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REPRESENTATIONAL MEASUREMENT FAILURE IN HEALTH TECHNOLGY ASSESSMENT

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

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ABSTRACT

Health technology assessment (HTA) depends upon quantitative claims whose scientific legitimacy rests upon lawful measurement. Measurement must precede arithmetic; multiplication, division and ratio formation require ratio measurement; admissible arithmetic is determined by scale properties; and manifest and latent attributes require different measurement frameworks. Previous investigations of HTA knowledge bases in Australia, Canada, New Zealand and the United States have consistently identified measurement inversion, curriculum inversion and program-content inversion, where the principles of representational measurement are largely absent while the conventional analytical methods of HTA are extensively endorsed.

This paper examines whether the publicly available Florida HTA and health-economics program-content knowledge base satisfies these scientific requirements. Rather than evaluating individual universities or investigators, the analysis considers the statewide educational and research framework represented through program descriptions, curricula, research priorities, publications, seminars and methodological statements across Florida universities and associated research programs. A fixed 37-topic assessment framework is applied, comprising 17 topics representing the principles of representational measurement and 20 topics representing the conventional methods of contemporary HTA and health economics.

The results demonstrate complete program-content inversion. None of the 17 representational-measurement topics is explicitly represented within the Florida knowledge base, while all 20 contemporary HTA topics are comprehensively represented (0/17 versus 20/20). Concepts fundamental to lawful quantitative science—including 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—are absent. In contrast, health economics, utilities, quality-adjusted life-years (QALYs), cost-effectiveness analysis, incremental cost-effectiveness ratios (ICERs), decision analysis, simulation modelling, probabilistic sensitivity analysis and related analytical methods form the core of the educational and research framework.

The findings indicate that Florida's HTA environment provides sophisticated technical instruction while omitting the scientific principles required to determine whether its quantitative methods are admissible. Students are taught how to apply economic evaluation and decision models before they are taught the measurement standards governing those analyses. The paper concludes that this represents a reversal of the scientific sequence required by normal quantitative science. The solution is not incremental curriculum revision but reconstruction. Representational measurement must become the organizing framework for HTA education, with quantitative claims grounded in lawful ratio measurement, admissible arithmetic, and credible, empirically evaluable, independently replicable and potentially falsifiable claims of therapy impact.

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. 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.

The present investigation extends earlier research-center program-content assessments by examining the Florida HTA and health-economics program-content knowledge base as a whole. Florida provides an important setting because of the breadth and diversity of its university-based academic healthcare environment. Major programs and research activities at the University of Florida, the University of South Florida, Florida State University, the University of Miami, Florida International University, the University of Central Florida, Florida Atlantic University, Nova Southeastern University and other institutions encompass health economics, HTA, economic evaluation, outcomes research, health services research, pharmacoeconomics, patient-reported outcomes, health policy and decision modelling. Florida therefore provides a substantial academic environment in which to examine the scientific foundations underlying contemporary quantitative health research.

The unit of analysis is not an individual university, research center or investigator. It is the publicly available program content through which the Florida HTA and health-economics knowledge base is expressed and reproduced. This includes teaching and training, program and course descriptions, research priorities, methodological statements, projects, publications, seminars and other publicly available descriptions of what relevant Florida programs research, apply and teach. The purpose is therefore to characterize the statewide program-content knowledge base rather than to infer what individual faculty members may know or address outside that publicly presented framework.

Two contrasting bodies of content are assessed using the fixed 37-topic framework. The first comprises 17 topics representing the requirements of representational measurement, including 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 comprises 20 topics representing contemporary health economics and HTA, including health economics, economic evaluation, utilities, QALYs, cost-effectiveness and cost-utility analysis, patient-reported outcomes, decision analysis, simulation and microsimulation, uncertainty analysis, value-of-information analysis, budget impact and related methods.

The question is deliberately narrow: does the Florida HTA and health-economics program-content knowledge base establish representational measurement as the foundation for quantitative claims before introducing or 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 and research environment in which arithmetic and modelling proceed without first establishing that the quantities involved possess the measurement properties required to support the operations performed.

Unlike California, Florida has no historical association with the development of representational measurement comparable to the pioneering work of R. Duncan Luce or Patrick Suppes. This absence, however, makes the present assessment no less important. The issue is not whether representational measurement originated within Florida academia, but whether the scientific principles that now define lawful quantitative measurement have been incorporated into the program-content framework of Florida health economics and HTA as the governing standard for quantitative claims [1] [2] .

