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REPRESENTATIONAL MEASUREMENT FAILURE IN HEALTH TECHNOLGY ASSESSMENT

AUSTRALIA: THE LONG SILENCE

0/17 FOR REPRESENTATIONAL MEASUREMENT AND THE 2027 RESEARCH-CENTER HTA CURRICULUM

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ABSTRACT

Over the past six months, Australian university-affiliated health technology assessment (HTA) and health economics research centers have been made aware of a fundamental challenge to the measurement foundations of contemporary HTA. Previous interrogations identified measurement inversion and curriculum inversion: extensive reliance upon utilities, quality-adjusted life-years (QALYs), incremental cost-effectiveness ratios (ICERs), economic evaluation and decision modelling accompanied by little recognition of the principles of representational measurement required to determine whether the numerical values employed support the arithmetic performed upon them. The present study extends these investigations by evaluating the collective program-content knowledge base of the major Australian university-affiliated HTA research centers.

Two explicitly defined sets of topics were applied to publicly available teaching, training, research and methodological content. The first comprised 17 topics representing the foundations of representational measurement, including measurement preceding arithmetic, attribute definition, scales of measurement, admissible transformations, ratio measurement, dimensional homogeneity, manifest and latent attributes, linear ratio measurement, Rasch measurement, person-item conjoint measurement, specific objectivity, invariance and attribute possession. The second comprised 20 topics characterizing contemporary HTA, including economic evaluation, cost-effectiveness and cost-utility analysis, utilities, QALYs, ICERs, decision-analytic modelling, uncertainty analysis, patient-reported outcomes, evidence synthesis, reimbursement decision making and resource allocation. The centers were pooled so that substantive representation by any center was sufficient for a topic to be recorded as present.

The contrast was complete. None of the 17 representational-measurement topics was identified, producing a score of 0/17, while all 20 contemporary HTA topics were represented, producing a score of 20/20. This does not indicate an absence of quantitative sophistication. Rather, Australian programs comprehensively represent the downstream analytical methods of contemporary HTA while omitting the logically prior measurement framework required to determine whether the numerical values entering those analyses possess the properties necessary to support the proposed arithmetic.

The implications are primarily academic rather than administrative. Representational measurement cannot simply be appended to the existing curriculum as another optional method. Once students are taught that measurement precedes arithmetic, that scale properties determine admissible operations, that multiplicative claims require appropriate measurement properties, and that manifest and latent attributes demand different measurement approaches, those principles necessarily become standards against which utilities, QALYs, ICERs and modelled claims must themselves be evaluated. Universities need not accept the resulting critique of contemporary HTA, but their responsibility as institutions of quantitative science requires that students be provided with the knowledge necessary to understand, evaluate and, where justified, reject it.

The commencement of the Australian academic year in early 2027 provides a prospective test of academic response. The present 0/17 result establishes a baseline against which curriculum change can be evaluated. Repeating the assessment in 2027 will determine whether

representational measurement has begun to enter Australian HTA teaching or whether the documented epistemic separation remains intact. What originated historically as an understandable omission can no longer remain indefinitely unexplored once the missing body of knowledge has been explicitly identified.

INTRODUCTION

Over the past six months, university-affiliated health technology assessment (HTA) and health economics research centers in Australia have been made aware of the extent to which measurement inversion and curriculum inversion characterize contemporary HTA [1 2]. The findings have been remarkably consistent. Across centers, the scientific requirements that should determine whether quantitative claims constitute lawful measurement receive little or no recognition, while utilities, quality-adjusted life-years (QALYs), incremental cost-effectiveness ratios (ICERs), economic evaluation and decision modelling are extensively represented. These findings are not uniquely Australian. They replicate a pattern identified across national HTA agencies, universities, professional organizations and research centers internationally. Australian HTA therefore appears to occupy the same epistemic environment as contemporary HTA globally: extensive sophistication in arithmetic, statistical analysis and modelling combined with an absence of the representational-measurement framework required to determine whether the numbers being manipulated possess the properties necessary to support those operations.

Historically, this failure is understandable. Contemporary HTA emerged within health economics without representational measurement occupying a foundational position. The pioneers of cost-effectiveness and cost-utility analysis did not first establish the attributes to be measured, determine their scale properties and then restrict subsequent arithmetic to operations admissible for those scales. Utilities, QALYs and modelled cost-effectiveness claims developed within what may be described as an epistemic doughnut hole: measurement science was largely absent from the intellectual framework within which the analytical methods of HTA evolved. Australian research centers inherited and subsequently developed this framework in parallel with similar developments internationally and with the methodological requirements of the Pharmaceutical Benefits Advisory Committee (PBAC).

That historical explanation, however, cannot indefinitely explain the contemporary position with a 35 year legacy. Australian centers have now been explicitly informed of the measurement challenge and its implications for HTA. Yet there has, so far, been no substantive public response to these findings and, as far as can be determined from publicly available program content, no corresponding change in the teaching framework. This silence is important. It does not demonstrate rejection of representational measurement, nor does it demonstrate acceptance. It simply leaves unresolved a foundational scientific challenge to a discipline that presents itself as quantitative. Once the challenge has been identified, continued reliance upon historical convention cannot substitute for demonstrating that the numerical constructs employed in HTA satisfy the measurement requirements necessary to support the arithmetic performed upon them.

The present assessment makes the contrast particularly stark. When the publicly available program content of the major Australian university-affiliated HTA and health economics research centers is treated collectively as a single knowledge base, none of 17 topics representing the foundations of representational measurement is identified, while all 20 topics representing the conventional HTA framework are present. The result is therefore 0/17 versus 20/20. This is not evidence of a lack of quantitative sophistication. Australian programs provide extensive teaching and research in economic evaluation, cost-effectiveness and cost-utility analysis, utilities, QALYs, ICERs, decision modelling, evidence synthesis, uncertainty analysis, patient-reported outcomes and healthcare resource allocation. The problem is that this extensive downstream analytical structure is not preceded by the upstream measurement framework required to establish whether its quantitative operations are admissible.

The consequences extend directly to university teaching. Representational measurement cannot simply be appended to the existing curriculum as an optional methodological topic [3].[4] If students are taught that measurement precedes arithmetic, that scale properties determine admissible operations, that multiplication and division require appropriate measurement properties, and that dimensional homogeneity must be respected, they will necessarily apply those standards to utilities, QALYs and ICERs. If they are taught to distinguish manifest from latent attributes, they will ask how each is measured and whether preference scores and patient-reported outcomes constitute measures of defined attributes. Introducing representational measurement therefore exposes the existing HTA curriculum to evaluation by standards that have previously been largely absent from it.

