MAIMON RESEARCH LLC

ARTIFICIAL INTELLIGENCE LARGE LANGUAGE MODEL INTERROGATION

REPRESENTATIONAL MEASUREMENT FAILURE IN HEALTH TECHNOLGY ASSESSMENT

AUSTRALIA: REQUIRED PROGRAM CONTENT FOR A GRADUATE COURSE IN HTA

Paul C Langley PhD Adjunct Professor, College of Pharmacy, University of Minnesota, Minneapolis, MN

LOGIT WORKING PAPER No 1841 AUGUST 2026

www.maimonresearch.com

Tucson AZ

ABSTRACT

Australian graduate education in health technology assessment (HTA) operates within an environment strongly influenced by the methodological requirements of the Pharmaceutical Benefits Advisory Committee (PBAC). University-affiliated research centers have consequently developed substantial expertise in economic evaluation, utilities, QALYs, cost-effectiveness analysis and reference-case modelling. Previous interrogations of Australian HTA, however, identify a contrasting absence of representational measurement as the scientific foundation for quantitative therapy evaluation. This creates a fundamental educational question: should graduate programs principally prepare students to reproduce the requirements of the existing reimbursement system, or provide the scientific knowledge required to determine whether those requirements support lawful quantitative claims?

This paper proposes 20 essential topics that an informed student should expect from graduate education in quantitative therapy evaluation. The topics are identical to those applied in other jurisdictions because measurement standards are not jurisdiction-specific. They progress from measurement preceding arithmetic, attribute definition, scales of measurement, admissible transformations, ratio measurement and dimensional homogeneity through the distinction between manifest and latent attributes. They culminate in two measurement pathways for therapy-impact claims: linear ratio measurement for manifest attributes and Rasch logit ratio measurement for latent attributes, with claims required to be empirically evaluable, replicable and capable of falsification.

Australia faces a distinctive transitional problem. PBAC may continue to require legacy methods, obliging research centers to retain expertise capable of servicing the existing reimbursement framework. Universities, however, have a different responsibility. PBAC requirements may determine what analyses are required for reimbursement; they should not determine what universities teach as quantitative science. Failure to distinguish these roles risks reproducing measurement failure for another generation and raises a question concerning the future viability of graduate HTA education.

A practical transition framework already exists. The Maimon Research nine-unit program comprises approximately 45,000 words of structured material covering lawful measurement and the construction of evaluable therapy-impact claims. As far as can presently be ascertained, it is the only program internationally designed specifically to support transition from legacy HTA to an HTA grounded in representational measurement, with continuing implementation support available to faculty and institutions. The challenge for Australian universities is therefore no longer simply curriculum improvement, but whether graduate education will remain committed to the PBAC-oriented legacy or begin constructing its scientifically defensible successor.

INTRODUCTION

Graduate education in Australia requires a substantial commitment of money, time and career opportunity. A prospective student considering advanced study in health technology assessment (HTA), health economics or quantitative therapy evaluation is therefore entitled to ask a straightforward question before enrolling: what scientific capabilities will this program actually give me? If the objective is expertise in quantitative therapy evaluation, the answer must extend beyond proficiency in the methods currently required by the Pharmaceutical Benefits Advisory Committee (PBAC). The student should expect to be taught the scientific requirements that determine whether a numerical claim concerning therapy impact is a measure, whether the arithmetic performed upon it is admissible and whether the resulting claim can contribute to the growth of objective knowledge.

This question has particular significance in Australia because the environment differs from that encountered in the United States. The PBAC occupies a dominant position in Australian pharmaceutical HTA. Its legacy methodological requirements have provided an important reference point for economic evaluation, reimbursement submissions and the activities of university-affiliated HTA and health-economics research centers. The resulting relationship is understandable. Research centers develop expertise relevant to the requirements of the national reimbursement system; they undertake research and evaluation within that environment; and students are educated in methods they are likely to encounter subsequently in government, academia, consulting and industry.

The problem arises when the requirements of a reimbursement agency become, in effect, the intellectual boundaries of graduate education.

Previous interrogations of the Australian HTA knowledge base, university research centers and educational environment have identified the same measurement inversion found internationally. Representational measurement does not appear to provide the organizing scientific foundation for quantitative therapy evaluation, while the conventional or legacy framework of utilities, QALYs, cost-effectiveness analysis, ICERs and reference-case modelling is extensively represented. The issue is not a lack of analytical expertise. Australian HTA research centers possess substantial capabilities in health economics, economic evaluation, epidemiology, outcomes research, statistics, modelling and health-services research. The problem is that this sophistication has developed within a legacy framework whose measurement foundations have now been challenged.

For the prospective student, that distinction is fundamental. A university should not merely prepare graduates to satisfy the current methodological requirements of the PBAC. It should provide them with the scientific knowledge necessary to determine whether those requirements themselves support defensible quantitative claims. Training someone to undertake a PBAC-compliant analysis and educating someone in quantitative therapy evaluation are not the same thing and never have been [1 2] .

The starting point remains elementary but non-negotiable: measurement precedes arithmetic. Before numbers are added, subtracted, multiplied, divided or incorporated into models, the attribute represented by those numbers must be defined and its measurement properties established. Students should understand the distinction between numerical assignment and measurement; nominal, ordinal, interval and ratio scales; admissible transformations; the axioms of representational measurement; ratio measurement; and dimensional homogeneity. These are not optional additions to an Australian HTA curriculum. They determine whether the arithmetic performed within that curriculum is scientifically admissible.

