A Method for Reconstructing the Medieval Arabic Scientific Mosaic

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Abstract

There are good reasons to think that there was a body of truths generally accepted by the scientific community under Abbasid rule during the middle ages. However, the indicators initially established by the scientonomy community to guide us in reconstructing past mosaics are not applicable in the case of the medieval Arabic scientific mosaic. Instead, by attending to the particular way that knowledge was disseminated in this community, we can see the primacy of the concepts passed down in authoritative texts. It is proposed here that a good way of determining which texts, and therefore theories, were accepted would be by tracking the unique record of licenses to teach [*'ijāzāt*] particular texts that exist from this period.

Introduction

MASM: medieval
Arabic scientific
mosaic

Just because an observational scientonomist *wants* to reconstruct some pre-modern scientific mosaic, does not necessarily mean the task will be *possible*. Barseghyan addresses the contingent nature of historical evidence, saying that a lack of extant indicators of the theories accepted in a given community (e.g., encyclopedias, curricula) may become a “virtually insoluble problem” (Barseghyan, 2015, p. 116). The reason is clear: absence of indicators means inability to make justified claims about theory acceptance. But even when we do have indicators, he says, our “historical microscopes” are not always calibrated to assess it. My aim here is to develop a method for reconstructing the medieval Arabic scientific mosaic (MASM) by first addressing the *prima facie* possibility of the task, and then calibrating our historical microscopes. *Prima facie* possibility will be addressed by dealing with some general arguments for and against the existence of MASM. I will then turn to the method itself by arguing that 1) despite a lack of standard indicators, it is possible to take *authoritative texts* as indicators of theory acceptance in MASM, and 2) we can track which texts were considered authoritative in which places based on the *license to teach* [‘ijāzāh] documents remaining from the educational system within which MASM was situated. At key points along the way I will formulate the main theoretical and methodological points for which I am arguing.

Before continuing, it is worth situating this paper in terms of the development of the field of scientonomy. This paper is a revised version of a paper written for the seminar of 2014, before the publication of *The Laws of Scientific Change*. The paper contributed to the development and eventual acceptance of the general idea that indicators of theory acceptance might be different for different communities (Barseghyan, 2015, p. 117). However, the actual modifications proposed in this paper pertain to *observational scientonomy* and concern MASM.

Existence of MASM

On the face of it, there are a number of compelling reasons to think that medieval Arabic culture was stable and lively enough to allow MASM to emerge. During the reign of the Abbasid dynasty (c. 750-1258 CE) there was a *Pax Islamica*, during which the lands controlled by Muslims – from Cairo to Baghdad especially, but further East and West, as well – were mostly free from external and internal conflict. The Quran provided a common language which enabled the flow of information (Stanton, 1990, p. 8), and Muslims were free to travel as they like, seeking and exchanging knowledge (Burke, 2008).

On the dates of the period in question, see Stanton, 1990, p. 7. The downfall of Baghdad in 1258 signaled the end of this stability, and the decline of MASM (Burke, 2008, p. 309). On the region in question, see Micheau, 1996, p. 1005.

The scholarly output of this period points to its intellectual vibrancy. Out of this period come many examples of the so-called “Arabic polymath”, a scholar bent on “exploring and advancing all knowledge available to them” (Stanton, 1990, p. 53). The Quran exhorts Muslims to investigate nature, and the members of the ruling class of this period – including certain caliphs, along with other types of political rulers and the aristocracy – were keen to support such an activity, funding a myriad of schools and translation houses (Stanton, 1990, pp. 6, 11). For example, the House of Wisdom in Baghdad, founded by al-Ma’mūn (r. 813-833), was responsible for preserving and passing on many Greek scientific sources to medieval Europe (Micheau, 1996, p. 986; Kaviani *et al.*, 2010, p. 1275; Stanton, 1990, p. 75). As a forerunner to Europe’s own scientific revolution, one would expect MASM to be developed enough to be considered a *bone fide* scientific mosaic.