This creates a particular difficulty in Australia because university teaching and research coexist with the established methodological framework of PBAC. Universities must prepare students to understand and participate in the existing reimbursement process, including the preparation and assessment of submissions for new products. At the same time, their academic responsibility extends beyond training students to comply with an administrative methodology. They must provide the scientific knowledge necessary to evaluate critically the methods they teach. If representational measurement challenges the measurement status of utilities, QALYs and cost-utility analysis, avoiding that challenge preserves institutional continuity but does not resolve the scientific question.

The purpose of this paper is therefore twofold. First, it assesses the extent to which the publicly represented teaching and research content of Australian university-affiliated HTA centers is dominated by the conventional arithmetically unlawful analytical framework while omitting the requirements of lawful measurement. Second, it considers the implications of continuing to put representational measurement to one side after its relevance has been explicitly raised. The issue is no longer simply how Australian HTA arrived at its present position. It is whether universities can continue to teach a quantitative discipline without providing students with the measurement principles required to determine whether its central quantitative claims are scientifically admissible. What was once an inherited epistemic omission is now becoming a question of conscious academic choice for unlawful measurement.

PROGRAM CONTENT OF RESEARCH CENTERS

This evaluation of the program content of teaching in Australian university-affiliated research centers builds upon an earlier study that demonstrated a substantial gulf between the teaching of representational measurement and that characterizing contemporary health technology assessment

(HTA) [5] . The earlier evaluation examined whether the scientific requirements governing measurement were represented in the teaching and research environment alongside the established methods of health economics and HTA. The present evaluation retains that distinction but applies a more comprehensive and explicitly defined set of issues to explore the two epistemic frameworks.

The principal difference lies in the topics selected for interrogation. Rather than relying upon a smaller group of broad methodological concepts, the evaluation identifies 17 topics representing the requirements of representational measurement and 20 topics representing contemporary HTA**.** These provide two contrasting descriptions of the knowledge that might be expected to characterize teaching and methodological training within university-affiliated HTA research centers. The purpose is to determine whether each topic is explicitly represented in the publicly available program content of the Australian centers when they are considered collectively.

The 17 representational-measurement topics begin with the proposition that measurement must precede arithmetic. They encompass the identification of the attribute to be measured; scales of measurement and their implications for admissible arithmetic; the axiomatic foundations of representational measurement; admissible transformations; ratio measurement and its requirements; dimensional homogeneity; and the distinction between manifest and latent attributes. The topic set then extends to the measurement pathways appropriate to these different forms of attribute, including linear ratio measurement for manifest attributes and Rasch measurement for latent attributes. Person-item conjoint measurement, specific objectivity and invariance, attribute possession and the role of the Rasch logit scale are included to identify whether the requirements for constructing measures of latent attributes are represented within the program-content knowledge base.

The 20 contemporary HTA topics characterize the analytical framework conventionally associated with health economics and technology assessment. These include health economics, HTA, economic evaluation, cost-effectiveness analysis, cost-utility analysis, utilities and preference-based outcomes, QALYs and incremental cost-effectiveness ratios. They also encompass decision-analytic modelling, Markov and related simulation methods, base-case economic modelling, sensitivity and uncertainty analysis, probabilistic methods, patient-reported outcomes and health-related quality of life. Evidence synthesis, comparative clinical evidence, reimbursement and policy decision making, resource allocation and methodological development within the conventional HTA framework complete the topic set.

The evaluation is deliberately based upon program content rather than the views of individual faculty members. It does not attempt to determine whether particular academics are personally familiar with representational measurement, nor does absence from publicly available material establish that no individual within a center possesses such knowledge. The question is narrower: whether these topics are represented in the publicly identifiable teaching, training and methodological environment through which the centers communicate their approach to HTA and health economics.

For this purpose, the major Australian university-affiliated HTA and health economics research centers are treated collectively as a single Australian academic HTA program-content knowledge base. The assessment encompasses Adelaide Health Technology Assessment, the Centre for Health Economics Research and Evaluation at the University of Technology Sydney, the Centre for Health Economics at Monash University, Deakin Health Economics, health economics and HTA activities at the University of Melbourne, the Health Economics Research and Modelling Unit at the University of Queensland, Griffith University health economics activities, and the other university-based programs included in the earlier Australian assessment. Publicly available descriptions of teaching, courses, training, research programs, methodological activities and associated academic content provide the basis for determining topic representation.

Pooling the centers is important to the design of the evaluation. The objective is not to produce scores for individual institutions but to characterize the Australian university HTA knowledge base as a whole. Accordingly, a topic is recorded as present if substantive evidence for it can be identified anywhere within the combined program content. Conversely, a topic is recorded as absent only when substantive representation cannot be identified across the pooled centers. This provides a deliberately inclusive test: recognition by any one of the centers is sufficient for the topic to be represented in the Australian knowledge base.

The resulting evaluation therefore consists of two parallel program-content interrogations. The first asks which of the 17 representational-measurement topics are explicitly represented across the combined Australian centers. The second applies the same criterion to the 20 topics characterizing contemporary HTA. The results are presented separately in the following two tables before consideration of their implications for Australian HTA teaching, research and the future structure of the curriculum.

ASSESSMENT RESULTS

The results for representational measurement are presented in Table 1. Of the 17 topics listed the knowledge base interrogation could find no evidence for their recognition or application

TABLE 1. REPRESENTATIONAL MEASUREMENT

No.	Program-content topic	Australian centers
1	Measurement must precede arithmetic	**Absent**
2	Explicit identification of the attribute before measurement	**Absent**
3	Nominal, ordinal, interval and ratio scales as constraints on arithmetic	**Absent**
4	Representational measurement as the foundation of quantitative claims	**Absent**
5	Axioms/requirements of representational measurement	**Absent**
6	Admissible transformations determine permissible mathematical operations	**Absent**
7	Multiplication and division require ratio measurement	**Absent**
8	Ratio measurement requires a non-arbitrary/true zero	**Absent**
9	Ratio measurement requires invariant equal units	**Absent**
10	Dimensional homogeneity as a requirement for meaningful arithmetic	**Absent**

No.	Program-content topic	Australian centers
11	Explicit distinction between manifest and latent attributes	**Absent**
12	Linear ratio measurement for manifest attributes	**Absent**
13	Rasch measurement as the required measurement model for latent attributes	**Absent**
14	Person–item conjoint measurement	**Absent**
15	Specific objectivity/invariance as a measurement requirement	**Absent**
16	Attribute possession as the basis for latent therapy-impact claims	**Absent**
17	Two allowable measurement forms for therapy impact: linear ratio and Rasch logit ratio	**Absent**

Representational-measurement score: 0/17

The pooled search did locate Rasch material in Australia generally, but not as an organizing principle of the university HTA program-content knowledge base. Searches for the more diagnostic concepts representational measurement, measurement preceding arithmetic, admissible transformations, dimensional homogeneity, specific objectivity and ratio measurement as a prerequisite for HTA arithmetic did not identify substantive adoption by the centers. That distinction is important: the existence of Rasch research somewhere in Australian academia does not establish recognition of Rasch or representational measurement within HTA.