The curriculum must then address therapy impact itself. Manifest attributes require linear ratio measurement. Latent attributes such as pain, fatigue, anxiety, physical function or need fulfilment require construction of a measurement continuum. Students should therefore understand Rasch person-item conjoint measurement, unidimensionality, fit, local independence, ordered thresholds, differential item functioning, invariance, specific objectivity, construction of the logit ruler and attribute possession [3].

The required claims are the same in Australia as everywhere else. There are two allowable measurement pathways for quantitative therapy-impact claims: linear ratio measurement for manifest attributes and Rasch logit ratio measurement for latent attributes. Claims should subsequently be stated prospectively, empirically evaluated, replicated and exposed to potential falsification. The scientific requirements do not change because the PBAC operates within a different methodological framework. Measurement standards are not jurisdiction-specific.

This creates an unavoidable transitional problem for Australian university research centers. The PBAC is unlikely to abandon its established legacy methodological requirements, and centers undertaking work for, or relevant to, PBAC should retain the capability to service those requirements. In the immediate future this may require two parallel capabilities. One would maintain expertise in the legacy methods necessary to operate within the existing PBAC environment. The other would establish lawful measurement as the scientific foundation for graduate education and develop the new HTA around manifest and latent attributes, ratio measurement and empirically evaluable therapy-impact claims.

Such a parallel arrangement is intellectually uncomfortable. A university could find itself teaching students why particular quantitative operations fail the requirements of measurement while simultaneously maintaining a group capable of performing those operations because they remain required within the existing reimbursement system. Yet that may be preferable to allowing the requirements of PBAC to determine indefinitely what Australian universities teach as quantitative science. The responsibility of a reimbursement agency and the responsibility of a university are not the same.

This brings the issue back to the prospective student and, ultimately, to the survival of university-based HTA education. Now the measurement failure of the legacy framework has been exposed, why should an informed student commit substantial resources to a graduate program that does no more than reproduce it? Reputation, methodological sophistication and proximity to the PBAC cannot by themselves answer that question. Students entering graduate education now should reasonably expect to acquire capabilities relevant to the HTA legacy of the past forty years but to the scientific requirements that will determine the HTA of the future.

The purpose of this paper is to apply the same 20 topics used to assess required graduate program content elsewhere. There is no Australian version of the measurement standard. The questions remain unchanged because the requirements of lawful measurement remain unchanged. Together they provide a straightforward test of what an informed student should expect to encounter in graduate education and, equally importantly, what an Australian university-based HTA research center should be capable of teaching.

The survival question is consequently difficult to avoid. Australian research centers can continue to reproduce the PBAC-oriented legacy while the scientific case against its measurement foundations becomes increasingly visible, or they can begin building a parallel educational capability around lawful measurement and the new HTA. The first preserves an established market for existing expertise. The second creates a credible scientific future for graduate education.

For the prospective student the question is simpler: if the program cannot provide the measurement knowledge required to evaluate therapy impact according to the standards of normal quantitative science, why enroll?

PROGRAM CONTENT RESULTS

The earlier assessments of the Australian HTA knowledge base and university-affiliated health-economics and HTA research-center environment provide the immediate background to the present paper. The results followed the now familiar pattern: representational measurement was effectively absent from publicly identifiable program content, while the established methods of legacy or contemporary HTA and health economics were comprehensively represented. There is no need to reproduce those findings here. Their importance lies not in Australian exceptionalism but in their consistency with evidence accumulated internationally.

Australia nevertheless presents a distinctive institutional environment. The PBAC occupies a central position in pharmaceutical HTA and reimbursement decision-making, and its methodological requirements have exercised a substantial influence over the economic-evaluation framework within which Australian HTA operates. University-affiliated health-economics and HTA research centers have consequently developed substantial expertise in legacy methods relevant to PBAC requirements and the wider Australian reimbursement environment. This is entirely understandable as a response to the demand for economic evaluation, cost-effectiveness and cost-utility analysis, utilities, QALYs, decision modelling, uncertainty analysis and related methods. The difficulty arises when expertise developed to satisfy the requirements of the existing reimbursement system also defines the scientific boundaries of graduate education.

The same pattern has emerged from investigations of measurement inversion, curriculum inversion and program-content inversion in Australia and internationally [4]. Across agencies, research centers, university programs and the wider HTA knowledge base, the principles of representational measurement receive little or no identifiable recognition]. Measurement preceding arithmetic, admissible transformations, ratio measurement, dimensional homogeneity, the distinction between manifest and latent attributes, and the requirements for constructing measures of latent attributes are largely absent. At the same time, extensive quantitative structures have developed that presume that the numerical values upon which they operate possess the properties required to support the arithmetic being performed.