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 arithmetic itself. Once those rules are applied, every numerical construct must satisfy them. The Florida review therefore assesses whether lawful measurement provides the scientific foundation for its HTA and health-economics program content or whether the legacy framework of contemporary HTA occupies that position without it. The breadth of Florida's university system and its extensive activity in health economics, outcomes research and healthcare policy provide a rigorous test of whether contemporary HTA program content is grounded in the measurement requirements of normal quantitative science.

.FOUNDATIONS OF QUANTITATIVE ANALYSIS

Before examining Florida 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.

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 Florida HTA and health economics, by contrast, are organized around economic evaluation, utilities, QALYs, cost-effectiveness and cost-utility analysis, decision analysis and modelling. Over some forty years, these methods have become deeply embedded within Florida's university and research environment, including major programs at the University of Florida, the University of South Florida, Florida State University, the

University of Miami, Florida International University, the University of Central Florida, Florida Atlantic University, Nova Southeastern University and other institutions active in health economics, outcomes research and health policy. Institutional acceptance, methodological sophistication and longevity, however, do 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 Florida program-content review therefore asks a straightforward question: does the publicly available Florida 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 Florida'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 across institutions such as the University of Florida, the University of South Florida, Florida State University, the University of Miami, Florida International University, the University of Central Florida, Florida Atlantic University, Nova Southeastern University and the wider Florida university system. 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 Florida, the significance lies not simply in the findings for individual universities but in the consistency with which the same analytical framework is reproduced across a diverse statewide academic environment. The issue therefore concerns not a single course or institution, but the scientific foundations of Florida's HTA and health-economics program-content knowledge base.

THE CRITICAL ROLE OF RATIO SCALES

The Florida 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 Florida HTA and health economics. 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 extensively represented across Florida's academic health economics and HTA environment. 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 Florida assessment therefore applies a straightforward criterion. Does the publicly available statewide 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 Florida, this criterion applies across a broad and diverse academic environment encompassing colleges of pharmacy, schools of public health, medical schools, health economics programs, HTA research, outcomes research and health services research distributed throughout the state's university system. The issue is therefore not whether Florida possesses sophisticated quantitative expertise. It clearly does. The issue is whether that expertise is founded upon the measurement requirements necessary to sport the quantitative claims being made.

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 Florida HTA and health-economics knowledge base.

The Florida 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, decision science and health policy. Material considered includes program descriptions, research priorities, methodological statements, projects, publications, seminars, training activities and related publicly available evidence. Relevant activities at the University of Florida, the University of South Florida, Florida State University, the University of Miami, Florida International University, the University of Central Florida, Florida Atlantic University, Nova Southeastern University, the University of North Florida, Florida A&M University and other identifiable Florida programs contribute to this statewide knowledge base. The objective is not to evaluate individual investigators, courses or institutions, but to characterize the methodological framework represented across Florida 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 preference-based outcomes, QALYs, incremental cost-effectiveness ratios, decision analysis, decision trees, Markov models, simulation and microsimulation, probabilistic sensitivity analysis, value-of-information analysis and related modelling methods. Florida provides extensive representation of these methods through its university programs, colleges of pharmacy, schools of public health, colleges of medicine, outcomes-research programs, health services research centers, pharmaceutical and health-economics research activities, and health-policy programs distributed throughout the state's university system.

The interrogation asks a single question: does the Florida 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 the propositions associated with 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, researched and applied without representational measurement being established as the prior framework determining whether those operations are admissible.

The Florida assessment therefore focuses on a narrow issue: whether the scientific requirements governing measurement are present in the statewide program-content knowledge base through which contemporary HTA and health economics are taught, researched and transmitted. The purpose is to determine whether lawful measurement provides the scientific foundation for quantitative analysis in Florida or whether the methods of the legacy HTA framework are represented without the prior measurement standards required to establish their arithmetic admissibility. Given the breadth and diversity of Florida's university-based health economics, outcomes research and HTA environment, the statewide knowledge base provides a rigorous test of that question.

ASSESSMENT FRAMEWORK

For this assessment, the Florida 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 Florida 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 comprehensively 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 without first establishing the measurement conditions governing their admissibility.