Table 2 presents the results for topics that characterize the program content of contemporary HTA,

TABLE 2: CONTEMPORARY HTA / HEALTH-ECONOMICS CONTENT

No.	Program-content topic	Australian centers
1	Health technology assessment	**Present**
2	Health economics	**Present**
3	Economic evaluation	**Present**
4	Cost-effectiveness analysis	**Present**
5	Cost-utility analysis	**Present**
6	Utilities / health-state utilities	**Present**
7	Quality-adjusted life-years (QALYs)	**Present**
8	Incremental cost-effectiveness ratios (ICERs)	**Present**
9	Decision-analytic modelling	**Present**
10	Markov/state-transition or related simulation modelling	**Present**
11	Reference/base-case economic modelling	**Present**
12	Sensitivity and uncertainty analysis	**Present**
13	Probabilistic methods / model uncertainty	**Present**

No.	Program-content topic	Australian centers
14	Patient-reported outcomes / quality of life	**Present**
15	Evidence synthesis / systematic review	**Present**
16	Meta-analysis / comparative clinical evidence	**Present**
17	Health-policy and reimbursement decision making	**Present**
18	Value-for-money / resource-allocation assessment	**Present**
19	Evaluation of pharmaceuticals, devices or other health technologies	**Present**
20	Methodological development/refinement of conventional HTA	**Present**

Contemporary HTA score: 20/20

Taken together, the two interrogations produce an unequivocal contrast. Across the pooled Australian university-affiliated HTA knowledge base, none of the 17 topics defining representational measurement was identified, while all 20 topics characterizing contemporary HTA were represented. The result is therefore 0/17 versus 20/20. The difference is not one of degree but of complete separation between the two bodies of program content. Contemporary unlawful HTA methods are comprehensively represented across the centers, while the representational-measurement framework against which quantitative claims might be assessed is absent. The significance of this contrast, and its implications for the scientific and educational foundations of Australian HTA, are considered in the following section.

INTERPRETING THE CONTRAST

The contrast between 0/17 for representational measurement and 20/20 for contemporary HTA is not simply a difference in curriculum emphasis. Nor can it reasonably be dismissed as the inevitable consequence of limited teaching time or specialization. The two sets of topics do not occupy equivalent positions in quantitative science. The 20 topics describe methods for performing analyses: economic evaluation, cost-effectiveness analysis, utilities, QALYs, ICERs, modelling, evidence synthesis and uncertainty analysis. The 17 topics address the logically prior question of whether the numerical values entering those analyses possess the measurement properties necessary to support the operations performed upon them. The disturbing feature of the Australian results is therefore not merely that one body of knowledge is absent while another is present. It is that the missing body of knowledge should determine the scientific admissibility of much of what is being taught.

These are university-affiliated research centers presenting themselves as repositories of expertise in health economics, HTA, outcomes research and quantitative decision making. Their role extends beyond teaching practitioners how to reproduce established procedures. Universities are expected to examine the scientific foundations of the methods they teach. If students are instructed to add, subtract, multiply and divide numerical values, construct ratios and project outcomes through mathematical models, the properties of those numbers cannot be treated as somebody else's problem. Before arithmetic is undertaken there must be an answer to a fundamental question: what has been measured?

This requirement is hardly novel. The distinction between nominal, ordinal, interval and ratio scales has been part of the methodological literature for approximately eight decades. Representational measurement theory subsequently provided a rigorous account of the relationship between empirical attributes, numerical representations and admissible transformations. The requirement that mathematical operations must be meaningful for the scale concerned is therefore not a recent objection devised specifically against the QALY. It belongs to the foundations of quantitative reasoning. Yet across the combined Australian HTA program-content knowledge base, the interrogation finds no substantive representation of scale type as a constraint upon arithmetic, admissible transformations, dimensional homogeneity or ratio measurement as a prerequisite for multiplicative operations.

This omission is particularly difficult to reconcile with the central role accorded to the QALY. The QALY is not generated merely by observing a patient. It is constructed through arithmetic: a health-state value is multiplied by time. The fact that time can be represented on a ratio scale does not establish the measurement properties of the other term in the multiplication. Before teaching students to calculate QALYs, a quantitative curriculum should therefore ask what attribute the utility value represents, what measurement scale has been constructed, what zero means, whether equal differences represent equal quantities, what transformations leave the representation invariant, and whether multiplication by time is meaningful. These are not optional philosophical embellishments. They are questions created by the arithmetic itself.

The same problem extends to ICERs. Students can be taught to calculate differences in costs, differences in QALYs and then divide one by the other. They can undertake deterministic and probabilistic sensitivity analyses around the resulting estimate. They can populate Markov models, undertake microsimulation and generate cost-effectiveness acceptability curves. None of this computational sophistication answers the prior measurement question. If the denominator does not possess the quantitative properties attributed to it, progressively more elaborate manipulation cannot supply those missing properties. Uncertainty analysis quantifies uncertainty around the numbers entered into the analysis; it does not establish that those numbers constitute lawful measures in the first place.

The 0/17 result becomes still more consequential when patient-reported outcomes are considered. Australian HTA programs clearly recognize health-related quality of life, utilities and patient-reported outcomes. What is absent is a corresponding foundational distinction between manifest and latent attributes. Yet the distinction is elementary to determining how measurement should proceed. Hospital days, treatment administrations and survival time are fundamentally different measurement problems from pain, fatigue, physical functioning or treatment satisfaction. The former concern attributes capable of direct observation and, when appropriately defined, linear ratio measurement. The latter are latent attributes whose possession cannot be observed directly. Assigning integers to questionnaire responses and summing them does not resolve that problem.

Rasch measurement is therefore important not because it is simply another psychometric technique that might conveniently be added to a methods course. It addresses the construction of measures for latent attributes through the conjoint relationship between persons and items, subject to requirements including unidimensionality, invariance and specific objectivity. The Australian academic literature contains applications of Rasch methods, so Rasch itself cannot be regarded as inaccessible to Australian universities. What is missing from the HTA program-content knowledge base is recognition of its role within a coherent theory of measurement and its relevance to claims concerning possession of latent attributes. The problem is not the complete absence of psychometric expertise; it is the failure to connect measurement science to the quantitative claims that HTA asks students to make.