The cumulative evidence suggests something more serious than the omission of a few topics from graduate curricula. There appears to be little evidence within contemporary Australian HTA of a systematic understanding, or even awareness, of representational measurement as the scientific foundation for quantitative claims. This conclusion is supported not by a single interrogation, research center or jurisdiction but by the remarkable consistency of findings across different forms of assessment and institutional settings. Australia should therefore be viewed as one expression of a much wider epistemic failure rather than an isolated educational problem**.**

The Australian findings are particularly important because of the maturity and sophistication of the country's academic HTA environment. Australia contains major university-affiliated research centers with extensive expertise in health economics, economic evaluation, outcomes research, epidemiology, public health, decision analysis, health-services research and healthcare policy. Some have longstanding relationships with the Australian HTA and reimbursement system. The apparent absence of representational measurement cannot therefore readily be attributed to limited academic infrastructure or lack of quantitative expertise. The contrast is precisely the opposite: extensive analytical sophistication exists alongside an apparent absence of the measurement framework required to establish the quantitative status of the numbers being analyzed.

The historical implication is substantial. Australian graduate education in HTA, health economics, outcomes research and related fields has prepared successive generations of practitioners to operate within an established national HTA environment without, as far as can be established from the accumulated evidence, placing representational measurement at the foundation of quantitative therapy evaluation. Students have been trained in increasingly sophisticated analytical methods without first being required to establish the measurement status of the numbers entering those analyses. The result has been the institutional reproduction of measurement failure: faculty teach the framework in which they themselves were trained, graduates enter universities, government, consulting and industry, some become future faculty, and the same assumptions are transmitted to another generation.

The position of the PBAC makes the Australian problem particularly interesting. The PBAC is unlikely to change simply because a different scientific standard is proposed for graduate education. Australian universities, however, can change**.** Research centers may therefore face an uncomfortable transitional requirement. They may need to retain a capability to undertake the legacy economic evaluation and modelling required to service the existing PBAC environment while simultaneously developing a separate educational and research pathway grounded in representational measurement. Such parallel tracking may appear anomalous, but the alternative is to allow the current requirements of a reimbursement system to determine indefinitely what universities present to students as quantitative science.

This distinction is fundamental. The responsibility of the PBAC is to operate the national pharmaceutical reimbursement process within its established policy and methodological framework. The responsibility of a university is different**.** A university must educate students in the scientific principles necessary to evaluate critically the methods they encounter, including methods required by government agencies. Preparing a student to undertake a PBAC-compliant economic evaluation cannot therefore be regarded as sufficient preparation in quantitative therapy evaluation if the student has not also been taught how to determine whether the quantities and arithmetic employed satisfy the requirements of lawful measurement.

This history gives particular importance to the question of required graduate program content. The objective is not to add another specialist topic called *measurement* to an already crowded curriculum. Nor is it sufficient to devote a lecture to scales of measurement while leaving the remainder of the quantitative program unchanged. If representational measurement establishes the conditions under which quantitative claims and mathematical operations are meaningful, it must provide the organizing scientific framework for the course**.** Measurement preceding arithmetic must govern what students subsequently do, rather than appear briefly before the curriculum returns to the legacy framework.

The 20 topics that follow are proposed on that basis. They are identical to those proposed for graduate HTA education elsewhere because the scientific requirements of measurement do not change with jurisdiction**.** Together they describe the minimum body of knowledge that an informed student should expect a graduate program in quantitative HTA to address. They begin with measurement preceding arithmetic and proceed through attribute definition, scale properties, admissible transformations, ratio measurement and dimensional homogeneity to the separate requirements for measuring manifest and latent attributes. They culminate in the two allowable measurement forms for therapy-impact claims with linear ratio measurement for manifest attributes and Rasch logit ratio measurement for latent attributes and the requirement that such claims meet the standards of normal science through empirical evaluation, replication and potential falsification.

The question for Australian graduate programs is therefore not whether these 20 topics would provide useful additions to existing teaching. It is whether a course claiming to educate students in quantitative HTA can reasonably omit them. Nor can the answer simply be that graduates need to understand the methods required by the PBAC. They may indeed need that capability while the existing system remains in place. But professional competence in servicing a legacy reimbursement framework and scientific competence in quantitative therapy evaluation are not the same thing and never have been.

There is also a question of survival. Once prospective students become aware that the measurement foundations of legacy HTA have been challenged and that an alternative framework grounded in lawful measurement is available, universities must be able to explain what scientific capability their graduate programs actually provide. Students are investing money, time and an important part of their future careers. A program whose principal justification is that it teaches methods required by the existing reimbursement system risks educating students for the continuation of the past rather than preparing them for the scientific requirements of the future.

After decades of Australian graduate education built around the legacy HTA framework, the question therefore needs to be asked now. Can Australian university research centers continue to reproduce the PBAC-oriented legacy without simultaneously developing the measurement knowledge required to move beyond it? If they do not make that transition, the issue will eventually cease to be merely whether their curricula satisfy the standards of normal quantitative science. The more immediate question for the prospective student will be simpler**:** if the program cannot provide the scientific foundations required for the new HTA, why enroll**?**

TWENTY ESSENTIAL TOPICS FOR A GRADUATE PROGRAM IN QUANTITATIVE THERAPY EVALUATION

The following 20 topics represent a coherent body of knowledge rather than a menu from which individual subjects might be selected. Each contributes to the progression from defining an attribute, through establishing a measure, to constructing an empirically evaluable therapy-impact claim. An informed prospective student should therefore establish whether these topics are addressed in the graduate program being considered.

1. Measurement must precede arithmetic

Why this is essential. Measurement establishes the properties of the numerical representation before arithmetic is undertaken. Those properties determine which mathematical operations are admissible. Arithmetic cannot retrospectively transform numbers into measures or supply measurement properties that were never demonstrated. A graduate student in quantitative therapy evaluation should therefore understand from the outset that the scientific sequence is attribute definition, measurement and only then arithmetic. Reversing this sequence substitutes numerical manipulation for measurement and undermines the quantitative status of subsequent claims.

