MAIMON RESEARCH LLC

ARTIFICIAL INTELLIGENCE LARGE LANGUAGE MODEL INTERROGATION

REPRESENTATIONAL MEASUREMENT FAILURE IN HEALTH TECHNOLGY ASSESSMENT

TEXAS: TIME TO INTRODUCE THE NEW HTA

THE REQUIRED TRANSFORMATION OF GRADUATE HTA EDUCATION

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ABSTRACT

Health technology assessment (HTA) has reached the point where transformation of graduate education is unavoidable. For more than forty years, contemporary HTA has developed around utilities, quality-adjusted life-years (QALYs), incremental cost-effectiveness ratios (ICERs), economic evaluation and reference-case simulation modelling without first establishing the measurement properties required to support their arithmetic. This reverses the required scientific sequence: measurement must precede arithmetic, scale properties determine admissible mathematical operations, and multiplication and division require ratio measurement.

The extent of this failure has now been documented through large language model interrogations of HTA knowledge bases, curricula and university research-center program content. Across jurisdictions and institutional settings, the findings consistently identify measurement, curriculum and program-content inversion: weak or absent recognition of representational measurement alongside comprehensive endorsement of the conventional HTA framework. This creates an immediate educational responsibility. Universities cannot continue to teach another generation of students measurement failure simply because faculty themselves inherited that framework. Graduate education must instead provide students with the scientific knowledge required to distinguish numerical assignment from measurement and lawful from inadmissible arithmetic.

The required transformation begins with the attribute and recognizes two measurement pathways for therapy-impact claims: linear ratio measurement for manifest attributes and Rasch logit ratio measurement for latent attributes. Claims should then be prospectively specified, empirically evaluated, replicated and capable of falsification.

The Maimon Research nine-unit, 45,000-word transformation program provides a structured template for this transition, supported by continuing 24/7 online Q&A assistance and opportunities for seminars, workshops and curriculum-development support. The objective is a new HTA graduate framework grounded in lawful measurement, admissible arithmetic and the standards of normal science.

INTRODUCTION

Health technology assessment has reached the point where transformation is unavoidable. For more than forty years, contemporary HTA has developed an increasingly sophisticated analytical framework around utilities, quality-adjusted life-years (QALYs), incremental cost-effectiveness ratios (ICERs), economic evaluation and reference-case simulation modelling. Yet the framework failed at its first quantitative step. It allowed arithmetic to precede measurement. The result is not a collection of minor methodological deficiencies requiring further refinement. It is a legacy of measurement failure.

The failure is particularly difficult to defend because the required standards are not new. For approximately eighty years, quantitative science has recognized that scale properties determine the arithmetic that numbers can support. Multiplication and division require ratio measurement. Measurement requires a defined attribute. A measure must represent that attribute according to specified measurement properties, and arithmetic must preserve dimensional homogeneity.

Representational measurement subsequently provided the formal axiomatic foundations for establishing when numerical representations qualify as measures. These are standards to which quantitative disciplines are expected to conform. Contemporary HTA did not.

The extraordinary question is therefore not simply how utilities and QALYs fail these requirements. It is how a quantitative discipline embedded within major universities survived for forty years without confronting them. Generations of faculty were educated within an epistemic framework in which representational measurement played little or no role. They taught what they had been taught. Their students became practitioners and faculty and transmitted the same framework to another generation. Professional organizations, journals, research centers and graduate programs reinforced it. Repetition created authority; institutionalization substituted for scientific challenge. That history may explain the legacy. It cannot justify continuing to teach it.

Universities cannot continue to educate another generation of graduate students in measurement failure. Once the requirements of lawful measurement are finally recognized, the responsibility of faculty changes. Utilities, QALYs, ICERs and reference-case models cannot continue to be presented as established quantitative science merely because they are familiar, widely published and professionally endorsed. Students must instead be taught the scientific standards necessary to determine whether a numerical claim is a measure and whether the arithmetic performed upon it is admissible.

The good news is that abandoning the legacy does not leave HTA without a quantitative foundation. It reveals what that foundation should have been from the beginning. Measurement precedes arithmetic. The attribute comes first. Therapy-impact claims require lawful measurement: linear ratio measurement for manifest attributes and Rasch logit ratio measurement for latent attributes. Claims can then be stated prospectively, evaluated empirically, replicated and exposed to falsification.

This is the new HTA. It is not another methodological option competing with the legacy framework. It follows from accepting the measurement standards required by normal quantitative science. The task facing universities is therefore no longer to refine what has been inherited. It is to stop reproducing measurement failure and introduce graduate students to the HTA that lawful measurement requires.

The central educational issue runs through everything that follows. *Universities cannot continue to teach students measurement failure***.** Faculty may have inherited the contemporary HTA framework without being exposed to representational measurement. That explains the past; it cannot determine the future. Once the measurement requirements governing quantitative claims have been identified, continuing to teach utilities, QALYs, ICERs and reference-case modelling as though their quantitative foundations were scientifically secure becomes increasingly difficult to defend. The responsibility of graduate education is not to reproduce the epistemic legacy of HTA but to expose that legacy to the standards of normal science and teach the measurement framework that those standards require.

