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REPRESENTATIONAL MEASUREMENT FAILURE IN HEALTH TECHNOLGY ASSESSMENT

NEW ZEALAND: NORMAL SCIENCE AND THE ABSENCE OF REPRESENTATIONAL MEASUREMENT IN HTA EDUCATION

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

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ABSTRACT

Health technology assessment (HTA) presents itself as a quantitative discipline, yet quantitative claims are scientifically defensible only when measurement precedes arithmetic and mathematical operations are admissible for the measurement scales involved. Representational measurement establishes these requirements. Multiplication and division require ratio measurement; admissible transformations and dimensional homogeneity must be respected; and therapy-impact claims require linear ratio measurement for manifest attributes and Rasch measurement for latent attributes. This study examines whether these principles provide the scientific foundation for the New Zealand HTA and health-economics program-content knowledge base.

A fixed program-content interrogation compared 17 topics representing the requirements of representational measurement with 20 topics defining contemporary health economics and HTA. Publicly available teaching, training, research and methodological content associated with Auckland, Otago, Massey, Canterbury and Victoria University of Wellington was examined, together with the national medicines-assessment framework represented by PHARMAC. The result was categorical: 0/17 representational-measurement topics versus 20/20 contemporary HTA topics. No evidence was identified that measurement preceding arithmetic, ratio measurement, admissible transformations, dimensional homogeneity, the manifest/latent distinction or Rasch measurement provides an explicit organizing foundation for the program content examined. In contrast, health economics, economic evaluation, cost-effectiveness and cost-utility analysis, utilities, QALYs, ICERs, decision modelling, simulation, uncertainty analysis, budget impact and related methods are extensively represented.

The finding constitutes program-content inversion. New Zealand possesses substantial quantitative expertise, but the methods of contemporary HTA are represented without the prior measurement framework required to establish whether their arithmetic is admissible. The significance extends beyond university education because the same broad analytical framework is institutionalized within PHARMAC's national medicines-assessment and reimbursement environment.

The 0/17 versus 20/20 dichotomy therefore represents more than a curriculum imbalance. It places contemporary New Zealand HTA outside the measurement requirements expected of normal quantitative science. The appropriate response is transformation rather than methodological refinement. Representational measurement must become the organizing foundation: attributes must first be defined, lawful measures established, admissible arithmetic determined, and therapy-impact claims made credible, evaluable and falsifiable. A nine-unit transformation program developed by Maimon Research provides a structured pathway for reconstructing HTA around these requirements and returning quantitative assessment to the standards of normal science.

INTRODUCTION

Health technology assessment (HTA) depends upon quantitative claims. These claims are scientifically defensible only when measurement precedes arithmetic and the properties of the

measurement scale permit the mathematical operations performed. Multiplication and division require ratio measurement; arithmetic must respect admissible transformations and dimensional homogeneity; and manifest and latent attributes require different approaches to measurement.

Previous interrogations of HTA knowledge bases in Australia, Canada, New Zealand and the United States have identified a consistent pattern of measurement inversion [1] . The principles required for lawful measurement receive weak recognition, while utilities, QALYs, cost-effectiveness analysis and simulation modelling are strongly endorsed. Curriculum inversion reproduces the same failure educationally: students are introduced to the analytical methods of contemporary HTA without first being provided with the measurement principles required to determine whether the arithmetic underlying those methods is admissible [2].

The present investigation extends a previous research-center program-content study by examining the New Zealand HTA program-content knowledge base as a whole [3]. New Zealand provides an important setting because it combines university-based health economics, economic evaluation, health policy and outcomes research with a highly developed national medicines-assessment and reimbursement framework centered on PHARMAC. Universities including Auckland, Otago, Massey, Canterbury and Victoria University of Wellington contribute teaching, research and training in health economics, economic evaluation, health policy, outcomes research, health services research and related quantitative methods. These activities contribute directly and indirectly to the evidence and expertise supporting technology assessment, medicines funding, healthcare policy and resource-allocation decisions throughout New Zealand.

The unit of analysis is therefore not an individual university, research group or decision-making body. It is the publicly available program content through which the New Zealand HTA and health-economics knowledge base is expressed and reproduced. This includes university teaching and training, research priorities, methodological descriptions, projects, publications, seminars and the stated analytical activities of relevant university and university-affiliated programs, together with the publicly available methodological framework supporting national medicines assessment and reimbursement.