The most revealing feature of the 20/20 result is therefore its completeness. Australian centers have successfully incorporated virtually the entire conventional apparatus of contemporary HTA. They teach and research the downstream methods in considerable depth. There has been no comparable incorporation of the upstream measurement requirements. This makes it difficult to explain the 0/17 result simply by claiming that HTA programs cannot teach everything. They plainly select what they regard as essential to professional competence. Economic evaluation is essential. Cost-effectiveness is essential. Utilities and QALYs are essential. Modelling and uncertainty are essential. Yet the scientific rules determining whether the arithmetic underlying these methods is meaningful have not achieved comparable recognition.

Nor is conformity with international practice an adequate scientific defence. Australia is certainly not alone. The same measurement omission has characterized HTA internationally. But replication of an epistemic failure does not correct it. If NICE, PBAC, professional societies, journals and universities all employ the same analytical framework, their agreement demonstrates institutional consensus, not measurement validity. Scientific properties are not created by widespread acceptance. A quantity either possesses the required measurement structure or it does not. An arithmetic operation is either meaningful for the representation concerned or it is not. Consensus cannot transform an ordinal construction into a ratio measure.

There is consequently an uncomfortable distinction between historical explanation and contemporary responsibility. It is entirely plausible that the Australian centers inherited this framework without appreciating the missing measurement foundation. Their founders worked within an international health-economic paradigm in which these questions were rarely posed. The original failure therefore need not imply deliberate disregard of measurement science. It demonstrates instead the extraordinary depth of the epistemic gap within which contemporary HTA developed.

But that explanation cannot indefinitely protect the present curriculum. The measurement challenge has now been explicitly brought to the attention of Australian HTA research centers. The 0/17 finding identifies precisely what is missing. From this point forward, the question is no longer simply why previous generations failed to recognize representational measurement. It is what present university programs should do now that the omission has been identified.

At minimum, students should be informed that the scientific status of the quantitative framework they are being taught is contested on measurement grounds. They should learn the principles necessary to evaluate that challenge independently. Universities need not require students to accept the critique of utilities, QALYs or contemporary HTA. Indeed, they should encourage attempts to rebut it. But a rebuttal must engage the measurement argument itself. Demonstrating that QALYs are widely used, recommended by agencies, supported by published guidelines or embedded in reimbursement systems does not demonstrate their measurement properties.

This is where the 0/17 versus 20/20 contrast becomes most damaging. It exposes an inversion in educational priorities. Students are provided with an elaborate toolkit for manipulating numerical values without first being given the scientific framework necessary to determine what those numerical values permit them to do. Measurement has not governed arithmetic; arithmetic has proceeded largely independently of measurement. The result is not a minor curricular omission that can be repaired by inserting another lecture between existing modules. Once representational measurement is introduced seriously, it becomes a standard against which the existing 20 topics must themselves be examined.

Australian HTA research centers therefore face a straightforward academic challenge. They can demonstrate that their established quantitative methods satisfy the requirements of representational measurement. They can accept that some do not and reconstruct the curriculum accordingly. Or they can contest the relevance or interpretation of those measurement requirements and provide the scientific argument for doing so. What is increasingly difficult to defend is a fourth position: continuing to teach the entire 20/20 analytical framework while leaving the 0/17 measurement framework outside the intellectual boundaries of the discipline.

The central failure revealed by these results is therefore not lack of technical competence. It is more fundamental. Australian HTA has developed considerable expertise in what to do with numbers without establishing, as a prior requirement, what those numbers are entitled to mean. For university-based programs committed to quantitative science, that is precisely the question they should have asked from the beginning.

PROGRAM CONTENT REVIEWED

The collective program content is extensive. These centers undertake research and provide teaching or training in health economics, health technology assessment, economic evaluation, cost-effectiveness analysis, cost-utility analysis, decision modelling, evidence synthesis, quality of life, health-state utilities, QALYs, resource allocation and health policy. Their activities range from formal university courses and postgraduate programs to doctoral supervision, short courses, workshops, methodological research and participation in applied evaluations for government and other decision makers. Students and researchers are therefore exposed to a substantial technical apparatus for undertaking economic evaluation and translating clinical and economic evidence into claims intended to inform healthcare decisions.

Adelaide Health Technology Assessment provides a particularly clear example. Its activities encompass HTA, systematic review, comparative effectiveness and safety, economic evaluation and economic modelling. Its educational environment includes instruction in the principles and application of HTA and the use of economic evidence in decision making. Cost-effectiveness and cost-utility modelling form part of this methodological framework. This is especially significant given AHTA's longstanding involvement in Australian federal HTA and its contribution to methodological guidance. Adelaide therefore represents more than an academic interest in health economics: it illustrates the close connection between university-based methodological expertise and the analytical framework used in Australian health technology decision making.

The same pattern is apparent elsewhere. Monash has an extensive health-economics research and teaching environment encompassing economic evaluation, cost-effectiveness, healthcare financing, resource allocation and policy evaluation. Its researchers undertake applied evaluations intended to inform government and healthcare decisions, including analyses employing QALYs and incremental cost-effectiveness ratios. CHERE at UTS similarly has a longstanding program in applied health economics, economic evaluation, health services research, outcomes and policy analysis. Its research and training demonstrate the integration of conventional economic-evaluation methods into the Australian academic health-economics knowledge base.

Deakin Health Economics adds another substantial component to this collective framework. Its research and training encompass economic evaluation, health technology assessment, priority setting, resource allocation, quality of life and the economic evaluation of healthcare interventions. Deakin has particular strength in applied health economics and the use of economic evidence to inform healthcare policy and decision making. Its educational and research activities therefore reinforce the same conventional methodological architecture represented elsewhere: costs and outcomes are compared, health benefits may be represented through utilities and QALYs, and economic models are used to estimate cost effectiveness and support resource-allocation decisions. Deakin consequently strengthens the breadth of the pooled Australian knowledge base against which the absence of representational measurement is assessed.

At Melbourne, students can encounter cost-effectiveness analysis, cost-utility analysis, economic modelling, health-related quality of life, patient-reported outcomes and utility measurement as components of health-economics and evaluation teaching. The University of Queensland and Griffith programs add further depth in economic evaluation, modelling, health services research, priority setting, resource allocation and the application of health economics to policy and healthcare delivery. Taken collectively, therefore, the Australian centers provide substantial coverage of the methods conventionally regarded as necessary for professional competence in HTA. The 20 contemporary HTA topics used in the present interrogation are not peripheral to these programs. They describe much of their substantive methodological content.