Yet some scholars would resist considering MASM as particularly unified or scientific. (I will continue using the shorthand MASM in this section, even though I realize the arguments are calling the “mosaic” aspect of this abbreviation into question.) The two general categories of arguments against the existence of MASM are based on two broad features of medieval Arabic culture:

- 1) the nature of its educational system;
- 2) the abundance of schools of thought.

Ultimately, I do not think either of these arguments force us to give up the task of reconstructing MASM.

As for the first category, it seems that the nature of the educational system lacked the kind of experimental method and institutional stability that gradually took hold in medieval Europe. As will be discussed in more detail later, education within MASM was a personal affair between students and an individual teacher, where students would be seeking out new teachers for different subjects, according to their interests. In medieval Europe, being licensed to teach brought with it a fixed, linear curriculum, whereas teachers in MASM had little outside supervision (Makdisi, 1970, pp. 257, 262). One scholar says – though without providing any examples – that this is the reason for the “widespread prevalence of charlatanism and quackery” in MASM (Huff, 1993, p. 77). Potentially just as problematic, individual teachers [*shuyūkh*] taught in schools conjoined to mosques, and the Islamic faith was the “epistemological nucleus” for whatever they taught (Burke, 2008, p. 306). Intense Islamic traditionalism, says one author, abhors any innovation which takes Muslims further away from the essentially Islamic traditions established by Muhammed (Graham, 1993, p. 500).

Yet these worries are not decisive: the traditionalism worry seems to be overblown by the above-mentioned scholars, based on too narrow a view of what went on in MASM. Not only did caliphs encourage scientific progress, but classrooms were hardly dull, stagnant environments. Much like in medieval Europe, debates between students and teachers were common (Burke, 2008, p. 308), and there was an explicit emphasis on moving students from *mosque-schools*, which emphasized mere regurgitation of material, to the *madrassa* which valued a critical understanding of texts, to more informal schools of scientific research, if the student chose (Burke, 2008, p. 306). Moreover, while the individualistic nature of education in MASM was different than in medieval Europe, I will show later that this merely necessitates relying on different indicators for reconstructing the mosaic, not giving up the project entirely.

Another worry related to the educational system is that funding for non-religious scientific research was dependent on patrons and the government, who presumably could impose their views in a non-scientific way. Yet, the deeds of endowment we have from MASM point away from this worry: often wealthy patrons endowed research institutions to keep their money from being seized by the government in a way that still gave them social status, not to meddle with curriculum (Makdisi, 1981, p. 39). When the patrons did retain some administrative oversight of the endowed institutions, it was mostly over the material culture of the institution, not its curriculum (Tritton, 1957, pp. 111-112). Moreover, any meddling that did occur could be explained through the influence of sociocultural factors to MASM, and is not an argument against the existence of MASM (Barseghyan, 2015, pp. 233-240).

The secondary category of supposed obstacles to reconstructing MASM – based on the apparently problematic divisions of the intellectual community in this period – can also be answered. The first division is between the philosophers and the religious thinkers. Within curricula there was a distinction between the “religious” sciences, which revolved around understanding and applying the Quran, and the “foreign” sciences, which developed those subjects passed on by the Greeks (e.g., astronomy, medicine, mathematics). Some religious elite were wary that the foreign sciences would encroach on claims made by the religious sciences, leading to the persecution and imprisonment of, most notably, Ibn Rushd (Totah, 1926, p. 54). Some even regarded the foreign sciences as essentially “tainted”, to be dispensed with altogether (Huff, 1993, p. 68).

Yet despite this antagonism by some towards the foreign sciences, it seems that their basic tenants *were* taught in the madrasa system, for it was considered necessary to be an *ʿadīb* (a well-rounded gentleman) to be an effective civil servant. Ibn Qutaiba (d. 889) wrote it was common opinion that anyone not trained in, for example, agriculture, civil engineering, astronomy, and time-keeping, is only “partially qualified as a secretary” (cited at Bosworth, 1963, p. 98). The best example of an encyclopedia we have from MASM, to be discussed more below, was developed precisely for the *ʿadīb* class, not for the polymaths (Stanton, 1990, p. 137). If no one but the philosophers knew anything about the foreign sciences, then this worry would indeed be serious, but it seems that attitudes of antagonism towards the foreign sciences by the religious elite did not prevent there being a basic understanding of them amongst all intellectuals in MASM.