2. Definition of the target attribute before measurement

Why this is essential. Every therapy-impact claim concerns an attribute. Before selecting an instrument, assigning numbers or performing arithmetic, the student must be able to state precisely what is to be measured. Survival, hospital utilization, pain, fatigue and physical functioning represent different attributes and may require different measurement approaches. Failure to define the attribute creates ambiguity about what the resulting numbers represent. Attribute definition is therefore the necessary starting point for selecting a measure and constructing a defensible therapy-impact claim.

3. The distinction between numerical assignment and measurement

Why this is essential. Numbers may be assigned to observations for identification, ordering, classification or convenience without creating a quantitative measure. The fact that responses are represented by integers does not establish equal units, a meaningful zero or permissible arithmetic. Graduate students must therefore understand the difference between producing a numerical score and measuring an attribute. Without this distinction, numerical representations can acquire an appearance of quantitative precision while lacking the properties required to support the mathematical operations subsequently performed upon them.

4. Nominal, ordinal, interval and ratio scales

Why this is essential. The traditional hierarchy of measurement scales identifies fundamentally different numerical structures. Nominal values classify, ordinal values establish order, interval scales support meaningful differences, and ratio scales additionally support meaningful ratios where their defining requirements are satisfied. These distinctions are not introductory terminology to be mentioned and forgotten. They determine what can legitimately be done with numerical values. A graduate should be able to identify the scale properties of a proposed measure before deciding which arithmetic operations are meaningful.

5. Admissible transformations and permissible arithmetic

Why this is essential. A measurement scale is characterized by transformations that preserve the empirical relationships represented by its numerical assignments. These admissible transformations determine which mathematical statements remain invariant and therefore meaningful. Understanding this relationship prevents students from assuming that every mathematical operation available in software is scientifically permissible. Graduate education in quantitative therapy evaluation should establish the connection between scale structure, admissible transformation and arithmetic so that students can justify the operations applied to measures rather than simply calculate numerical results.

6. The axioms and requirements of representational measurement

Why this is essential. Representational measurement requires numerical relationships to represent corresponding empirical relationships in the attribute being measured. This depends upon conditions such as ordering, additivity, solvability, cancellation and related requirements appropriate to the measurement structure. These principles distinguish measurement from arbitrary numerical assignment. A graduate should understand why measurement requires evidence that the numerical system faithfully represents an empirical relational system. Without this foundation, there is no scientific basis for claiming that assigned numbers possess the quantitative properties attributed to them.

7. The requirements for ratio measurement

Why this is essential. Ratio measurement permits the widest range of arithmetic operations required for quantitative therapy-impact claims, but those operations are justified only when the defining properties of the scale have been established. Students should understand the requirements for invariant units, an appropriate non-arbitrary zero and meaningful ratio comparisons. Statements involving multiplication, division, proportions or claims that one quantity is twice another depend upon these properties. Ratio measurement should therefore be understood as a scientific requirement, not simply another label in a hierarchy of scales.

8. Dimensional homogeneity

Why this is essential. Quantities cannot be combined meaningfully merely because they are represented numerically. The dimensions represented by those quantities must be identified and the proposed arithmetic must preserve dimensional coherence. Dimensional homogeneity provides an elementary safeguard against constructing numerical expressions whose components have incompatible quantitative meanings. Graduate students should be able to examine every proposed therapy-impact calculation and ask what dimensions are being combined, what the resulting quantity represents and whether the operation produces a scientifically interpretable measure rather than an arbitrary numerical construction.

9. The distinction between manifest and latent attributes

Why this is essential. Therapy evaluation involves both directly observable and latent attributes. Hospital days, treatment administrations and survival time are manifest; pain, fatigue, anxiety and physical functioning are latent and cannot be directly observed. This distinction determines the appropriate measurement pathway. A graduate should not approach both categories with the same measurement strategy. Recognizing whether an attribute is manifest or latent is therefore a pivotal decision: it determines how a ruler can be constructed and how a quantitative therapy-impact claim can subsequently be expressed.

10. Linear ratio measurement for manifest attributes

Why this is essential. Manifest attributes capable of direct quantitative representation can be measured using linear ratio scales when the necessary properties of unit and zero are satisfied. Examples may include days hospitalized, treatment administrations or units of resource utilization. Students should understand how such measures are defined, why their units remain invariant and what arithmetic they support. This provides the first of the two measurement pathways required for therapy evaluation and establishes how changes in directly observable attributes can support meaningful quantitative therapy-impact claims.

11. Construction of therapy-impact claims for manifest attributes

Why this is essential. Measurement becomes scientifically useful when it supports an evaluable claim. Students should learn how a manifest attribute is translated into a protocol-defined therapy-impact claim specifying the target population, comparator, timeframe, unit of measurement and expected outcome. The claim should state in advance what observation would support or fail to support it. This moves graduate education beyond descriptive numerical analysis to hypothesis-driven therapy evaluation in which a measured impact is capable of being independently assessed, replicated and potentially rejected by empirical evidence.