What is striking is what does not accompany this extensive technical training. Across the pooled program knowledge base there is no corresponding framework requiring quantitative analysis to begin by identifying the attribute to be measured and establishing the properties of the resulting measure before arithmetic is undertaken. The four classical scales of measurement are not presented as determining admissible mathematical operations; multiplication and division are not conditioned upon prior demonstration of ratio measurement; dimensional homogeneity is not established as a prerequisite for meaningful quantitative claims; and the axioms of representational measurement do not provide the scientific foundation for economic evaluation.

Equally absent is a systematic distinction between manifest and latent attributes and the different measurement requirements each entails. Linear ratio measurement for manifest attributes and Rasch measurement for latent attributes is not presented as the two measurement pathways for constructing therapy-impact claims. Rasch conjoint measurement, specific objectivity, invariance and attribute possession consequently do not occupy the foundational position that would be required if latent therapy-impact claims were expected to satisfy representational measurement standards. Patient-reported outcomes and utilities may be discussed extensively, but this does not amount to establishing that the numbers produced constitute measures possessing the properties required for the arithmetic subsequently performed upon them.

This contrast is the basis for the program-content interrogation. The Australian academic HTA knowledge base is neither technically undeveloped nor methodologically sparse. It is sophisticated within the boundaries of the contemporary HTA paradigm. Precisely for that reason, the contrast between 0/17 representational-measurement topics and 20/20 contemporary HTA **topics** is consequential. The finding is not that Australian centers fail to teach quantitative methods. It is that they comprehensively teach the methods for manipulating quantitative claims while the logically prior scientific framework for determining whether those numerical values support the proposed arithmetic is absent. The resulting pattern is one of program-content inversion: arithmetic and modelling occupy the center of the curriculum, while the requirements that should determine their admissibility remain outside it.

If a student is seeking a graduate course in quantitative evaluation for health technology assessment, the evidence from these program reviews suggests that they should look elsewhere, and probably outside Australia. The issue is not the absence of sophisticated instruction in health economics, economic evaluation, decision modelling, cost-effectiveness analysis, utilities or QALYs. Australian universities offer substantial expertise in all of these areas. The problem is more fundamental. A student seeking an education in quantitative measurement would reasonably expect to be taught the scientific conditions that must be satisfied before numbers can support quantitative claims: the definition of the target attribute, the distinction between manifest and latent attributes, scales of measurement, admissible transformations, dimensional homogeneity, the requirement for ratio measurement where multiplication and division are undertaken, and the construction of measures capable of supporting evaluable and falsifiable claims.

The program reviews provide little evidence that these foundations occupy a substantive place in Australian graduate HTA education. Until they do, there is an important distinction between being trained in the established methods of contemporary HTA with PBAC submissions and being educated in the requirements for lawful quantitative measurement. A prospective student seeking the latter would therefore need to identify a program that explicitly places representational measurement at the foundation of its curriculum rather than assuming that numerical analysis itself constitutes measurement.

THE CONTRIBUTION OF REPRESENTATIONAL MEASUREMENT

The introduction of representational measurement into Australian HTA programs will have consequences extending far beyond the addition of another methodological topic to an already crowded curriculum. The significance of the 0/17 versus 20/20 program-content finding is that the missing material concerns the scientific conditions that should precede the methods already being taught. Representational measurement would therefore enter the curriculum not alongside economic evaluation, utilities, QALYs, ICERs and decision modelling, but logically before them. Its contribution would be to establish the rules determining whether the numerical values employed by these methods are measures and whether the arithmetic performed upon them is admissible. This would change the organizing principle of the program from learning how to manipulate numbers to first establishing what those numbers represent and what mathematical operations they support.

The starting point would become the attribute. Before selecting an instrument, assigning a score, constructing a health state or building an economic model, students would be required to state precisely what attribute is being assessed. This immediately introduces unidimensionality and the distinction between manifest and latent attributes. Manifest attributes such as hospital days, emergency department visits, treatment administrations or survival time can, when appropriately defined, be represented directly on linear ratio scales. Latent attributes such as pain, fatigue, physical functioning or need fulfilment cannot be observed directly and require a measurement model capable of constructing a measure from observations. This distinction would precede instrument selection and statistical analysis rather than appearing, if at all, after data have already been generated.

A second contribution would be to restore the relationship between scale properties and arithmetic. Students would be required to understand nominal, ordinal, interval and ratio measurement not as introductory terminology but as constraints upon permissible quantitative operations. Addition, subtraction, multiplication, division and the construction of ratios cannot be justified simply because numerical values have been assigned. The properties of the measurement scale determine the operations that are meaningful. Ratio claims require a scale possessing the properties necessary to support ratios, including an appropriate zero and invariant units. Dimensional homogeneity would similarly become a routine requirement. Before two quantities were multiplied, divided or aggregated, students would have to establish what each quantity represents and whether the resulting operation produces a meaningful dimension.

This would inevitably affect the teaching of utilities and QALYs. At present, students can learn how health-state utility values are generated, how they are incorporated into models, and how utility is multiplied by time to estimate QALYs. Under a representational-measurement curriculum, an additional and logically prior question must be answered: what are the measurement properties of the utility values? If multiplication is proposed, have the requirements for ratio measurement been demonstrated? What is the status of zero? What does a negative utility imply for the proposed scale? What attribute is being measured, and in what units? The purpose of introducing these questions would not be to instruct students in advance that a particular method must be rejected. It would be to require established HTA methods to satisfy the same measurement standards expected of quantitative claims elsewhere in science.

The treatment of latent attributes would undergo an equally important change. Patient-reported outcomes could no longer be treated as quantitative merely because responses have been assigned numerical scores and aggregated. Representational measurement would introduce students to the requirements for constructing measures of latent attributes and, in particular, to Rasch measurement. Concepts such as conjoint measurement of persons and items, unidimensionality, invariance, specific objectivity, ordered response categories, item fit, differential item functioning and ruler stability would become part of the methodological foundation. The objective would be to establish a measurement system before claims of change or therapy impact were made. Attribute possession would then provide the basis for interpreting where an individual or population is located on the latent continuum and how that location changes following intervention.

Economic modelling would consequently occupy a different position within the curriculum. Modelling would remain a potentially useful analytical technique, but it could no longer confer measurement properties upon its inputs. Increasing computational sophistication cannot transform ordinal scores into ratio measures or repair dimensional incoherence. Students would therefore learn to distinguish sharply between measurement and subsequent statistical or mathematical manipulation. Before constructing a model, they would be expected to establish that its quantitative inputs possess the properties required by the operations undertaken. The model would become downstream of measurement rather than a substitute for it.