STUDENT EXPECTATIONS

A student entering a graduate program in HTA, health economics, pharmacoeconomics or outcomes research has a reasonable expectation that the university will provide an education grounded in the accepted standards of quantitative science. The student is not simply purchasing instruction in techniques currently used by a profession. The university is representing that the knowledge and methods taught within its graduate program have been subjected to the scientific scrutiny appropriate to an advanced quantitative discipline.

That expectation carries important consequences.

Students should expect to be taught what measurement is before being taught what arithmetic to perform. They should understand that measurement begins with a defined attribute; that a measure must be unidimensional; that nominal, ordinal, interval and ratio scales possess different properties; that those properties determine admissible mathematical operations; and, critically, that multiplication and division require ratio measurement. These are not specialist topics for students who elect to study measurement theory. They are elementary requirements for anyone expected to make quantitative claims.

A student should therefore be entitled to ask some very simple questions. ***What is the attribute being measured? Is it unidimensional? What type of measure has been constructed? Where is its zero? Are its units invariant? What transformations are admissible? Does it possess the properties required for the arithmetic being performed?***

If a graduate program teaches students to multiply health-state values by time without first requiring them to establish the necessary measurement properties, something has gone seriously wrong. If students are taught to calculate QALYs and ICERs before they are taught why ratio measurement matters, the scientific sequence has been reversed. The student is being trained to perform arithmetic without being given the knowledge necessary to determine whether that arithmetic is lawful.

The responsibility rests with the university and its research centers. A university cannot defend a graduate program merely by pointing out that it teaches methods widely used by HTA agencies, industry and professional organizations. Graduate education is not vocational replication of current practice. Universities are expected to expose established methods to criticism and to teach students the standards by which those methods can be accepted or rejected.

Research centers have the same responsibility. They are not simply collections of investigators pursuing individual projects. When attached to universities they contribute to the intellectual environment through which a discipline is defined, taught and transmitted. Their research programs, seminars, publications, graduate supervision and methodological priorities help determine what students understand to constitute legitimate quantitative inquiry. University affiliation carries scientific authority, and with that authority comes responsibility.

Nor is it sufficient to argue that faculty teach what they themselves were taught. That may explain how the present situation arose. It cannot justify its continuation. *The epistemic inheritance of faculty must not become the scientific inheritance of another generation of students.*

Students should instead leave graduate education capable of constructing and defending lawful quantitative claims. For therapy impact, that means understanding the two required measurement pathways: *linear ratio measurement for manifest attributes and Rasch logit ratio measurement for latent attributes*. They should know how to define the attribute, establish the measure, determine admissible arithmetic and formulate claims capable of empirical evaluation, replication and falsification.

This is the minimum expectation of graduate education in a quantitative discipline. *Students should not have to discover after graduation that the arithmetic they were taught rests upon quantities whose measurement properties were never established.*

RESPONSIBILITY OF THE UNIVERSITY

The responsibility of the university is unequivocal: *it must educate students in the standards governing quantitative science, not train them in the reproduction of measurement failure*. A graduate qualification carries the authority of the university. It signals that the recipient has acquired more than familiarity with prevailing professional practice. It should certify an ability to understand the scientific foundations of that practice, to distinguish measurement from numerical assignment, to determine whether mathematical operations are admissible and, where necessary, to reject methods that fail those standards.

This is the minimum expectation of graduate education in a quantitative discipline. Students should not have to discover after graduation that the arithmetic they were taught rests upon quantities whose measurement properties were never established. Nor should they discover that fundamental questions concerning attributes, unidimensionality, scale properties, admissible transformations and ratio measurement were omitted because they did not form part of the epistemic tradition inherited by their faculty. A graduate program should provide students with the knowledge required to challenge the methods they are being taught, not merely the technical competence required to reproduce them.

This responsibility becomes substantially greater because the measurement failure of contemporary HTA has now been extensively documented. With the assistance of artificial intelligence and large language models, it has become possible to interrogate large and previously inaccessible bodies of HTA knowledge systematically and consistently. Agencies, university research centers, graduate curricula, professional organizations, journals and national HTA environments can be examined against the same fixed propositions derived from the requirements of representational measurement. What previously might have been dismissed as criticism of particular methods can now be examined as a characteristic of the discipline's knowledge base itself.

The results have been remarkably consistent. Across countries, institutions and different forms of interrogation, the same pattern emerges: measurement inversion within the HTA knowledge base, curriculum inversion in what students are taught, and program-content inversion in what universities and research centers publicly identify as their methodological foundations. Measurement preceding arithmetic, ratio measurement, admissible transformations, dimensional homogeneity, unidimensional attributes and the distinction between manifest and latent measurement receive little or no identifiable recognition. At the same time, utilities, QALYs, cost-effectiveness analysis, ICERs and reference-case modelling are extensively represented and institutionally endorsed.