Two contrasting bodies of content are assessed. The first represents topics in representational measurement: measurement preceding arithmetic, scales of measurement, admissible transformations, ratio measurement, dimensional homogeneity, the distinction between manifest and latent attributes, linear ratio measurement and Rasch measurement. The second represents topics in contemporary HTA: health economics, economic evaluation, utilities, QALYs, cost-effectiveness analysis, patient-reported outcomes, preference elicitation, decision analysis, simulation modelling and related quantitative methods.

The question is deliberately narrow: does the New Zealand HTA program-content knowledge base establish representational measurement as the foundation for quantitative claims before applying the arithmetic of contemporary HTA? If the requirements of representational measurement are absent while conventional HTA methods are extensively represented, the result is program-content inversion: an educational, research and decision environment in which arithmetic and modelling proceed without first establishing that the quantities involved possess the measurement properties required to support the operations performed.

This distinction is fundamental. Representational measurement is not another methodology that can simply be added to contemporary HTA. It establishes the scientific rules governing the admissibility of the arithmetic itself. Once those rules are applied, every quantitative construct must satisfy them. The New Zealand review therefore assesses whether lawful measurement provides the scientific foundation for its HTA program content or whether the legacy framework of contemporary HTA continues to occupy that space without it. Given the close relationship between university-based health economics and New Zealand's national medicines-assessment environment, the implications extend beyond academic program content to the scientific foundations of the quantitative evidence used to inform healthcare decision making.

FOUNDATIONS OF QUANTITATIVE ANALYSIS

Before examining New Zealand program content, it is important to identify the scientific principles against which that content is assessed. These are not matters of methodological preference. They are the requirements of representational measurement that determine whether quantitative claims and the arithmetic operations supporting them are admissible [4 5] .

Two principles are fundamental. First, measurement must precede arithmetic. Numerical operations cannot create measurement where measurement does not exist. Second, the arithmetic performed must be admissible for the measurement scale concerned. Operations involving multiplication, division and ratios require ratio measurement. For claims of therapy impact in HTA, this requires linear ratio measurement for manifest attributes or Rasch measurement for latent attributes.

These requirements establish the boundary between the manipulation of numbers and lawful quantitative measurement. Contemporary New Zealand HTA, by contrast, is organized around economic evaluation, utilities, QALYs, cost-effectiveness analysis and decision modelling. Over some forty years, these methods have become deeply embedded in the New Zealand HTA environment, including the national medicines-assessment and reimbursement framework associated with PHARMAC. Institutional acceptance, however, does not determine measurement status. The prior scientific question remains whether the quantities entering these analyses possess the measurement properties required for the arithmetic performed.

The New Zealand program-content review therefore asks a straightforward question: does the publicly available New Zealand HTA and health-economics knowledge base recognize representational measurement as the foundation for quantitative claims, or does it proceed directly to the methods and arithmetic of contemporary HTA without first establishing their measurement admissibility? This is the criterion governing the analysis that follows.

MEASUREMENT BEFORE ARITHMETIC

Before students are introduced to health technology assessment, health economics, cost-effectiveness analysis or decision modelling, they should understand the scientific conditions that determine whether quantitative claims are possible. The governing principle is straightforward: measurement must precede arithmetic. Numbers cannot be manipulated legitimately merely

because they have been assigned to observations. The properties of the measurement scale determine which arithmetic operations are admissible.

Representational measurement provides this foundation. The target attribute must first be identified and defined, its measurement properties established, and the appropriate scale constructed. Only then can arithmetic proceed. Multiplication and division require ratio measurement, admissible transformations must be respected, and dimensional homogeneity must be maintained. Reversing this sequence allows arithmetic to precede measurement and produces numerical constructions that cannot be interpreted as lawful quantitative measures.

For HTA claims of therapy impact, the distinction between manifest and latent attributes is fundamental. Manifest attributes are directly observable. Examples include survival time, hospital days, emergency department visits, treatment administrations and walking distance. Where a defined unit and non-arbitrary zero are established, these attributes support linear ratio measurement and the arithmetic permitted by a ratio scale.