12. Why ordinal observations and summed scores do not constitute latent measures

Why this is essential. Questionnaire response categories commonly represent ordered observations, but assigning integers to those categories does not establish equal intervals between them. Adding such integers together does not, by itself, create a measure with invariant units. Graduate students working with patient-reported outcomes must understand this distinction. Otherwise, arithmetic performed on summed scores may be interpreted as measurement without the necessary quantitative structure having been demonstrated. Recognizing the limitations of ordinal observations is the starting point for legitimate measurement of latent attributes.

13. Rasch person–item conjoint measurement

Why this is essential. Latent attributes cannot be directly observed and require a measurement framework capable of constructing a quantitative continuum. Rasch measurement locates persons and items conjointly on the same latent-attribute scale, providing a basis for transforming ordered observations into measures. Graduate students should understand the logic of this relationship rather than treating Rasch as merely another statistical technique. Its importance lies in constructing a ruler for an otherwise unobservable attribute so that differences in attribute possession can support quantitative therapy-impact claims.

14. Construction of a Rasch logit measurement continuum

Why this is essential. Understanding Rasch measurement requires more than knowing its name or operating software. Students should learn how response data are used to estimate person and item locations, how the provisional continuum is constructed and how logits provide the common metric upon which persons and items are located. This establishes the practical bridge between ordinal observations and latent measurement. A graduate should understand where the resulting measures come from, what they represent and why construction of the ruler precedes its use in evaluating therapy impact.

15. Requirements for a defensible Rasch ruler

Why this is essential. A fitted Rasch model does not automatically establish a defensible measurement instrument. Students should understand the empirical requirements that the ruler must satisfy, including unidimensionality, item fit, local independence, ordered response thresholds, differential item functioning, targeting and stability. These requirements test whether the proposed instrument behaves as a measurement system rather than merely providing a statistical description of response data. A graduate should therefore be capable of evaluating whether a proposed latent ruler meets the conditions necessary for quantitative interpretation.

16. Invariance and specific objectivity

Why this is essential. A fundamental objective of measurement is that comparisons should not depend arbitrarily upon the particular measuring instrument or sample used. Rasch specific objectivity requires person comparisons to remain invariant across appropriate items and item comparisons across appropriate persons, subject to the requirements of the measurement model. Students should understand why this property is central to constructing a defensible latent measure. Without appropriate invariance, observed differences may reflect characteristics of the instrument or sample rather than differences in possession of the target attribute.

17. Attribute possession on a Rasch logit scale

Why this is essential. The purpose of latent measurement is to determine the extent to which a person possesses the specified attribute. Once a defensible Rasch ruler has been constructed, the person's response pattern locates that individual on the latent continuum. Graduate students should understand this concept of attribute possession because it changes the focus from questionnaire scores to measures of the attribute itself. Therapy impact can then be expressed as a change in possession rather than simply as a numerical change in an aggregated response score.

18. Therapy-impact claims for changes in latent-attribute possession

Why this is essential. A latent measure should ultimately support an empirically evaluable claim about therapy impact. Students should learn how changes in attribute possession are specified prospectively for a defined population, comparator and timeframe using the Rasch logit measure. The claim must identify the expected change and the evidence that would count against it. This connects latent measurement directly to hypothesis testing and replication. Rasch measurement thereby becomes part of a scientific protocol for evaluating therapy impact rather than an isolated psychometric exercise.

19. The two allowable measurement forms for quantitative therapy-impact claims

Why this is essential. A coherent graduate curriculum should bring the preceding measurement principles together into two pathways for quantitative therapy-impact claims: **linear ratio measurement for manifest attributes and Rasch logit ratio measurement for latent attributes**. The student should understand why the nature of the attribute determines which pathway is appropriate and why other numerical representations cannot simply be assumed to constitute measures. A graduate should leave able to identify the attribute, select the appropriate measurement form and defend the quantitative status of the resulting claim.

20. The requirements of normal science

Why this is essential. Quantitative therapy evaluation should culminate in claims capable of participating in normal scientific inquiry. The attribute must be defined, the measure must satisfy appropriate measurement requirements, and the claim must specify the population, comparator, timeframe and predicted therapy impact. Most importantly, the claim must be empirically evaluable, open to replication and capable of falsification. A graduate program should therefore produce students able not merely to generate numbers, but to construct quantitative claims that can succeed or fail when confronted by evidence.

FACULTY AND STUDENTS

The 20 topics described above imply more than revision of a syllabus. For Australian universities and university-affiliated HTA and health-economics research centers, they require a change in the relationship between faculty, students and the quantitative framework that has traditionally defined graduate education in HTA, health economics, pharmacoeconomics and outcomes research. If measurement becomes the organizing principle of therapy evaluation, both faculty and students enter a post-legacy environment in which established methods can no longer be accepted simply because they are familiar, widely used, institutionally supported or required within the existing PBAC reimbursement framework. Every quantitative claim must instead begin with the attribute, satisfy the requirements of measurement and employ only arithmetic justified by the properties of the measure.

For Australian faculty, this presents an unusual academic challenge. Many current teachers and researchers were themselves educated within programs in which representational measurement was absent. They subsequently developed research careers, publications, teaching materials and professional relationships within the same framework. In Australia, that inheritance has been reinforced by the practical importance of preparing analyses relevant to PBAC and the wider reimbursement environment. The evidence from measurement inversion, curriculum inversion and program-content inversion suggests that the omission of representational measurement has consequently been reproduced across successive generations. Faculty cannot therefore be expected to correct the problem merely by being told that measurement should receive greater emphasis. The first requirement is acquisition of a body of knowledge that, for many, was not part of their own graduate education.