Representational measurement would also change the nature of therapy-impact claims. Rather than beginning with a reference-case model intended to generate a lifetime cost-per-QALY estimate, students could begin with claims concerning defined attributes in specified populations over stated time periods. Manifest claims could be expressed using appropriate linear ratio measures; latent claims could employ appropriately constructed Rasch measures. Claims would be accompanied by protocols specifying the attribute, measure, comparator, timeframe, success criterion and conditions under which the claim would be rejected. This reconnects HTA with empirical evaluation, replication and falsification and shifts emphasis from producing modelled numerical projections to testing claims about observable therapy impacts.

The implications for Australian programs are therefore substantial. Representational measurement cannot readily be confined to a single lecture entitled “measurement theory” while the remainder of the program continues unchanged. Once students are taught that measurement precedes arithmetic, they must be encouraged to apply that principle throughout the curriculum. Once they understand admissible transformations, ratio measurement and dimensional homogeneity, these standards must be applied to utilities, QALYs, ICERs and economic models as readily as to any other quantitative construct. Once the distinction between manifest and latent attributes is recognized, instruments claiming to quantify latent outcomes must demonstrate that they actually construct measures of those attributes.

The contribution of representational measurement would therefore be transformative rather than supplementary. It would fill the epistemic gap identified by the 0/17 program-content finding, but in doing so it would necessarily expose the existing 20/20 HTA framework to scientific scrutiny. Some established methods might satisfy the required standards; others might require reconstruction or abandonment. That outcome should not be determined by convention, institutional authority or historical acceptance, but by the measurement properties of the claims themselves. For Australian universities, the central question is therefore not whether representational measurement deserves a place somewhere within HTA teaching. It is whether a discipline presenting itself as quantitative science can legitimately organize its teaching around arithmetic and modelling without first teaching the scientific requirements that determine whether that arithmetic is meaningful.

THE REVISED CURRICULUM AND THE PBAC

The introduction of representational measurement into Australian HTA programs would create an immediate question concerning their relationship with the Pharmaceutical Benefits Advisory Committee (PBAC) [6] . Australian universities do not educate students in an institutional vacuum.

Graduates enter pharmaceutical companies, consulting organizations, government agencies and academic research centers where preparation and evaluation of PBAC submissions constitute an important professional activity. A curriculum must therefore ensure that students understand the methodological framework within which PBAC operates. The difficulty is that understanding an established framework is not the same as endorsing its scientific foundations.

The current PBAC Guidelines place economic evaluation at the center of submissions for new pharmaceutical products. Depending upon the clinical claim and circumstances, submissions may incorporate cost-effectiveness or cost-utility analysis, health-state utilities, QALYs, incremental cost-effectiveness ratios and decision-analytic modelling. Students entering Australian HTA practice consequently need to understand how these analyses are constructed, how clinical evidence is translated into model inputs, how costs and outcomes are estimated, how uncertainty is represented and how results are presented to PBAC. A reconstructed curriculum would not make this knowledge disappear. It would, however, change its status. These methods would be taught as requirements and conventions of the prevailing reimbursement framework rather than assumed to constitute scientifically valid measurement merely because they are accepted within that framework.

This distinction becomes critical when preparing a submission for a new product. A graduate trained in representational measurement would first ask what therapy-impact attributes are being claimed. Are they manifest attributes, such as survival, hospital admissions, treatment discontinuations, adverse events or days in hospital? Or are they latent attributes, such as pain, fatigue, physical function or need fulfilment? The next question would concern measurement: what measure represents each attribute, what scale properties does it possess, and what arithmetic can legitimately be performed upon it? Only after these questions have been answered would statistical analysis, economic evaluation or modelling follow. The sequence would therefore be attribute → measurement → admissible arithmetic → empirical claim, rather than model → numerical inputs → calculated outcome.

For manufacturers this could substantially broaden the evidentiary structure supporting a new product. Alongside whatever economic evaluation PBAC currently expects, a submission could present a portfolio of directly evaluable therapy-impact claims expressed in lawful measurement terms. Manifest claims might include reductions in hospital days, emergency presentations, treatment administrations or other resource units measured on linear ratio scales. Latent claims could be based upon appropriately constructed Rasch measures capable of demonstrating changes in possession of the relevant attribute. Each claim could specify the target population, comparator, timeframe, measurement system, expected magnitude of effect and criterion for empirical failure. The submission would then contain claims capable of subsequent evaluation and replication rather than relying exclusively upon projected lifetime outcomes generated within a reference-case simulation.

The tension arises with utilities and QALYs. Once students have been taught that multiplication requires appropriate measurement properties, they cannot simply suspend that requirement when constructing a PBAC cost-utility analysis. Before multiplying a utility value by time, they must ask whether the utility possesses the properties required for that operation. Similarly, before interpreting an ICER expressed as cost per QALY, they must consider whether its denominator constitutes the quantity it is claimed to represent. A university could continue to teach students how PBAC-compliant cost-utility models are constructed, but intellectually it would have to distinguish procedural compliance with an agency methodology from conformity with the standards of representational measurement.

This does not require graduates to refuse to prepare PBAC submissions. In the transitional period, they may have to operate within two frameworks simultaneously. They would need to know how to satisfy the existing requirements of the national reimbursement system while also understanding the scientific limitations of the methods being requested. Indeed, this could improve submissions by making their assumptions and measurement status more transparent and by supplementing conventional economic analyses with empirically evaluable claims constructed on defensible measures. The immediate objective would not be to prevent products from entering the PBAC process but to introduce an alternative evidentiary framework capable of being evaluated alongside existing practice.

The longer-term implications are more difficult. If Australian universities adopt representational measurement as the scientific foundation for quantitative HTA, an increasing divergence could emerge between what students are taught constitutes lawful measurement and what the established PBAC framework asks them to calculate. That divergence could not indefinitely be resolved by teaching one set of standards in measurement classes and another in applied pharmacoeconomics. Students would reasonably ask why the rules governing quantitative science apply to one part of their education but not to another. Research centers would similarly have to decide whether their role is simply to reproduce established submission methods or to subject those methods to independent scientific scrutiny.

Ultimately, therefore, curriculum reconstruction would create an opportunity for reconsidering the PBAC submission itself. Rather than requiring the university system to accommodate indefinitely to an inherited methodological framework, the relationship could operate in the opposite direction: developments in measurement science could inform the evolution of national HTA requirements. Submissions for new products could progressively move toward portfolios of protocol-driven, evaluable and falsifiable therapy-impact claims based upon lawful measures, while costs could be attached separately to observed resource utilization where required for budgeting and decision making.

The relationship between the revised curriculum and PBAC should therefore not be characterized as opposition between universities and government. Universities have a responsibility to teach students both how the existing system operates and the scientific standards by which its methods should be judged. PBAC has a responsibility to determine what evidence it requires for reimbursement decisions. The potential conflict arises only if compliance with existing methodological guidance is treated as sufficient evidence of scientific validity. A curriculum grounded in representational measurement would make that assumption impossible. It would equip future practitioners both to work within the current PBAC process and, more importantly, to ask whether that process should itself change as Australian HTA returns to the requirements of measurement, empirical evaluation and normal science.