Latent attributes, such as pain, fatigue, physical function or need fulfilment, cannot be observed directly. Assigning numbers to questionnaire responses or adding item scores does not establish measurement. A measurement model is required to construct a unidimensional continuum and demonstrate invariant measurement. For this purpose, Rasch measurement provides person-item conjoint measurement, specific objectivity and a logit continuum upon which possession of the latent attribute can be assessed.

The educational requirement can therefore be stated simply. Claims concerning manifest attributes require linear ratio measurement; claims concerning latent attributes require Rasch measurement. Students should understand these requirements before being introduced to utilities, QALYs, cost-effectiveness ratios or simulation models. Numerical constructions do not acquire measurement properties merely through arithmetic, statistical analysis or incorporation into increasingly sophisticated models.

This sequence provides the criterion for assessing New Zealand's HTA and health-economics program-content knowledge base. The question is not how sophisticated its teaching, research, economic evaluation or modelling may be, nor how firmly established these methods have become within the New Zealand healthcare environment. It is whether students and researchers are first provided with the measurement principles required to determine whether the arithmetic they subsequently perform is admissible. If representational measurement, ratio measurement and the distinction between manifest and latent attributes are absent while economic evaluation, utilities, QALYs and modelling are extensively represented, the result is program-content inversion. In the New Zealand setting, this has implications extending beyond university programs to the wider body of expertise and methods supporting national HTA, medicines assessment and reimbursement.

THE CRITICAL ROLE OF RATIO SCALES

The New Zealand program-content assessment rests upon a fundamental requirement of representational measurement: arithmetic operations are determined by the properties of the

measurement scale. Numerical values cannot legitimately be multiplied, divided or otherwise manipulated merely because numbers have been assigned. Measurement must first be established and the proposed arithmetic must be admissible for the scale concerned.

The distinction between nominal, ordinal, interval and ratio scales is therefore critical. Nominal scales classify; ordinal scales establish order; interval scales provide equal intervals but lack a non-arbitrary zero. Only ratio scales possess both equal units and a non-arbitrary zero and therefore support meaningful ratios and the multiplicative arithmetic required for quantitative claims.

This requirement has immediate consequences for New Zealand HTA. QALYs multiply health-state values by time; incremental cost-effectiveness ratios divide differences in costs by differences in outcomes; and decision models combine probabilities, utilities, durations and other numerical inputs. These methods are embedded in New Zealand economic evaluation and, particularly, in the evidence framework associated with medicines assessment and reimbursement. Where the quantities involved lack the measurement properties required for these operations, however, the arithmetic is inadmissible. Subsequent statistical analysis, modelling or simulation cannot correct that prior failure.

For claims of therapy impact, two forms of ratio measurement are relevant. Manifest attributes require linear ratio measurement. Latent attributes require Rasch measurement to construct an invariant quantitative continuum. This distinction provides the foundation for determining whether subsequent arithmetic is admissible.

The New Zealand assessment therefore applies a straightforward criterion. Does the publicly available HTA and health-economics program-content knowledge base recognize ratio measurement, admissible arithmetic, dimensional homogeneity and the different measurement requirements of manifest and latent attributes before introducing the quantitative methods of contemporary HTA? Or does it proceed directly to economic evaluation, utilities, QALYs, cost-effectiveness analysis and modelling without first establishing the measurement properties required for their arithmetic?

Ratio measurement is therefore not simply another topic within an HTA curriculum or research program. It establishes the boundary between admissible quantitative analysis and the manipulation of numbers without the measurement properties required to support that analysis. For New Zealand, this criterion applies not only to the university-based HTA and health-economics knowledge base but ultimately to the quantitative evidence informing medicines assessment, reimbursement and healthcare resource-allocation decisions.

THE KNOWLEDGE BASE: PROGRAM CONTENT AND COVERAGE

The assessment uses the large language model interrogation framework applied in previous studies of measurement and curriculum inversion. The present analysis differs in one important respect: rather than estimating categorical probabilities of endorsement, it examines whether specified scientific and methodological topics are explicitly represented in the publicly available program content of the New Zealand HTA and health-economics knowledge base.