Even if it is possible to conceive of a mosaic that crosses the religious/foreign science divide, the abundance of sects on a purely religious level may require at least as many mosaics as religious sects. Sects cropped up

mainly over matters of Islamic law, that is, the interpretation and application of the Quran. Different conclusions would be reached depending on how groups differently applied literal and allegorical hermeneutics to particular passages (Huff, 1993, p. 82). There were four main schools of Sunni law, and then a further divide between the Sunnis and the Shiites (Stanton, 1990, p. 28). Since education always began with religious training, under one particular school of thought, it seems students' mosaics would be divided from the outset, even were they to eventually learn the same basic tenants of the foreign sciences.

Yet it is possible we could discern a core to the religious sciences, as with the foreign sciences. The bulk of the disagreements between religious schools of thought were over practical, normative issues, *not* over the fundamentals of their religious worldview, and hence *not* over issues under the purview of MASM. Only about 200 of the Quran's 6,000 verses deal with advice for specific situations, thus jurisprudence was a more sought after discipline in medieval Arabic culture than theology, and there was little disagreement over the basics of belief (Stanton, 1990, p. 23). This unity over matters of basic belief made possible the "congregational mosque", a mosque fully-funded by the government, intended to be a non-partisan place for communication of official views, religious and otherwise (Stanton, 1990, p. 31).

It is possible that MASM may end up needing to be subdivided on the basis of further considerations like geography, but this at least shows that neither of the above worries rules out finding one or more core sets of beliefs that change in a law-governed way. Even scholars who are (rightly) critical of what they call "essentialism" about MASM's theories and methods admit that medieval Arabic thinkers saw themselves as working with a set of inherited theories and practices, constituting their unique tradition (Sabra, 1996, p. 669; Graham, 1993, p. 495). Far from being undercut by the diversity and locality of history, scientonomy assumes that this is the case and seeks to analyze how scientific mosaics change through time (Barseghyan, 2015, p. 88). It seems that MASM is amenable to such an analysis.

Indicators of Acceptance in MASM

Now that we have deflected the arguments against the possibility of MASM, we need to determine how to go about actually *reconstructing* it. To that end, we have to accomplish two tasks. First, we need to ensure that indicators of theory acceptance actually existed for this scientific community. Second, we must ensure that we can access and understand them. As mentioned earlier, analyzing MASM might be desirable and seem possible in principle, but turn out to be practically impossible based on a lack of historical evidence. At the outset, the historical evidence looks bleak, for a number of categories of historical documents that we would normally take to be indicative of theory acceptance in a mosaic (e.g. encyclopedias, textbooks, university curricula) do *not* function this way for MASM. I will briefly show why those standard indicators are *not* useful for our project, and then argue for what is.

There is only one example from the time of MASM of what appears to be a precursor to the modern encyclopedia, called the *Keys to the Sciences*, written by al-Khwarizmi after Hellenistic influence had reached its peak in the 10th century (Bosworth, 1963, p. 97). His goal in the encyclopedia is to define and explain for the *adib* class all the "conventional and technical terms" accepted by the "specialists" in all of the religious *and* foreign sciences (cited at Bosworth, 1963, p. 100). Though this is a single-author work, his emphasis on objectivity and the opinions of specialists (as opposed to his own analysis) makes this as likely to be representative of MASM in the 10th century as could be hoped for. Yet having only one such snapshot of MASM is obviously a small foothold upon which to base our analysis. Other purported encyclopedias, such as Al-Farabi's *The Enumeration of the Sciences* and the *Epistles* of the Brethren of Purity, appear much more aligned to a particular sect's normative vision of science. So it appears that encyclopedias cannot serve as the primary indicator of theory acceptance in MASM.