This should not be interpreted as a criticism of faculty competence within the framework in which they were trained. Australia has substantial expertise in economic evaluation, statistics, epidemiology, decision analysis, health-services research, outcomes research and related quantitative methods. Australian research centers have also developed considerable expertise in the preparation, review and interpretation of evidence relevant to national HTA and reimbursement requirements. The problem is more fundamental. Expertise in these areas does not automatically provide expertise in representational measurement. The post-legacy challenge requires faculty themselves to examine attributes, scales, admissible transformations, ratio measurement, dimensional homogeneity, manifest and latent attributes, Rasch measurement, specific objectivity and attribute possession. Only then can these principles be incorporated coherently into graduate teaching.

The responsibility extends well beyond adding a lecture or module entitled *Measurement*. If students are taught that measurement precedes arithmetic, that proposition must have consequences throughout the course. If they are taught that scale properties determine admissible operations, those restrictions must subsequently be respected. If manifest and latent attributes require different measurement pathways, assignments, research projects and assessments must reflect that distinction. Representational measurement cannot occupy one week of an Australian graduate course and then disappear while the remainder of the curriculum returns to utilities, QALYs, ICERs and reference-case modelling as though the measurement questions had never been raised. Integration rather than acknowledgement is the standard.

Faculty must also be prepared for a different type of classroom. Students who understand representational measurement should be encouraged to ask elementary but potentially disruptive questions: *What is the attribute? Is this a measure or merely a score? What is the scale type? Where is the zero? Are the units invariant? What transformations are admissible? Does the proposed arithmetic preserve dimensional homogeneity? Is the attribute manifest or latent? If latent, how was the ruler constructed?* They should also be entitled to ask why a method that fails these tests should be accepted merely because it forms part of established PBAC practice. These questions should not be regarded as challenges to faculty authority. They are precisely the questions that graduate education in quantitative science should encourage.

The responsibility of the Australian graduate student is correspondingly greater. Students should not approach HTA as a collection of procedures to be mastered, reproduced and subsequently applied in PBAC submissions, academia, consulting, industry or government. They should expect to understand why a quantitative operation is scientifically admissible before performing it. The objective is not proficiency in software, conformity with an established analytical template or the ability to reproduce a PBAC-compliant model. It is the ability to construct and defend a quantitative claim. Students should therefore be prepared to challenge their own assumptions, identify measurement failures and reject numerical operations that cannot be justified by the properties of the measure.

The post-legacy curriculum also provides students with a much clearer destination. Therapy evaluation begins by defining the target attribute and determining whether it is manifest or latent. For manifest attributes, the student should be able to construct or identify an appropriate linear ratio measure. For latent attributes, the student should understand the construction and evaluation of a Rasch logit ratio measure and the assessment of attribute possession. These are not simply two additional analytical techniques. They constitute the only two measurement pathways through which quantitative therapy-impact claims can be constructed.

The final obligation shared by faculty and students is to return quantitative therapy evaluation to the requirements of normal science. Claims should be specified prospectively and expressed in terms that permit empirical evaluation. They should be open to replication and, critically, capable of falsification. Failure is therefore not something to be avoided by constructing increasingly elaborate analytical systems. A claim that fails when confronted by evidence contributes to knowledge because it can be rejected, revised or replaced. Faculty should teach this process; students should expect to participate in it.

Transition to a post-legacy environment will inevitably be demanding in Australia precisely because the existing academic and reimbursement infrastructure is so well established. Courses, research programs, doctoral supervision, publications, professional networks and relationships with the national HTA system cannot be reconstructed overnight. Nor should faculty be expected simply to discard decades of accumulated expertise. The immediate requirement is different: established quantitative methods must be reconsidered against the standards of measurement that should have preceded them. Those that satisfy the requirements can be retained; those that do not must either be reconstructed or recognized for what they are: legacy methods maintained because the existing reimbursement system continues to require them.

This creates Australian dilemma. The PBAC may not change, but universities and research centers must. Centers undertaking PBAC-related work may need, at least during a transitional period, to maintain expertise in the legacy framework required to service the existing reimbursement system while simultaneously developing a scientifically separate educational and research capability grounded in lawful measurement. This parallel arrangement is hardly ideal. Faculty who understand the constraints imposed by ratio measurement may reasonably question why they should continue devoting intellectual effort to analyses containing operations they no longer regard as scientifically admissible. Yet the continuing requirements of the PBAC do not remove the responsibility of universities to educate students according to the standards of quantitative science. How long these will last is an open question, One possible route through this dilemma is to explore how far lawful measurement can be introduced within the existing PBAC environment. Rather than treating PBAC requirements as defining the outer boundary of permissible analysis, researchers could examine where the existing framework allows therapy-impact claims based upon linear ratio measurement for manifest attributes or Rasch logit ratio measurement for latent attributes to be presented alongside whatever legacy analyses remain mandatory. The objective would not be to evade PBAC requirements, but to begin distinguishing explicitly between analyses undertaken because they are required for reimbursement and claims constructed because they satisfy the requirements of lawful measurement. Such an approach could provide a bridge between servicing the existing system and developing its scientific successor.