The New Zealand knowledge base comprises the publicly accessible teaching, research and training environment associated with universities and university-affiliated programs in health economics, health technology assessment, outcomes research, comparative effectiveness research, health services research, pharmacoeconomics and health policy. Material considered includes program descriptions, research priorities, methodological statements, projects, publications, seminars, training activities and related publicly available evidence. Relevant activities across Auckland, Otago, Massey, Canterbury, Victoria University of Wellington and other identifiable New Zealand programs contribute to this national knowledge base. The objective is not to evaluate individual investigators or institutions, but to characterize the methodological framework represented across New Zealand as a whole.

As noted above, two contrasting groups of content are examined. The first represents representational measurement. It includes measurement preceding arithmetic, scales of measurement, the axioms of representational measurement, ratio measurement, admissible transformations and arithmetic, dimensional homogeneity, the distinction between manifest and latent attributes, linear ratio measurement for manifest attributes, and Rasch measurement for latent attributes.

The second represents contemporary HTA. It includes health economics, economic evaluation, utilities and multiattribute utility instruments, QALYs, incremental cost-effectiveness ratios, decision analysis, decision trees, Markov models, microsimulation, probabilistic sensitivity analysis and related modelling methods. In the New Zealand context, these methods also form part of the wider analytical environment supporting medicines assessment, reimbursement and healthcare resource-allocation decisions.

The interrogation asks a single question: does the New Zealand HTA and health-economics program-content knowledge base establish representational measurement as the foundation for quantitative claims before presenting the analytical methods of contemporary HTA? The criterion is the presence or absence of explicit program content rather than a probability of endorsement.

This distinction is important. Earlier interrogations demonstrated the relative strength with which knowledge bases endorsed measurement inversion and curriculum inversion. Program-content interrogation provides a more direct test. If representational measurement is absent while the methods of contemporary HTA are extensively represented, the result is program-content inversion. Arithmetic, modelling and simulation are taught and applied without first establishing the measurement conditions that determine whether those operations are admissible.

The New Zealand assessment therefore focuses on a narrow issue: whether the scientific requirements governing measurement are present in the national program-content knowledge base that teaches, researches and transmits contemporary HTA and health economics. The purpose is to determine whether lawful measurement provides the scientific foundation for quantitative analysis in New Zealand or whether the methods of the legacy HTA framework are represented without the prior measurement standards required to establish their arithmetic admissibility.

ASSESSMENT FRAMEWORK

For this assessment, the New Zealand program-content knowledge base was defined as the publicly available material describing relevant teaching and training in health economics, HTA, outcomes research, pharmacoeconomics and related fields. Sources included program and curriculum descriptions, courses and modules, syllabi where available, learning objectives, seminars, workshops, teaching resources and associated educational material. The purpose was to establish what students and trainees are expected to encounter across the New Zealand HTA and health-economics educational environment, not what individual faculty members may know or address in their independent research.

The relationship between the two components is the critical issue. Contemporary HTA methods cannot be taught independently of the measurement requirements governing their arithmetic. If students are taught that measurement precedes arithmetic, that multiplication and division require ratio measurement, and that manifest and latent attributes require different measurement strategies, they possess the scientific criteria required to judge whether subsequent HTA methods are admissible. Where these foundations are absent, utilities, QALYs, cost-effectiveness ratios and simulation models can be introduced without confronting the measurement properties required for their arithmetic.

Program-content inversion is therefore identified where contemporary HTA methods are extensively represented (20/20 topics) while the prior requirements of representational measurement are absent (0/17 topics). This is more than an imbalance in program content. It reverses the scientific sequence: arithmetic and modelling are introduced before the conditions governing their admissibility have been established.

Program-content inversion places contemporary New Zealand HTA in direct conflict with the standards of normal quantitative science. A discipline cannot claim scientific status merely because it generates numbers, employs sophisticated models or supports important policy and reimbursement decisions. Scientific quantitative claims require lawful measurement, admissible arithmetic, empirical evaluation and the possibility of falsification. If the foundational requirements of representational measurement are absent while utilities, QALYs, ICERs and simulation models are accepted without demonstrating that their arithmetic is admissible, HTA is operating outside those requirements. In that sense, contemporary New Zealand HTA occupies a quantitative universe of its own: one in which numerical manipulation has been permitted to substitute for measurement. The 0/17 versus 20/20 program-content inversion is therefore not simply an educational deficiency. It signals disciplinary isolation from the measurement standards governing normal science. New Zealand HTA is effectively out in left field, sustained by internally accepted conventions rather than the scientific rules that determine whether quantitative claims are legitimate.

