a scientific culture in the Muslim World'.[6]

[6] The 2016 *Istanbul declaration on Islam and Science.* published with the *Islam and Science Report* by the Muslim Science Task Force, March 14, 2016. Dr. Munā Abū al-Faḍl has also argued that "it is time that we grasp the reins of our situation and resolve to adopt the scientific method so that we contribute our share in adding to the stock of the contemporary human sciences, taking all the while as starting point our own experience and cultural distinctiveness, in addition to our own initiatives in this effort towards resolving our practical problems." See Dr. M. Abu al-Faḍl, مفهوم الأمة وأزمة الفصام بين العلوم الإسلامية والإنسانية - الإحياء , Vol. 29, January 2009, p.88.

Once this is demonstrated, the educator will be able to initiate some attitudinal changes towards positive leaning techniques: open-mindedness, enthusiasm and responsibility (a willingness to consider and act upon/apply the consequences). A fundamental part of the inculcation of this scientific attitude, and one that may run against a cultural habit of deference and the questioning of established authorities, includes the legitimisation of doubt as an affirmation, rather than an enfeebling, of the scientific endeavour. It requires developing the habit of questioning established views and assumptions and equally their proponents. It means developing a legitimisation and comfort with skepticism and the *provisional* nature of knowledge, as a challenge to the emotionally satisfying, but scientifically unproductive, formula of 'truth = certainty'. Conversely the educator may demonstrate how the application of doubt applies equally to the individual student, that is, the need to encourage self-examination and apply the questioning process to the problem of the subjective inquirer. All these elements will accordingly need to be introduced as new habits to develop (units *A2.1.2* and *A2.1.3*).

- *Module A2.2 - Basic methodological principles*

To root this new mode of thinking in the student the educator can lay out the fundamental principles that characterise the scientific attitude. These will include such matters as using precision in the use of vocabulary and definitions. For example, terms such as 'assumption', 'construct', 'hypothesis', 'theory' and 'fact' (unit *A2.2.1*), are often over-loosely employed. There is also the importance of eliminating bias in the exploration of the possible conflicts between the different fields of knowledge, and the importance of applying the questioning process to the problem of the subjective inquirer (unit *A2.2.2*). A related discussion is the importance of avoiding the tendencies towards relativism that post-structuralist thinking has promoted, with its solipsistic view that each person has a reality unto themselves, and the conception that all perceptions and points of view have equal validity. These tendencies are destructive to science in that the removal of perception of error destroys the vital critical and self-correcting mechanisms of scientific investigation (unit *A2.2.3*).

- *Module A2.3 - The methodology of effective argument*

For this module the educator will introduce a number of techniques that train the student to nuance his decisions according to a consistent methodology of evidence-gathering, evaluation and testing. The methods include how to construct meaningful and productive questions, and how to test and challenge established authorities, how to order the investigation in a coherent sequence, the role of facts and the neutral accumulation of data, along with the application of reasoning and logic (unit *A2.3.1*).. The educator can demonstrate in this module the appropriate employment of inductive and deductive reasoning, and the prioritisation of the former in scientific investigation on the grounds that it permits the application of a practically achievable sample of evidence not previously conditioned by the observer (unit *A2.3.3*). Of particular importance in the methodology of effective argument and demonstration are a number of techniques such as blind controls and random sampling. The educator can illustrate these, along with the all-important principle of *falsifiability* – whereby the investigator lays out with honesty any factors which, if observed, would refute the hypothesis. In this way the investigator can add robustness to the argumentation by actually facilitating critiques of it. Such techniques, taken together, support the 'predictive power' of the hypothesis; that is, its ability to explain future phenomena due to the coherence of its argumentation and supporting data.

- *Module A2.4 - Argumentation fallacies and the detection of pseudo-science*

Finally, the educator can inculcate awareness also of the common fallacies employed in argumentation, and those which indicate a weak, deceptive or instrumentalised hypothesis. Key indicators of weak scientific reasoning will include the reliance upon selective or anecdotal evidence supportive only of the investigator, the absence of testing to the claims or confirmation bias (selectivity of evidence), the over-reliance on confirmation rather than refutation, the use of

unacceptably low samples, the use of circular arguments, complex loaded questions and definitions or some unhelpful correlation assumptions (unit *A2.4.1*).

The educator can also warn of more consciously deceptive techniques undertaken by those with suspect motives, such as placing the burden of proof upon the skeptic rather than on the hypothesis itself, the evasion of peer review, the employment of loaded descriptions of others' argumentation (the so-called 'straw man' arguments), or the employment of *ad hominem* argumentation (attacking the character, motive or other attribute of the person critiquing his argument, rather than attacking the substance of the criticism itself). (unit *A2.4.2*).

…

Having established the conceptual background to knowledge acquisition, and its historical rise over centuries of human endeavour, the educator can demonstrate conclusively that far from some alien superstructure imposed over other cultures and heritages, what is now termed the 'scientific method' is an organic, culturally undifferentiated, collectively accumulated product of human experience.

By thus illustrating the advantages of the scientific method, and the pitfalls of failing to adhere to its standards, the educator will be playing a vital role in vindicating the indigenisation of modern systems of knowledge acquisition into the heritage of the student in the Middle East. Most importantly, the educator will be introducing to the student a new dimension to the understanding of what constitutes an authentic and authoritative route to knowledge.