Curriculum lists are more abundant than encyclopedias, but reveal the same normative tendencies. Building upon Aristotle's division of the sciences (speculative, practical and productive) in their own unique ways, these documents seem to be more exercises in arguing for one's own view on the theoretical relationship between fields of inquiry, than a description of the actual sequence of subjects taught (Nasr, 1983, p. 60). Thus, when one scholar

haphazardly combines all such lists he could find to give a supposed overall picture of the medieval Arabic curriculum, the result is disjointed and disorienting (Tritton, 1957, pp. 130-139; Stanton, 1990, p. 125).

One might think that the lists of books in MASM's famous libraries could indicate what theories were considered acceptable. With books being as precious as they were, perhaps libraries would limit themselves to books whose views their community embraced. However, at their peak, medieval Arabic public libraries held between 100,000 and 1,000,000 volumes, and it is unlikely that every proposition in these books was consciously known, much less accepted (Stanton, 1990, p. 131). Moreover, libraries were vulnerable to the party-preference of the ruling caliph in the form of book burnings, so whether a book was or was not in a library might say more about who was in power at the moment than what was accepted in MASM (Micheau, 1996, p. 990).

Finally, seeing whether some principle was *used* (in the technical scientonomic sense distinguished at Barseghyan, 2015, p. 31) by medieval Arabic scientists would not tell whether it was *accepted*, because of their belief about the relation between human and divine action. For example, in medicine it was sometimes held that the real healing work was done by God, not natural laws (i.e. occasionalism; see Huff, 1993, p. 88). Theoretically speaking, physicians were viewed as helpers, and so the fact that they believed doing *x* resulted in *y* did not mean they necessarily *accepted* the naturalistic explanation for this found in Greek sources (Stanton, 1990, p. 99). Some may have, of course, but the point is that this prevents our taking *theory use* as any kind of indicator of *theory acceptance*.

With all of these potential indicators of MASM ruled out, I will now present my suggestion for what *does* indicate theory acceptance in MASM. In a nutshell, the organization of the medieval Arabic educational system and their view of texts by trustworthy authors means that *authoritative texts* function as indicators of theory acceptance in MASM. After this section, I will argue for the way we can know which texts were taught authoritatively at which places and at which times.

I have touched on the importance of the personal student-teacher relationship in MASM, but the other key feature of education in MASM was that it revolved around authoritative texts. To have studied under someone was to have “read” under them (Makdisi, 1981, p. 141). Meetings of a class discussion [*ḥalqah*] were comprised of students copying down either a text the teacher was authorized to teach or his commentary on it, followed by question and answer. Eventually students would have to have their notes approved, and they would be tested for memorization *and* comprehension before they were given license to teach the text themselves (Makdisi, 1981, p. 152). This is how both formal (religious) and informal (foreign science) class discussion mostly ran (Stanton, 1990, pp. 123-124).

Not just any book would be the object of this gauntlet of memorization and comprehension, but only those considered authoritative. The system was such that the only texts that could be taught were ones taught by the authoritative author himself, or ones that had passed down a line of trustworthy teachers (through the process of memorization and comprehension described above) from an original authority. Graham sums up the way that texts could embody their original authoritative author's teachings as follows: “Documents alone, without a line of *persons* possessed of *both* knowledge and righteousness to teach and convey them across the years, are useless as instruments of authoritative transmission” (Graham, 1993, p. 507). How the original author became authoritative, and why they accepted the opinions they did, is another question entirely, but once a text was authoritative it would be *taught and accepted as true*.