The two frameworks are consequently incompatible as foundations for quantitative analysis. Representational measurement requires arithmetic to be constrained by measurement. Once this principle is accepted, every subsequent quantitative method must satisfy its requirements. Ratio-free numerical constructions cannot be exempted simply because they are established components of contemporary HTA or embedded within New Zealand's medicines-assessment and

reimbursement environment. Conversely, when representational measurement is absent, there is no corresponding measurement constraint preventing such constructions from being accepted, taught and applied.

ASSESSMENT RESULTS

PROGRAM CONTENT REVIEW

Jurisdiction
New Zealand

Knowledge Base
New Zealand Health Technology Assessment, Health Economics and Outcomes Research Program-Content Knowledge Base

Purpose

This review evaluates the publicly available program content associated with health technology assessment (HTA), health economics, economic evaluation, outcomes research, health services research and related quantitative health research in New Zealand against a single scientific criterion: whether representational measurement is explicitly recognized as the foundation for quantitative claims before the methods of contemporary HTA are taught or applied.

Particular attention is given to scales of measurement, ratio measurement, admissible transformations and arithmetic, dimensional homogeneity, the distinction between manifest and latent attributes, linear ratio measurement and Rasch measurement. These provide the scientific conditions that must precede arithmetic operations intended to support quantitative claims concerning therapy impact.

Programs and Content Reviewed

The review treats New Zealand as a single national program-content knowledge base. Publicly available material was examined from major university programs, courses, research activities and associated national HTA and medicines-assessment activities concerned with health economics, economic evaluation, health policy, outcomes research and related fields.

The knowledge base includes material associated with, among others:

- University of Auckland — School of Population Health, including health economics and POPLHLTH 720 Cost Effectiveness Evaluation. The latter explicitly addresses economic evaluation, cost-effectiveness, quality-of-life measurement and decision-analytic modelling, with assessed exercises in decision trees, Markov models and sensitivity analysis.
- University of Otago — Department of Public Health and Department of Economics, including PUBH 735 Economics of Health Policy Decision Making, PUBH 736

Economic Evaluation, ECON306 Economics of Health and Education, and research in health economics, economic evaluation, patient-reported outcomes and microsimulation.

- Massey University — including the Manawatū/Palmerston North academic environment, 178718 Health Economics, postgraduate economics and the Master of Health Service Management. Health Economics explicitly includes healthcare microeconomics, demand and supply, hospital behavior, moral hazard, cost-benefit analysis and health-policy issues.
- University of Canterbury — ECON338 Health Economics Overview and ECON658 Health Economics, addressing health and medical-care markets, health production, insurance, treatment, government intervention and health policy.
- Victoria University of Wellington — including HLWB 502 Health Economics and Financing and associated health-policy and economics teaching.
- Other identifiable New Zealand university research and teaching associated with health outcomes, quality-of-life measurement, economic evaluation, simulation and health policy.
- PHARMAC| Te Pātaka Whaioranga — the principal national medicines-assessment and reimbursement environment, including the Prescription for Pharmacoeconomic Analysis (PFPA), cost-utility analysis, QALYs, economic modelling, technology assessment and budget impact analysis.

This coverage demonstrates that New Zealand's health-economics program-content knowledge base is substantially broader than Auckland and Otago alone. Massey provides dedicated postgraduate health-economics teaching, Canterbury provides undergraduate and postgraduate health economics, Wellington incorporates health economics and financing into health-policy education, while PHARMAC provides a highly developed national framework for applied economic assessment.

TABLE 1: REPRESENTATIONAL MEASUREMENT

Topic	Explicitly recognized	New Zealand program evidence
Representational measurement	No evidence identified	—
Scales of measurement as constraints on arithmetic	No evidence identified	—
Measurement precedes arithmetic	No evidence identified	—
Axioms of representational measurement	No evidence identified	—
Ratio measurement as prerequisite for multiplication and division	No evidence identified	—
True zero and equal units	No evidence identified	—

Topic	Explicitly recognized	New Zealand program evidence
Admissible transformations	No evidence identified	—
Admissible arithmetic by scale type	No evidence identified	—
Dimensional homogeneity	No evidence identified	—
Manifest and latent attributes as distinct measurement classes	No evidence identified	—
Linear ratio measurement for manifest attributes	No evidence identified	—
Possession of latent attributes	No evidence identified	—
Rasch measurement as requirement for latent attributes	No evidence identified	—
Person–item conjoint measurement	No evidence identified	—
Specific objectivity and invariance	No evidence identified	—
Rasch logit ratio measurement for latent attributes	No evidence identified	—
Two admissible ratio measures for therapy impact	No evidence identified	—

Result: 0/17 representational-measurement topics explicitly recognized as foundational components of the publicly available New Zealand program-content knowledge base.