Program-content inversion places contemporary Florida HTA in direct conflict with the standards of normal quantitative science. Scientific status does not follow from generating numbers, employing sophisticated statistical methods or constructing increasingly complex models. Quantitative science requires lawful measurement, admissible arithmetic, empirical evaluation, replication and the possibility of falsification. If the foundational requirements of representational measurement are absent while utilities, QALYs, ICERs and simulation models are represented without first establishing that their arithmetic is admissible, HTA is operating outside those requirements. The 0/17 versus 20/20 result therefore identifies more than an educational deficiency. It signals a separation between Florida's HTA program-content framework and the measurement standards required by normal quantitative science.

This finding is particularly significant in Florida because it cannot plausibly be attributed to a lack of quantitative expertise or academic resources. Florida has developed a broad and technically sophisticated university-based environment encompassing colleges of pharmacy, schools of public health, colleges of medicine, health services research programs, outcomes research, health economics and healthcare policy. The program-content inversion identified here occurs throughout that well-developed educational and research environment. The problem is therefore not insufficient analytical sophistication, but the absence of the prior measurement framework required to determine whether that sophistication is being applied to quantities capable of supporting the arithmetic performed.

The two frameworks are consequently incompatible as foundations for quantitative analysis. Representational measurement requires arithmetic to be constrained by measurement. Once that principle is accepted, every subsequent quantitative method must satisfy its requirements. Numerical constructions cannot be exempted simply because they are established components of contemporary HTA, extensively taught across Florida universities, or supported by decades of methodological convention. Conversely, where representational measurement is absent from the organizing framework, there is no corresponding measurement constraint preventing such constructions from being taught, researched and applied. The Florida 0/17 versus 20/20 result captures this incompatibility in its clearest form.

ASSESSMENT RESULTS PROGRAM CONTENT REVIEW

Florida, United States

Knowledge Base

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

Purpose

This review evaluates publicly available program content associated with health technology assessment (HTA), health economics, economic evaluation, outcomes research, health services research, pharmaceutical economics and related quantitative health research in Florida against the fixed 37-topic framework. The criterion is whether representational measurement is explicitly established as the scientific foundation for quantitative claims before the methods of contemporary HTA and health economics are taught, researched or applied.

The statewide knowledge base includes major activities associated with the University of Florida; University of South Florida; Florida State University; University of Miami; Florida International University; University of Central Florida; Florida Atlantic University; Nova Southeastern University; University of North Florida; Florida A&M University; and associated colleges of pharmacy, schools of public health, colleges of medicine and interdisciplinary health services research programs. Publicly available program descriptions consistently identify health economics, pharmacoeconomics, economic evaluation, comparative effectiveness research, patient-reported outcomes, outcomes research, health services research, implementation science, healthcare policy, cost-effectiveness analysis and decision modelling as core components of teaching and research. These programs collectively constitute the Florida HTA and health economics program-content knowledge base evaluated here.

Topic results are presented in Table 1 for representational measurement.

TABLE 1: REPRESENTATIONAL MEASUREMENT

Topic	Explicitly recognized	Florida 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	—

Topic	Explicitly recognized	Florida program evidence
Ratio measurement as prerequisite for multiplication and division	No evidence identified	—
True zero and equal units	No evidence identified	—
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 foundations of the publicly available Florida HTA/health economics program-content knowledge base reviewed.

Unlike California, Florida has no historical association with the development of representational measurement comparable to the work of Luce and Suppes. Nevertheless, the review demonstrates exactly the same outcome. Across the publicly available program content examined, no evidence was identified that representational measurement has been incorporated as the scientific framework governing graduate education or research in HTA, health economics or outcomes research. The organizing principles of lawful measurement are absent from the Florida knowledge base.

Topic results for contemporary HTA are presented in Table 2.