The PBAC is perfectly entitled to determine the evidentiary and analytical criteria it considers appropriate for exercising its guardianship of the Pharmaceutical Benefits Scheme. It may retain its present Guidelines, continue to require cost-effectiveness and cost-utility analyses, and expect manufacturers to prepare submissions accordingly. These requirements are well established, widely understood and supported by decades of accumulated experience in submission preparation and assessment. What the PBAC cannot reasonably expect, however, is that its administrative requirements should place the underlying methodology beyond academic criticism. Compliance with PBAC Guidelines and scientific validity are separate questions. Universities and their research centers must remain free to examine whether utilities, QALYs, ICERs and reference-case models satisfy the requirements of lawful measurement and to teach students the scientific principles necessary to make that assessment. The PBAC's authority to specify what it requires for reimbursement cannot become an authority to determine what universities may question, investigate or teach. Nor should academic centers allow their close relationship with the national reimbursement process to discourage scrutiny of its measurement foundations. If contemporary HTA can withstand examination against representational measurement, that should be demonstrated through open scientific debate. If it cannot, institutional convention cannot provide its defense. PBAC can require compliance with its Guidelines; it cannot require academic silence about their scientific foundations.

THE LONG SILENCE

For several decades Australian HTA developed within a broadly shared methodological framework built around economic evaluation, utilities, QALYs, ICERs and decision modelling. Representational measurement was largely absent from that framework, as it was internationally. The original omission can therefore reasonably be understood as an epistemic failure rather than a deliberate rejection of measurement science. Universities, research centers and PBAC operated within substantially the same inherited paradigm, and there was little reason for participants to perceive a conflict between what universities taught, what researchers investigated and what the national reimbursement system required.

That explanation, however, has a limited life. The major Australian university-affiliated HTA research centers have now been aware for months of the challenge presented by representational measurement. The issue has been communicated directly and supported by analyses of measurement inversion, curriculum inversion and program-content inversion. The most recent program-content interrogation makes the contrast particularly stark: across the combined Australian academic HTA knowledge base, none of the 17 representational-measurement topics is substantively represented, while all 20 topics defining contemporary HTA are represented. Historical ignorance may explain how this epistemic gap arose. It cannot indefinitely explain its continuation after the gap has been explicitly identified.

This creates an immediate educational responsibility. These research centers are located within universities, participate in teaching and supervision, train future researchers and practitioners, and contribute to the methodological environment in which HTA is practiced. Students entering the next study period should therefore at minimum be informed that a fundamental scientific challenge has been raised concerning the measurement foundations of the methods they are being taught. This does not require a university to endorse the critique in advance. It does require students to be made aware of it, to understand the principles of representational measurement upon which it rests, and to be given the opportunity to evaluate the established HTA framework against those principles. A university should not protect an established methodology from critical scrutiny simply because the consequences of that scrutiny may be uncomfortable.

Yet even this apparently modest response creates a profound problem. Representational measurement cannot easily be quarantined within a single lecture and then forgotten. Once students are taught that measurement precedes arithmetic, that scale properties determine admissible operations, that multiplication and division require ratio properties, and that dimensional homogeneity must be respected, they can apply these principles immediately to the remainder of their HTA education. They can ask whether utility values support multiplication by time, whether the resulting QALY is a dimensionally coherent quantity, whether an ICER constructed upon QALYs has the interpretation attributed to it, and whether preference scores constitute measures of defined latent attributes. Introducing representational measurement therefore introduces a standard against which the existing curriculum itself must be judged.

This explains why silence may appear institutionally attractive. Australian academic HTA has a close practical relationship with the methodological framework of PBAC. Universities prepare graduates to undertake economic evaluations, construct models and contribute to submissions for new products. Research centers undertake related methodological and applied work. If universities introduce measurement standards that lead students to question the scientific status of utilities, QALYs and cost-utility analysis, an uncomfortable divergence may emerge between what the university teaches as the requirements of quantitative science and what the national reimbursement system continues to request. Silence postpones that conflict and preserves the existing alignment between academic teaching, research practice and PBAC methodology.

But silence is not a neutral long-term position. Once the challenge is known, the question changes. It is no longer simply why representational measurement was historically absent from Australian HTA. It becomes why students continue to be taught the arithmetic of contemporary HTA without being introduced to the measurement principles that determine whether that arithmetic is admissible. Nor is it sufficient to argue that the PBAC requires the established methods. Universities have responsibilities extending beyond training students to comply with an administrative framework requiring unlawful measurement. They must also equip students to examine critically the scientific foundations of that framework.

The next study period therefore represents an important threshold. Australian HTA programs do not have to accept the conclusions of the representational-measurement critique. They may challenge them and should do so if they believe them mistaken. But students should know that the challenge exists and should be taught enough measurement science to evaluate it themselves. The academically defensible choices are engagement, rebuttal or reconstruction; continued exclusion becomes increasingly difficult to justify once the issue has been brought explicitly to the attention of those responsible for teaching the discipline.

The silence of change is therefore understandable, but it has consequences. What began historically as an epistemic omission is becoming a conscious curricular decision. Representational measurement can be rejected only by demonstrating why its requirements do not apply; it can be accepted only with consequences for the existing HTA framework; and it can be taught neutrally only by allowing students to discover those consequences for themselves. Silence may preserve the status quo for another study period, but it cannot resolve the scientific question. For university-based HTA programs, the immediate responsibility is more modest and more fundamental: students should be told that the measurement challenge exists and be given the scientific tools to judge it.

THE RESPONSIBILITY OF THE UNIVERSITY

The implications of program-content inversion extend beyond individual HTA research centers and their faculty. These centers operate under the authority and reputation of universities. Their courses, degrees, research programs and teaching activities are presented to students as components of a university education. The issue therefore cannot be reduced to whether individual faculty members are entitled, under principles of academic freedom, to prefer one methodological framework to another. Academic freedom protects inquiry, criticism and intellectual disagreement. It does not remove the responsibility of a university to distinguish between the teaching of a contested methodology and the presentation of quantitatively inadmissible operations as established scientific practice.

Universities already recognize this distinction throughout their curricula. They may legitimately teach astrology as an historical or cultural phenomenon, examine séances as part of the history or psychology of belief, or study tarot cards anthropologically. What would be difficult to defend is a university course in which tarot cards were taught as an established scientific method for making healthcare resource-allocation decisions without informing students that the method failed accepted scientific standards. Academic freedom would protect the investigation of the claims made for tarot; it would not require the university to confer scientific legitimacy upon them. The same principle applies, without equating HTA with these examples, whenever a quantitative discipline is challenged on the scientific admissibility of its central methods.