The wording here is important. "No evidence identified" does not mean that no New Zealand researcher has encountered measurement theory or Rasch methods. Rather, no evidence was identified that the specified concepts constitute the organizing scientific foundation of the publicly available HTA/health-economics program content examined.

TABLE 2: CONTEMPORARY HEALTH ECONOMICS AND HTA FRAMEWORK

Topic	Explicitly represented	New Zealand program evidence
Health economics	Yes	Auckland; Otago; Massey; Canterbury; Wellington
Health technology assessment	Yes	PHARMAC; Auckland/Otago economic-evaluation environment

Topic	Explicitly represented	New Zealand program evidence
Economic evaluation	Yes	Auckland POPLHLTH 720; Otago; PHARMAC
Cost-effectiveness analysis	Yes	Auckland; Otago; PHARMAC
Cost-utility analysis	Yes	Otago; PHARMAC PFPA
Pharmacoeconomics	Yes	PGARMAC PFPA and medicines-assessment environment
Utilities and preference-based outcomes	Yes	Auckland quality-of-life measurement; Otago EQ-5D valuation; PHARMAC
Quality-adjusted life-years (QALYs)	Yes	Otago research; PHARMAC
Incremental cost-effectiveness ratios (ICERs)	Yes	Economic-evaluation and cost-effectiveness research
Measurement and valuation of health outcomes / patient-reported outcomes	Yes	Auckland; Otago health-outcomes and EQ-5D research
Decision analysis	Yes	Auckland; Otago
Decision-tree modelling	Yes	Auckland POPLHLTH 720
Markov modelling	Yes	Auckland POPLHLTH 720; economic-modelling research
Simulation and microsimulation modelling	Yes	Otago microsimulation research
Probabilistic sensitivity and uncertainty analysis	Yes	Auckland and health-economic modelling
Value-of-information analysis	Yes	Advanced New Zealand health-economic decision research
Budget impact analysis	Yes	PHARMAC Cost Resource Manual
Health care priority setting and resource allocation	Yes	Otago; Massey; PHARMAC
Value-for-money / value assessment	Yes	PHARMAC PFPA; health-economics programs
Policy, reimbursement and decision use of economic evaluation	Yes	PHARMAC; Auckland; Otago; Massey; Canterbury; Wellington

Result: 20/20 contemporary health-economics and HTA topics represented in the publicly available New Zealand program-content knowledge base.

The evidence for this side of the framework is extensive. Auckland's POPLHLTH 720 explicitly teaches economic evaluation and cost-effectiveness, quality-of-life measurement and decision-analytic modelling; students undertake decision-tree, Markov-model and sensitivity-analysis exercises. Otago explicitly identifies health economics and economic evaluation within teaching and research, including priority setting, patient-reported outcomes and microsimulation. Massey's

178718 Health Economics substantially extends the national educational footprint, while Canterbury provides both undergraduate and postgraduate health-economics courses and Wellington offers Health Economics and Financing.

PHARMAC provides particularly strong evidence for the applied national framework. Its PFPA describes cost-utility analysis as its preferred economic method and explicitly addresses economic modelling, health-related quality of life, costs, time preference and uncertainty. PHARMAC states that its economic analyses inform funding decisions. Its Cost Resource Manual explicitly provides inputs for both cost-utility and budget-impact analyses. PHARMAC also explicitly describes QALYs as the health-benefit metric used in cost-utility analysis.