TABLE 2: CONTEMPORARY HEALTH ECONOMICS AND HTA FRAMEWORK

Topic	Explicitly represented	Florida program evidence
Health economics	Yes	University of Florida, University of South Florida, Florida State University and other Florida programs
Health technology assessment	Yes	University research centers and HTA-related research activities
Economic evaluation	Yes	University of Florida, USF, University of Miami and associated programs
Cost-effectiveness analysis	Yes	University of Florida, USF, University of Miami, FIU and others
Cost-utility analysis	Yes	Florida HTA, pharmacoeconomics and outcomes research
Pharmacoeconomics	Yes	Colleges of Pharmacy, particularly University of Florida and Nova Southeastern University
Utilities and preference-based outcomes	Yes	Outcomes research and health-status assessment
Quality-adjusted life-years (QALYs)	Yes	Economic evaluation and value-assessment research
Incremental cost-effectiveness ratios (ICERs)	Yes	Economic evaluation programs and publications
Measurement and valuation of health outcomes / patient-reported outcomes	Yes	Outcomes research programs across Florida universities
Decision analysis	Yes	Decision-analysis teaching and modelling activities
Decision-tree modelling	Yes	Health economics and economic evaluation instruction
Markov modelling	Yes	Health-economic modelling research
Simulation and microsimulation modelling	Yes	Comparative effectiveness and modelling programs
Probabilistic sensitivity and uncertainty analysis	Yes	Economic evaluation and decision modelling
Value-of-information analysis	Yes	Health-economic modelling research

Topic	Explicitly represented	Florida program evidence
Budget impact analysis	Yes	Health economics and healthcare policy research
Health care priority setting and resource allocation	Yes	Health policy, economics and population health programs
Value-for-money / value assessment	Yes	Outcomes research and value assessment
Policy, reimbursement and decision use of economic evaluation	Yes	Healthcare policy and reimbursement research

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

ASSESSMENT OF THE FLORIDA RESULT

The Florida program-content review identifies a complete inversion in the scientific ordering of health technology assessment education and research. Across the 37 topics examined, none of the 17 topics defining representational measurement is explicitly recognized as the scientific foundation for quantitative claims, while all 20 topics associated with contemporary health economics and HTA are represented. The resulting profile of 0/17 for representational measurement and 20/20 for the contemporary HTA framework is not a minor curriculum imbalance. It indicates that the methods of contemporary HTA are taught, researched and applied without prior establishment of the measurement conditions required to support their arithmetic.

The absence begins at the most fundamental level. No evidence was identified that representational measurement itself is introduced as the framework governing quantitative inquiry. There is no explicit recognition that measurement must precede arithmetic, that scale type determines admissible mathematical operations or that the axioms of representational measurement must be satisfied before numerical assignments can be treated as measures. These omissions remove the scientific criteria by which the legitimacy of every subsequent analytical construct should be assessed.

The failure to recognize scales of measurement as constraints on arithmetic is particularly important. Nominal, ordinal, interval and ratio scales possess different mathematical properties and support different operations. Multiplication, division and ratio formation require ratio measurement. Addition and subtraction require at least interval properties, while ordinal numbers support order but not arithmetic differences. Yet the Florida program-content knowledge base provides no explicit indication that students are first taught to determine whether the numbers entering an HTA analysis possess the scale properties required for the operations performed.

This omission has direct consequences for the treatment of utilities, QALYs and incremental cost-effectiveness ratios. Utilities generated from preference-based instruments are routinely incorporated into cost-utility analyses, multiplied by time to construct QALYs and then used as denominators in ICERs. These operations depend upon lawful ratio measurement. If utility scores

do not possess equal units and a non-arbitrary zero, multiplication by time does not create a meaningful quantity. The subsequent division of cost by that constructed quantity cannot create a scientifically interpretable ratio. The absence of ratio measurement from the curriculum therefore removes the very standard required to determine whether the central arithmetic of contemporary HTA is admissible.

No evidence was identified for true zero, equal units, admissible transformations or admissible arithmetic by scale type. These are not abstract theoretical refinements. They determine whether a measure remains meaningful under transformation and whether comparisons, differences and ratios preserve empirical interpretation. A ratio measure must possess a non-arbitrary zero and remain invariant under similarity transformations. Without these properties, statements that one therapy produces twice the benefit of another or that one intervention has a particular cost per unit of benefit cannot be interpreted as lawful quantitative claims.

Dimensional homogeneity is also absent. This is a basic scientific requirement that quantities may be added or compared only when they share the same dimension and that multiplication and division create quantities with interpretable compound dimensions. The QALY is typically presented as the product of time and utility, but the dimensional status of utility is neither established nor defended. The absence of dimensional analysis allows heterogeneous and non-measured quantities to be combined as though numerical assignment alone were sufficient to create quantitative meaning.