We know that this system would have resulted in the acceptance of propositions in authoritative texts as true because of the way it parallels the reception of religious texts (the Quran, commentaries on the Quran, and the sayings of Muhammed). These texts were authoritative because of the original authorities they issued from (Muhammed and his Companions), and a whole “science of men” grew up to evaluate those who had passed the texts along. Human links in the chain would be ranked with respect to their morality and credibility, and this would be used to determine whether a textual variant was “sound, good, weak fabricated, etc.” (Heck, 2008, p. 321). Though perhaps not with such rigor, this same “science of men” extended to the rest of the religious and foreign sciences (Graham, 1993, p. 508). In this respect, texts from any authority were similar to revelation, as

seen in the following statement about Greek texts from an Arabic scholar at one point associated with the House of Wisdom (Al-Jahiz, cited at Sabra, 1996, p. 660, *emphasis mine*):

Our share of wisdom would have been much reduced, and our means of acquiring knowledge weakened, had the ancients not preserved for us their wonderful wisdom, and their various ways of life, in writings which have *revealed* what was hidden from us and opened what was closed to us, thereby allowing us to add their plenty to the little we have, and to attain what we could not reach without them.

Barseghyan states that indicators of theory acceptance are “surely not the opinions of individual (albeit great) scientists” (Barseghyan, 2015, p. 114). That is still basically true here, yet when an individual great scientist became authoritative, his opinions, if passed down *both* in a book *and* in the requisite manner, do indicate to us what theories were accepted by the community they were taught in. I am not sure if it matters whether we describe the book as authoritative, or the teacher, but I lean towards describing the *book* as authoritative, and the *teacher* as trustworthy. This gives us an abstract method for reconstructing MASM:

Licenses to Teach as Indicators

With indicators of theory acceptance in MASM established, we now need to make sure there is a way to determine which authoritative texts were taught in which places. Merely knowing that Aristotle’s *Posterior Analytics* was taught *somewhere* in the Abbasid lands does not help us reconstruct the mosaic with any precision. What we need is, for lack of a better term, indicators of indicators, and for these we turn to medieval Arabic *license to teach* [‘ijāzāt] documents.

I have already mentioned that a person was licensed to teach a text in the foreign sciences in the same way as they were in the religious sciences, but the material details of this are of particular importance for reconstructing MASM. A license would normally be written on the inner cover or flyleaf of the book taught to the student (Totah, 1926, p. 56), and it would typically set out the lineage of teachers who had taught the teacher bestowing the license, back to some original authority. The license would thereby endow the student with ability both to teach that text and, in teaching it, to pass on the ability to teach it – to continue the line of trustworthy transmission

³**ijāzāh**: license to teach (plural: ‘ijāzāt)

(Graham, 1993, p. 511). As further proof that licenses were meant to be taken seriously, they were often written the same sort of impressive style that was used to establish someone as qualified to serve as a “notary or official witness” (Stewart, 2004, p. 50). Assuming we know where a license was written, which is often either on the license or in a biographical document of the student (Stewart, 2004, p. 65; Micheau, 1996, p. 995), it provides concrete insight into what was being taught authoritatively, and hence accepted, when and where. And unlike encyclopedias, we have no dearth of extant licenses (e.g. Totah, 1926, pp. 53, 57). One scholar says that examples are “so numerous” that he need only cite a few (Totah, 1926, pp. 53), and another says (writing in the last decade) that this resource has been “underutilized” by historians (Stewart, 2004, p. 48).

Almost certainly the testimony of licenses will leave some gaps, but a compilation of licenses could be used to triangulate where texts were considered authoritative, whether we know this explicitly or not. That is, if we know that one student studied under a certain teacher, but we do not have the license that teacher gave to that student, we could fill in the gap provided we *do* have a license from that teacher to *another* student. Of course, it is possible the other student would have learned different texts under that teacher than the first student, so such inferences would need to be made tentatively. Nevertheless, they would tell us what sort of authoritative texts were in the air, so to speak, and enough such triangulations could persuasively fill out the picture of MASM. After enough research it could turn out that webs of authority converge around opposing poles, such that we need to acknowledge the existence of multiple mosaics, and there would be nothing at odds with this method in that conclusion.