Artificial intelligence did not create this measurement failure. Nor does an LLM determine the scientific standards against which HTA is judged. Those standards derive from the established principles of measurement and representational measurement. The contribution of LLM interrogation is different: it provides a means of examining whether those principles are represented across knowledge bases of a scale that would previously have been extraordinarily difficult to assess systematically. The resulting evidence makes the extent and consistency of the omission visible.

Universities confront a situation very different from that of an earlier generation. Faculty may legitimately say that they were never taught representational measurement and inherited the contemporary HTA framework from their own teachers. ***That explains the historical failure. It cannot justify its continued transmission now that the failure has been documented*.** The measurement problem is no longer hidden within an unquestioned epistemic legacy.

This changes the responsibility owed to the next generation of students. Once universities and research centers have been confronted with evidence that the quantitative framework they teach systematically omits the measurement standards required to justify its arithmetic, continuing to reproduce that framework without addressing those standards is impossible to defend. Another cohort of students should not be educated in measurement failure simply because the previous cohort was.

The cycle of epistemic inheritance must therefore be broken. The question is no longer whether contemporary HTA has been taught for forty years. It is *what universities will teach now that its measurement failure has been exposed and systematically documented*. Graduate education must provide the next generation with the scientific foundations required to recognize that failure, move beyond it and construct the lawful measurement framework that the new HTA requires.

THE REQUIRED TRANSFORMATION

Recognizing the failure of contemporary HTA is only the first step. Universities and faculty require a practical framework for replacing it. It is not sufficient to tell faculty that measurement must precede arithmetic or that ratio measurement is required. They need a structured body of knowledge showing how these requirements change the teaching and practice of HTA from the ground up. This is provided in the Maimon Research nine-unit transformation program [i]. *To our knowledge, this is the only program designed specifically to provide the scientific* and educational framework required for a new start in HTA.

The Maimon Research program is designed as more than a sequence of educational materials. It provides a structured template for faculty, researchers and practitioners seeking to understand and implement the transition from legacy HTA to a framework grounded in representational measurement. The program comprises 45,000 words of structured instructional material with the nine units moving progressively from measurement preceding arithmetic through attributes, scales of measurement, admissible arithmetic and dimensional homogeneity to the distinction between manifest and latent attributes, linear ratio measurement, Rasch measurement, attribute possession and the construction of empirically evaluable therapy-impact claims. The program can therefore be used for individual faculty preparation, as a framework for reconsidering existing graduate teaching, or as the foundation for developing a new postgraduate course in HTA organized around the requirements of lawful measurement and normal science.

An important feature of the program is that participants are not left simply to work through the material independently. Those enrolled have access to continuing 24/7 on line Q&A support as they study the units and, importantly, as they begin to apply the framework in teaching, research or therapy evaluation**.** Questions arising from particular attributes, proposed measures, Rasch applications, therapy-impact claims, protocols or curriculum development can be raised as they occur. The purpose is to support the transition from understanding the principles to applying them in practice. This continuing interaction is particularly important for faculty whose previous education did not include representational measurement and who may be reconsidering assumptions embedded in many years of teaching and research. The objective is not simply completion of nine units, but development of the capability to use the measurement framework independently and to introduce it confidently to students and colleagues.

The program can also provide a starting point for broader institutional engagement. Where universities, research centers, academic departments or professional groups wish to explore the implications of the new HTA in greater depth, additional activities can be developed around their particular requirements, including seminars, faculty discussions, workshops, small-group sessions, curriculum-development support and presentations addressing specific measurement or therapy-evaluation problems. These activities allow institutions to move beyond individual enrollment toward a wider reconsideration of how HTA is taught and applied. A fee is charged for access to the nine-unit program to support the maintenance, administration, updating and continuing availability of the system, including participant support. The larger objective, however, is transformation: to provide faculty and institutions with an accessible, supported pathway for replacing the legacy of measurement failure with graduate education grounded in lawful measurement, admissible arithmetic and empirically evaluable claims.

The nine-unit program is therefore offered as a template for faculty preparation and the development of a post-legacy graduate HTA program. Universities may use the framework to reconsider existing teaching or as the foundation for constructing a new graduate course organized explicitly around representational measurement.

Access to the program involves a fee. The purpose of that charge is to support the continuing maintenance of the system through which the program is provided, including hosting, administration, updating and continued availability of the educational materials. It should not obscure the larger purpose of the initiative. The objective is to make available a structured transition framework that universities and faculty can use to move beyond the measurement failures of contemporary HTA.

The required transformation therefore does not have to begin with each university independently reconstructing the measurement framework from first principles. The framework already exists. The immediate question is whether faculty and graduate programs are prepared to use it as the starting point for a post-legacy HTA curriculum grounded in lawful measurement, admissible arithmetic and the standards of normal science.

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REFERENCES

[i] Maimon Research. HTA Reconstruction. https://maimonresearch.com/hta-reconstruction-program-and-fees/