The review also identifies no explicit distinction between manifest and latent attributes as separate measurement classes. This distinction should precede instrument selection and analytical design. Manifest attributes, such as survival time, hospital admissions, emergency department visits, treatment administrations and medication possession, may be observed directly and represented through lawful linear ratio measures when units and zero points are defined. Latent attributes, such as pain, fatigue, depression, physical function and need fulfilment, cannot be observed directly. They require a measurement model capable of constructing an invariant quantitative continuum.

The absence of this distinction means that fundamentally different kinds of attributes are treated within a common numerical framework. Counts, durations, summed questionnaire scores, utility values and modelled outcomes are all entered into analyses without first determining whether they represent manifest or latent attributes and whether the selected measurement strategy is appropriate to the attribute in question. This is a foundational category error. Before therapy impact can be quantified, the attribute must be defined and the lawful measurement system appropriate to that attribute must be established.

The Florida knowledge base provides no explicit recognition of linear ratio measurement for manifest attributes. This is significant because manifest attributes offer the most straightforward basis for credible and empirically evaluable therapy-impact claims. Hospital days, treatment administrations, emergency visits, time to discontinuation and medication possession can be defined in units with non-arbitrary zeros. They support transparent protocols, direct observation, replication and falsification. Yet this measurement framework is not identified as one of the two admissible foundations for therapy-impact claims.

The omission is even more pronounced for latent attributes. No evidence was identified for possession of latent attributes, Rasch measurement as a requirement for latent measurement, person-item conjoint measurement, specific objectivity, invariance or Rasch logit ratio measurement. These concepts define the scientific conditions necessary for constructing measures from ordered categorical responses. Without them, summed scores and transformed questionnaire outputs remain ordinal observations rather than lawful measures.

Rasch measurement is not another optional psychometric technique. It provides the requirements for constructing a unidimensional continuum, calibrating persons and items conjointly, testing invariance, identifying differential item functioning and determining whether respondents possess more or less of the defined latent attribute. Its absence means that latent attributes are commonly represented through raw scores, summed Likert responses, preference weights or algorithmically transformed values without demonstrating that the resulting numbers possess interval or ratio properties.

The failure to recognize possession is especially revealing. For a latent attribute, the relevant outcome is not merely whether a respondent produces a higher numerical score after treatment. The scientific question is whether the person possesses more of the defined attribute and whether that change can be located on an invariant measurement continuum. Without a possession framework, positive numerical change is easily mistaken for measured therapy impact even when the instrument does not satisfy the requirements of unidimensionality, invariance or conjoint measurement.

The absence of the final representational-measurement topic, recognition of two admissible ratio measures for therapy impact, brings the pattern together. The Florida program-content knowledge base does not identify linear ratio measurement for manifest attributes and Rasch logit ratio measurement for latent attributes as the lawful foundations for therapy-impact claims. Instead, it comprehensively represents the conventional methods of contemporary HTA.

All 20 contemporary HTA and health-economics topics are present. Health economics, health technology assessment, economic evaluation, cost-effectiveness analysis, cost-utility analysis and pharmacoeconomics are explicitly represented. Utilities, preference-based outcomes, QALYs and ICERs form part of the accepted quantitative vocabulary. Measurement and valuation of health outcomes, including patient-reported outcomes, are present, but without the prior measurement framework required to distinguish valuation from measurement.

Decision analysis, decision-tree modelling, Markov modelling, simulation, microsimulation, probabilistic sensitivity analysis, uncertainty analysis and value-of-information analysis are also represented. These methods may be technically sophisticated, but their scientific legitimacy depends upon the measurement properties of the quantities entering the models. A simulation cannot repair a failure of measurement. More elaborate computation cannot transform ordinal preferences into ratio measures, create dimensional homogeneity or establish a non-arbitrary zero.

Budget-impact analysis, healthcare priority setting, resource allocation, value-for-money assessment and the policy use of economic evaluation complete the contemporary framework. These topics demonstrate the administrative and decision-facing orientation of the Florida

knowledge base. Students are prepared to support reimbursement, formulary, pricing and resource-allocation decisions. They learn how to apply the accepted technical conventions of HTA. What they are not first provided with is the scientific framework required to determine whether the quantitative claims generated by those conventions are lawful.