ASSESSMENT

The New Zealand interrogation produces the same striking result as Australia, Canada and the United States: 0/17 versus 20/20. No evidence was identified that any of the 17 representational-measurement topics provides an explicit foundation for New Zealand HTA and health-economics program content. In contrast, all 20 topics defining contemporary health economics and HTA are represented. This is not simply a difference in emphasis between two approaches to quantitative analysis. It is a categorical separation between an absent measurement framework and a comprehensively represented contemporary HTA framework. Nor can the finding be attributed to the particular orientation of one or two universities; it characterizes the national program-content knowledge base examined.

The breadth of conventional health-economics education makes the finding particularly important. A student can encounter health economics at Auckland, Otago, Massey, Canterbury or Wellington through somewhat different routes. Auckland provides particularly explicit economic-evaluation and modelling instruction; Otago combines health economics, economic evaluation, priority setting and outcomes research; Massey incorporates health economics within economics and health-service management; Canterbury provides dedicated health-economics courses; and Wellington integrates health economics and financing with health policy. New Zealand therefore possesses a substantial and diverse academic environment through which the concepts and methods of health economics are transmitted.

Yet the representational-measurement side of the fixed assessment produces the opposite result. The publicly available content examined does not establish measurement before arithmetic, ratio measurement as the prerequisite for multiplication and division, admissible transformations, dimensional homogeneity, or the distinction between manifest and latent attributes as the prior scientific framework within which quantitative methods are to be judged. Nor was evidence identified that linear ratio measurement and Rasch logit ratio measurement are presented as the two required measurement approaches for therapy-impact claims. Under the criterion applied in this study, this is program-content inversion: the methods of quantitative analysis are represented without the prior measurement framework required to determine whether their arithmetic is admissible.

The national significance is amplified by PHARMAC. New Zealand does not merely teach health economics academically; PHARMAC's economic-assessment framework employs cost-utility

analysis, health-related quality-of-life values, QALYs, economic modelling and consideration of budgetary consequences. The broad analytical framework represented within university program content therefore has a direct counterpart in national medicines assessment and resource-allocation decision making. Program-content inversion cannot consequently be dismissed as an isolated educational issue. The same intellectual framework extends from the development of expertise within universities to the methods applied within the national HTA environment.

This makes the 0/17 versus 20/20 dichotomy substantially more consequential than an imbalance between subjects. If students and researchers were first taught that measurement precedes arithmetic, that mathematical operations are constrained by measurement properties, and that multiplication and division require ratio measurement, they would possess the scientific criteria required to interrogate every quantitative method subsequently encountered. They could determine whether the quantities entering an analysis possess the properties required for the arithmetic performed upon them. The program-content finding indicates that this representational-measurement framework is not explicitly provided as the prior organizing foundation. The problem is therefore not that New Zealand lacks sophisticated quantitative methods; it is that those methods are represented without the measurement standards required to establish their quantitative legitimacy.

The New Zealand finding consequently parallels the Australian result. New Zealand possesses substantial expertise in health economics, economic evaluation, modelling, health policy and medicines assessment. What the fixed interrogation identifies is a failure in the scientific ordering of that expertise. Contemporary health-economic methods occupy the program-content knowledge base, while the representational-measurement framework against which their arithmetic should first be judged does not. Under the standards of normal quantitative science adopted in this assessment, the response cannot be the addition of a measurement lecture to an otherwise unchanged framework. Representational measurement changes the organizing principle itself: define the attribute, establish lawful measurement, distinguish manifest from latent attributes, determine the arithmetic permitted by the resulting measure, formulate credible and evaluable claims, and only then proceed to quantitative analysis. On this criterion, the New Zealand finding calls for transformation rather than refinement.

To support that transformation, Maimon Research has developed a comprehensive nine-unit curriculum designed specifically to reconstruct HTA around the requirements of representational measurement. The program supplies the scientific foundation absent from the program-content knowledge base identified here. It begins with the principle that measurement precedes arithmetic and develops the requirements of scale type, ratio measurement, admissible transformations and dimensional homogeneity before distinguishing the measurement of manifest and latent attributes. It then develops linear ratio measurement for manifest attributes and Rasch measurement for latent attributes, including possession of the latent attribute, before moving to the construction of credible, evaluable and falsifiable therapy-impact claims and their assessment through prospective protocols. The objective is not to supplement contemporary HTA but to provide a practical pathway to an HTA framework operating within the standards of normal quantitative science. A complete description of the nine-unit curriculum, together with supporting teaching materials and implementation guidance, is available on the Maimon Research website [6].

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