This distinction is particularly important for Australian HTA. The 0/17 versus 20/20 finding does not establish that faculty members are acting improperly or that universities deliberately designed scientifically defective programs. It establishes a much narrower but consequential fact: the publicly represented program-content knowledge base comprehensively incorporates contemporary HTA while failing to incorporate the representational-measurement requirements against which its quantitative operations can be assessed. Once this discrepancy has been identified, the responsibility of the university is not necessarily to accept the critique. It is to ensure that the critique can be examined.

That responsibility cannot reasonably be discharged by invoking academic freedom. If faculty believe that utility values support multiplication by time, that QALYs constitute legitimate quantitative measures and that cost-per-QALY ICERs are scientifically meaningful ratios, they should be free to defend those propositions. Equally, students should be provided with the measurement principles necessary to determine whether those propositions can be sustained. The university's responsibility is not to dictate the conclusion but to ensure that the relevant scientific standards are not excluded from the inquiry.

This becomes especially important once the university has been placed on notice, as it has, that a foundational challenge exists. Historical omission can explain why representational measurement was absent when programs were created. Continued exclusion is harder to justify after the issue has been explicitly identified. At that point, the question moves beyond the preferences of an individual lecturer or research center. It concerns whether a university is prepared to continue presenting a quantitative curriculum without requiring engagement with established measurement principles that potentially challenge the admissibility of its central arithmetic.

The appropriate university response is therefore neither censorship nor protection of the status quo. It is scientific scrutiny. Representational measurement should be introduced; the established HTA framework should be tested against it; proponents of utilities, QALYs and cost-effectiveness modelling should be invited to defend their measurement foundations; and students should be allowed to judge the competing arguments. If the contemporary framework survives that examination, its academic position will be strengthened. If it does not, university status cannot provide a sanctuary within which scientifically inadmissible methods continue to be taught simply because they are institutionally established.

Ultimately, this is what distinguishes a university from a professional training organization. Its purpose is not merely to prepare graduates to reproduce the procedures currently required by PBAC or any other agency. It is to subject those procedures to critical scientific examination. Academic freedom protects the right to challenge the measurement critique; it cannot reasonably be invoked as a right to prevent that critique, and the scientific standards upon which it rests, from entering the classroom.

THE 2027 TEST

The beginning of the new Australian academic year in early 2027 will provide a natural opportunity to assess whether the present findings have produced any identifiable response. By that point, the major university-affiliated HTA research centers will have been aware of the representational-measurement challenge for a substantial period. The question will therefore be straightforward: to what extent has representational measurement been incorporated into the teaching of HTA?

This can be evaluated using the same 17-topic framework applied in the present study. The purpose would not simply be to determine whether the words *measurement* or *Rasch* have appeared in course descriptions. The relevant question is whether students are being introduced to the principle that measurement precedes arithmetic; that attributes must be defined before measurement; that scale properties determine admissible mathematical operations; that ratio measurement is required for multiplicative claims; that dimensional homogeneity must be respected; and that manifest and latent attributes require different measurement approaches. For latent attributes, the assessment would additionally determine whether Rasch measurement, conjoint measurement, invariance, specific objectivity and attribute possession have entered the curriculum as components of a coherent measurement framework.

The 2027 assessment would therefore provide an unusually clear test of academic response. The present 0/17 versus 20/20 result establishes the baseline. Repeating the interrogation after the commencement of the 2027 academic year would demonstrate whether the measurement knowledge base has begun to change. A movement from 0/17 would provide evidence of engagement, even if the conventional HTA curriculum remained substantially intact. A continuing 0/17 would have a different significance. By then, continued absence could no longer readily be attributed to lack of awareness of the challenge.

Universities need not accept the conclusions advanced in this paper. They are entirely entitled to reject them. But rejection should follow examination, and students should be provided with the knowledge necessary to understand what is being rejected and why. The 2027 academic year therefore represents more than another teaching cycle. It provides an opportunity to determine whether Australian HTA education has begun to engage with representational measurement or whether the epistemic separation documented here remains unchanged.

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 [7]. 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**.** Their sequence can be translated directly into a curriculum progressing from measurement theory to the practical construction and application of therapy-impact measures. Faculty can build around the units the lectures, readings, worked examples, exercises and assessments required for graduate instruction, while applying the same principles to research and HTA practice. 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.

CONCLUSION

The central finding of this assessment is unambiguous. Across the pooled program content of the major Australian university-affiliated HTA and health economics research centers, none of the 17 topics defining representational measurement was identified, while all 20 topics characterizing contemporary HTA were represented. The result, 0/17 versus 20/20, identifies not a minor curricular imbalance but the absence of an entire body of knowledge in Australia concerned with the scientific foundations of quantitative measurement.

The immediate issue is therefore not what the PBAC might do. Nor is there a need for prolonged joint reviews, working parties or consultations to determine whether representational measurement might eventually prove useful to HTA decision making; a typical Australian response which, as an Australian, I am well aware of. That mistakes the nature of the problem. Representational measurement is not a new HTA technique competing for inclusion alongside economic modelling, sensitivity analysis or evidence synthesis. It provides the principles, accepted over 80 years, by which quantitative representations and the arithmetic performed upon them are judged. The question facing universities is consequently much simpler: should students being educated in a quantitative discipline be taught the scientific requirements governing measurement and meaningful arithmetic or an unlawful measurement legacy?

Australian HTA programs have now been aware of this challenge for months. Historical ignorance may explain why representational measurement was absent when the contemporary curriculum developed. It cannot indefinitely justify its continued exclusion. Universities need not accept the conclusions that follow from applying representational measurement to utilities, QALYs, ICERs or reference-case models. Faculty are free to challenge those conclusions. But students should be introduced to the body of knowledge necessary to understand the challenge and judge the competing arguments themselves.

The beginning of the 2027 academic year therefore provides a clear test. The present assessment establishes the baseline at 0/17. A subsequent review can determine whether measurement preceding arithmetic, scale properties, admissible transformations, ratio measurement, dimensional homogeneity, manifest and latent attributes, Rasch measurement, specific objectivity and attribute possession have begun to enter Australian HTA teaching.

The choice facing Australian universities is not between supporting PBAC and supporting representational measurement. It is more fundamental. It concerns what knowledge a university has a responsibility to provide to both prospective and existing students when it claims to educate them in quantitative science. Once a recognized body of measurement knowledge has been shown to be absent, continued absence becomes increasingly difficult to characterize as oversight. The question for 2027 is whether Australian HTA programs choose to fill that epistemic void.

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