As far as I have seen in my research for this paper, *ʿijāzāh* documents only exist in Arabic, which in many places under Islamic rule was the language of scientific discourse. That is why the methods being developed here are called indicators of the Medieval Arabic scientific mosaic. But of course this paper is essentially a preliminary study; certainly not all scholars under Islamic rulers in the middle ages were ethnically Arab, and other languages, such as Persian, were used in some Islamic lands for scientific discourse. So if we find a significant amount of *ʿijāzāh* documents in other languages, or in communities intertwined with the Arabic-speaking community of the middle ages, then we will need to consider a revision of the scope of this method at that time.

Yet there are several possible worries about this method. For one, the web of connections is likely to get very entangled, and not everyone in the web would have studied with everyone else. We might think it invalid to reconstruct a version of MASM which includes the views distinct students learned from distinct teachers, if some of those students never studied with some of those teachers, no matter how many other connections existed between the teachers and students in other respects. But I think this is analogous to the way that we consider there to be a general scientific mosaic today which includes certain propositions known by historians, and others known by physicists, even if those specialists do not know the content of the other’s discipline. It does not seem that all individuals within MASM need to *consciously* accept some proposition in order for historians to consider a proposition accepted in MASM, provided we know it was taught in the requisite way.

The second worry is that even if we know some book was taught somewhere, we may not know whether the extant copy of that book corresponds to the text as it was taught at the time. Some people may have been working with mistranslations of the text being taught, such that our corrected contemporary editions which diverge from the ones that were actually in use (e.g. Heck, 2008, p. 325). Too many rogue professors or bad manuscripts could mean that this whole method is founded on flimsy evidence. I admit that this would be problematic, but one would hope that rogue professors were infrequent, and insofar as the discipline of textual criticism exists to reconstruct the most historically accurate versions of medieval manuscripts, this is not a problem unique to reconstructing MASM.

A third worry is that texts might be taught or not taught somewhere due to sociocultural factors, and not because the community did or did not accept their propositions. A caliph might arbitrarily declare such-and-such book to be taught as authoritative, or, as one story recounts, a book could cease to be taught in a city simply because booksellers were withholding it to raise demand! (Tritton, 1957, p. 115) But this worry is easily diffused once we recall the relationship between the mosaic and sociocultural factors. The method for reconstructing MASM seems to be “a proposition was accepted in MASM, if it was included in the books that were taught in a

trustworthy manner and which had authoritative authors”. These sociocultural factors would not violate *the sociocultural factors in theory acceptance theorem* because they would only affect the circumstances surrounding the mosaic, not the process of theory acceptance itself (Barseghyan, 2015, p. 235).

In short, the licenses to teach can be taken as indicative of which texts were considered authoritative in MASM. This makes our method for reconstructing MASM more specific:

Lastly, we need a way of dealing with the contradictions that are likely to arise between authoritative texts, which seems a likely enough scenario to emerge. It will not work to just assume that thinkers in MASM somehow accepted contradictory theories, for the Quran entails that all fields of knowledge fit together and are graspable as a unified whole, since nature is finite and perfectly created by God (Stanton, 1990, p. 71; Nasr, 1983, p. 59). Each attempt to classify the sciences, seen earlier, was in fact an attempt to sum up all *possible* knowledge. In this respect, MASM seems to abide *the zeroth law of scientific change*, which says that elements of the mosaic are compatible at any given time (Barseghyan, 2015, p. 153).

To achieve this harmony of propositions, thinkers in MASM relied on a hierarchization of their authoritative texts and a variety of hermeneutical techniques. The highest authorities were the religious ones (the Quran and the sayings of Muhammed), and the main hermeneutical technique was to take less clear passages as allegorical in relationship to clearer or more authoritative passages (McAuliffe, 2003, p. 315). Ibn Rushd says that this method is something that “Muslims are unanimous in holding”, and that they only disagree over which passages deserve to be treated allegorically, and which do not (Averroes, 2007, p. 314). The details of their allegorical theory do not concern us here, it is enough to see that the method of “accept propositions as they are harmonized in hermeneutically sound ways” could be considered just as much a part of MASM’s method of theory acceptance as “trust propositions in authoritative books”.