That is precisely where the responsibility of the university becomes important. Australian universities are not required to accept the conclusions advanced here without criticism. Faculty should be encouraged to challenge representational measurement, the proposed distinction between manifest and latent measurement pathways and the conclusions drawn for contemporary HTA. Academic disagreement is entirely appropriate. What cannot be defended is the continued education of graduate students in quantitative therapy evaluation without exposing them to the body of measurement knowledge necessary to understand and participate in that challenge. Academic freedom protects criticism and disagreement; it does not require a university to reproduce the methodological assumptions of a reimbursement agency as though they define the boundaries of quantitative science.

The scale and international standing of the Australian HTA and health-economics research environment make the opportunity particularly significant. A transition within the major university-affiliated research centers would influence not only current graduate students but future faculty, researchers and practitioners entering government, pharmaceutical and biotechnology companies, consulting, healthcare systems and academia. Conversely, continuing to reproduce an educational framework in which representational measurement remains absent would transmit the same epistemic limitation to another generation.

There is also a question of survival. Australian research centers may continue to have a market for PBAC-related expertise because the reimbursement system requires it. That does not necessarily guarantee a future market for graduate education built around the same legacy. An informed prospective student may reasonably distinguish between learning how to satisfy the current requirements of the PBAC and acquiring the scientific capabilities necessary for a career in quantitative therapy evaluation. If the latter is the objective, universities must be able to demonstrate that their programs provide more than technical competence in an inherited reimbursement framework.

The 20 topics proposed here consequently represent more than required program content for Australia. They define a different educational relationship. Faculty are responsible for providing the measurement foundations, subjecting them to critical examination and demonstrating their application; students are responsible for understanding, questioning and applying them. The common objective is a graduate capable of moving beyond inherited incorrect numerical procedures to the construction of therapy-impact claims grounded in linear ratio measurement for manifest attributes or Rasch logit ratio measurement for latent attributes, and capable of contributing through those claims to the continuing evolution of objective knowledge.

For Australian universities, the distinction is ultimately straightforward. PBAC requirements may determine what analyses must currently be submitted for reimbursement. They should not determine what a university teaches as the requirements of quantitative science.

TRANSITION TO LAWFUL MEASUREMENT

The transition to lawful measurement requires more than demonstrating the measurement failures of contemporary HTA. It requires a replacement framework grounded in representational measurement. The Maimon Research nine-unit transformation program provides that framework [5]. Beginning with the principle that measurement must precede arithmetic, the program progresses through the definition of attributes, scales of measurement, admissible arithmetic, dimensional homogeneity, manifest and latent attributes, linear ratio measurement, Rasch measurement, attribute possession, and the construction of empirically evaluable therapy-impact claims. The purpose is not to add measurement to the existing HTA paradigm while leaving its analytical structure intact. It is to replace that structure with one in which quantitative claims must first satisfy the requirements of lawful measurement and can then be evaluated, falsified and replicated.

At the same time, the nine units provide the substantive foundation for a graduate course in lawful measurement for HTA. Comprising approximately 45,000 words of structured instructional material**,** the program provides sufficient depth to move beyond a brief introduction to measurement theory and support a systematic transition from the legacy HTA framework to one grounded in representational measurement. Its sequence can be translated directly into a graduate curriculum progressing from measurement preceding arithmetic, attributes and scales of measurement through admissible arithmetic and dimensional homogeneity to manifest and latent attributes, linear ratio measurement, Rasch measurement, attribute possession and the construction of empirically evaluable therapy-impact claims.

As far as can presently be ascertained, this is the only program available internationally designed specifically to support the transition from legacy HTA to an HTA grounded in the requirements of lawful measurement**.** That distinction is important. The program is not intended to add a measurement component to contemporary HTA while leaving utilities, QALYs and reference-case modelling undisturbed. It provides a structured pathway for reconsidering the scientific foundations of the discipline itself and for rebuilding quantitative therapy evaluation around measurement before arithmetic, ratio measurement and claims capable of empirical evaluation and falsification.

The resulting course would replace the conventional emphasis on utilities, mapping, QALYs and reference-case modelling with an alternative scientific structure: defining the target attribute, determining whether it is manifest or latent, constructing the appropriate linear or Rasch ratio measure, and using that measure to formulate empirically evaluable claims. The nine-unit program therefore provides not simply a critique of the legacy framework, but the content and organizing structure from which its educational replacement can be built.

Faculty and practitioners who enroll will have access to a 24/7 question-and-answer support service, providing continuing assistance as they work through the implications of representational measurement for teaching, research and HTA practice. This becomes particularly important where faculty are using the program as the foundation for curriculum development. Questions concerning course structure, individual topics, measurement concepts, examples, assignments and their application to existing HTA material can be addressed as they arise. Participants are therefore not expected to complete the nine units and then independently determine how an unfamiliar scientific framework should be translated into teaching or practice. Continuing support is intended to make the movement from understanding to implementation an integral part of the transition.

Additional faculty and institutional support can also be arranged on an agreed basis. This may include Zoom seminars and workshops, assistance with graduate-course and curriculum redesign, development of teaching materials, recommended references and readings, and guest lectures addressing particular aspects of representational measurement and its application to HTA. Support can be tailored to individual faculty members, courses, departments, research centers or professional groups. The nine-unit program should therefore be understood as the starting point for a managed transition to lawful measurement. It provides the replacement scientific framework, the substantive elements required to construct a graduate course around that framework, and continuing access to the expertise and educational resources required for implementation. The objective is not simply to demonstrate why contemporary HTA must change, but to provide faculty and practitioners with the foundations and practical means to build, teach and apply its replacement. There is no going back.