As reconstructors of MASM, it is possible we will sometimes have access to MASM’s own reconciliation of discrepancies (i.e. as worked out in texts from the period), but when we do not, it is reasonable to adopt their hermeneutical techniques and fill in the interpretive gaps on our own. This need not taint the project with idle speculation, for this issue does not plague the historian of MASM in a way categorically different from any other period. We know that within several decades after Muhammed died there were already variant readings of the Quran competing for authority, showing that no text, however important, is immune to misunderstanding over time (McAuliffe, 2003, pp. 315-316). I would suspect that even the far more dispassionate encyclopedias from the last century would contain internal discrepancies that would pose similar, albeit fewer problems.

This kind of discretion would also help us deal with cases where we have a text that we know was authoritative via *the teaching license method*, but which contains views that it would be absurd to consider as accepted theories in MASM. If an observational scientonomist finds, for example, an authoritative text on astronomy with a view reported in it that is at odds with the rest of the text, and does not seem to have had any actual influence over the

scientific community, it would be better to consider such a view as merely *pursued*, as opposed to something taught as accepted.

Authoritative texts, as discerned through teaching licenses, ought to be the primary way of reconstructing MASM. But once the main features of MASM are fleshed out, it would be possible to turn to other indicators of theory acceptance and use them as *confirmatory or supplementary* evidence. Had they been relied on from the outset, they would have posed a biased, piecemeal sketch of MASM. Yet once we have discerned what the main webs of influence and authority are, we can situate medieval encyclopedias and curriculum lists within their appropriate place, and they can be used to confirm triangulated links of teaching influence, or even to tell us more about their particular slice of MASM. For example, it would have been wrong to take al-Khwarizmi's *Keys to the Sciences* as representative of the whole MASM, but once we can see roughly where in the 10th century the text best fits, the rest of its propositions could be taken as representative of that slice as well.

Even curricula, normative as they seem to be, sometimes contain insights into certain principles and texts accepted by the community they were directed towards. For example, al-Farabi and Ibn Sina's curriculum lists both contain suggestions about key books to read for certain subjects. Since it seems that the main novelty behind these lists lies in their argument for how the branches of science relate to one another, such seemingly mundane suggestions as what books to read could be taken to confirm the authoritative texts we infer from teaching licenses (Jolivet, 1996, pp. 1009, 1017). It might be true that their curricula were biased towards the sub-mosaic they were teaching in, but provided we use our primary indicators to situate them in that sub-mosaic, making supplementary or confirmatory use of them would be legitimate.

Conclusion

My goal here has been to develop a method for investigating a particular period of scientific history, the medieval Arabic scientific mosaic (MASM), in light of the descriptive aims of observational scientonomy. Based on the sources available to me, it seems that authoritative texts and licenses to teach, used in tandem, are our best option for reconstructing the development of MASM with as much concrete detail as possible. As I stated at the beginning, I have been roughly discussing the years 750-1258 CE. Any further specificity about which years *the teaching license method* applies to must await further investigations into the actual sources. Of course, if the *'ijāzāt* are not as informative as we would like, we would need to go back and try to find another manner of approach. However, that should not prevent the proposed modifications from being accepted as a way of getting the observational scientonomy for this period off the ground.

Suggested Modifications

Thus, I suggest the following modification:

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Accept the following propositions concerning MASM in c. 750-1258 CE in the Abbasid caliphate:

- Authoritative texts are indicative of theories accepted in MASM.
- Licenses to teach [*'ijāzāt*] are reliable indicators of which texts were considered authoritative in MASM.

Accept that the following method ought to be employed when reconstructing the theories accepted in MASM:

- *Teaching License Method*: A proposition can be said to be accepted in MASM if the evidence of the licenses to teach [*'ijāzāt*] indicates so.

Teaching License Method

A proposition can be said to be accepted in MASM if the evidence of the licenses to teach [*'ijāzāt*] indicates so.

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