CONCLUSION

The issue facing graduate HTA education in Australia is no longer whether additional attention might usefully be given to measurement. The accumulated evidence from measurement inversion, curriculum inversion and program-content inversion indicates a more fundamental problem: representational measurement has not provided the scientific foundation for the quantitative methods taught and applied within contemporary HTA. The consequence has been the transmission across successive generations of students of an analytical framework in which arithmetic has been allowed to precede measurement. In Australia, this legacy has been reinforced by an HTA environment in which university research centers have developed substantial expertise in methods required by PBAC and the wider reimbursement system.

The 20 topics identified in this paper define what an informed student should now expect from a graduate program concerned with quantitative therapy evaluation. They are not optional additions to an established curriculum and they do not change because the Australian reimbursement environment has particular methodological requirements. They constitute a coherent body of knowledge beginning with attribute definition and measurement before arithmetic, proceeding through scales of measurement, admissible transformations, ratio measurement and dimensional homogeneity, and culminating in the distinction between manifest and latent attributes. The endpoint is equally clear: quantitative therapy-impact claims require linear ratio measurement for manifest attributes or Rasch logit ratio measurement for latent attributes.

The challenge is therefore one of transition rather than curriculum expansion. Faculty must acquire and integrate a body of measurement knowledge that may have been absent from their own graduate education. Students, in turn, should expect more than technical proficiency in inherited quantitative procedures or the ability to undertake a PBAC-compliant economic evaluation. They should leave a graduate program capable of identifying an attribute, establishing its measurement requirements, selecting the appropriate measurement pathway and constructing a therapy-impact claim that is empirically evaluable, replicable and capable of falsification.

Australia presents a particular complication because the PBAC is unlikely to change simply because the measurement foundations of contemporary HTA are challenged. University-affiliated research centers may therefore continue to require expertise in utilities, QALYs, cost-effectiveness analysis and reference-case modelling to undertake work within the existing reimbursement environment. This creates the possibility of an uncomfortable transitional arrangement: centers may need to maintain a legacy capability to service the PBAC while simultaneously developing a scientifically distinct educational and research capability grounded in representational measurement. The existence of the first requirement cannot, however, justify neglect of the second.

Indeed, the distinction goes directly to the responsibility of the university. PBAC requirements may determine what analyses are required for reimbursement; they cannot determine what constitutes lawful quantitative science. Universities have a responsibility to provide students with the scientific knowledge necessary not merely to reproduce established professional practice but to evaluate it. A graduate capable of constructing a PBAC submission but unable to determine whether the arithmetic underlying that submission is admissible has acquired technical competence within an established system, not a complete scientific education in quantitative therapy evaluation.

Australian universities and research centers therefore have an opportunity to define what graduate education in HTA should mean in a post-legacy environment. Given Australia's substantial academic infrastructure in health economics, pharmacoeconomics, outcomes research, medicine, pharmacy, public health and health-services research, the intellectual resources for such a transition clearly exist. The choice is whether those resources continue to reproduce an inherited analytical framework in which representational measurement remains absent or are redirected toward an HTA in which measurement determines what arithmetic is permissible.

The standard should not be whether a program reproduces established PBAC practice or prepares students to apply methods that have been accepted for decades. Institutional acceptance, reimbursement requirements and widespread use do not establish scientific validity. The appropriate standard is whether the program equips students to construct defensible quantitative claims and thereby contribute to normal science and the evolution of objective knowledge.

There is finally a question of survival. The PBAC may continue to provide demand for researchers capable of servicing the legacy framework, but that does not guarantee continuing student demand for graduate education built around it. Once prospective students understand the distinction between learning how to satisfy an existing reimbursement system and learning how to construct scientifically defensible quantitative therapy-impact claims, universities will increasingly have to explain what knowledge they are actually selling.

For the prospective student investing substantial time, money and career opportunity, the question is therefore simple: does the Australian graduate program being considered provide this scientific education? If it cannot demonstrate a coherent pathway from attribute definition, through lawful measurement, to empirically evaluable and falsifiable therapy-impact claims, why enroll?

For Australian universities and research centers, the corresponding question is more consequential: if the PBAC remains committed to legacy HTA, will graduate education remain committed to it as well?

ACKNOWLEDGEMENT

I acknowledge that I have used OpenAI technologies, including the large language model, to assist in the development of this work. All final decisions, interpretations, and responsibilities for the content rest solely with me.

REFERENCES

---

[1] Stevens S. On the Theory of Scales of Measurement. *Science*. 1946;103(2684):677-80

[2] Krantz D, Luce R, Suppes P, Tversky A. Foundations pf Measurement Vol 1: Additive and Polynomial Representations. New York: Academic Press, 1971

[3] Bond T, Zi Yan, Heene M. Applying the Rasch Model: Fundamental measurement in the human sciences (4th Ed). New York: Routledge, 2021

[4] Australia: University research centers and the absence of measurement in HTA education. Logit Working Paper No 1789. https://maimonresearch.com/logit-working-paper-no-1789-july-2026/

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