The contrast between 0/17 and 20/20 therefore defines program-content inversion. The knowledge base is comprehensive where contemporary HTA methods are concerned and silent where the scientific foundations of measurement are concerned. Arithmetic, modelling and decision frameworks are introduced before the properties of the quantities entering those operations have been established. This reverses the sequence required by normal quantitative science.

The problem cannot be resolved by adding a single module on measurement theory. Representational measurement is not one topic among many within HTA. It is the framework that determines whether all other quantitative topics are scientifically admissible. Once measurement preceding arithmetic, ratio measurement, admissible transformations, dimensional homogeneity and the manifest-latent distinction are introduced, utilities, QALYs, ICERs and reference-case models cease to be accepted starting points. They become objects of scientific evaluation.

This is why the two bodies of knowledge cannot be treated as complementary. A curriculum cannot simultaneously teach that multiplication requires ratio measurement and continue to present utility-by-time multiplication as scientifically legitimate without demonstrating that utilities are ratio measures. It cannot teach dimensional homogeneity while continuing to accept QALYs without specifying coherent dimensions. It cannot teach that latent attributes require invariant measurement while treating summed questionnaire scores or preference algorithms as measures. It cannot teach falsifiability while relying on modelled claims that are not prospectively specified for empirical evaluation.

The contradiction is structural. The contemporary HTA framework survives educationally because the principles capable of testing its quantitative legitimacy are absent. The omission of representational measurement is therefore not simply a missing component of an otherwise complete curriculum. It is the condition that allows the inherited analytical framework to remain epistemically closed.

The Florida result is especially important because it is distributed across a broad and diverse academic environment. The pattern is not confined to one university, one discipline or one research center. It is reproduced across pharmacy, public health, medicine, health services research, population health, healthcare administration and health policy. This breadth indicates that program-content inversion is institutional rather than local.

The implications for university education are unavoidable. A university may provide technical instruction in established HTA methods, but it should not present competence in those methods as equivalent to education in quantitative science. Scientific education requires students to understand the conditions under which quantitative claims are possible before learning how to manipulate numbers. The Florida knowledge base reverses that responsibility. It teaches the technical framework first and omits the scientific standards by which that framework should be judged.

The path forward is reconstruction rather than supplementation. The curriculum should begin with the definition of attributes, the distinction between manifest and latent variables, scales of measurement, admissible transformations, dimensional homogeneity and the requirement that multiplication, division and ratio formation rest upon lawful ratio measures. Manifest therapy-impact claims should be developed through linear ratio measurement. Latent therapy-impact claims should be developed through Rasch logit ratio measurement, including unidimensionality, person-item conjoint measurement, specific objectivity, invariance and possession.

Only after lawful measurement has been established should arithmetic, statistical analysis and modelling be introduced. Claims should then be framed prospectively through protocols specifying the target population, comparator, attribute, measurement instrument, timeframe, success criterion and falsification rule. This sequence restores the scientific order: define the attribute, establish the measure, determine the admissible arithmetic, formulate the claim and subject it to empirical evaluation.

The Florida program-content review therefore reaches an unequivocal conclusion. The publicly available knowledge base comprehensively represents the technical methods of contemporary HTA but does not explicitly represent the scientific foundations required to justify their quantitative use. The 0/17 versus 20/20 result is the clearest possible expression of curriculum inversion. Florida's universities have institutionalized an advanced technical training environment organized around utilities, QALYs, ICERs and modelling, but not an HTA curriculum grounded in lawful measurement. Until representational measurement becomes the organizing scientific principle, the Florida HTA program-content knowledge base cannot credibly be described as education in normal quantitative science.

CONCLUSION: THE CHALLENGE OF TRANSFORMATION

Now that the measurement problem has been exposed, the challenge facing Florida universities, research centers and the wider HTA and health-economics community is substantial. The issue is no longer whether contemporary HTA might benefit from greater attention to measurement theory. The Florida program-content findings, together with the earlier demonstrations of measurement and curriculum inversion, identify a foundational problem: the central analytical framework of contemporary HTA depends upon arithmetic operations that are inadmissible under the requirements of representational measurement and the standards of normal quantitative science. The measurement cat is out of the contemporary HTA litter box. It cannot simply be put back.

There is therefore no scientific basis for defending the status quo. The relevant question is no longer whether utilities, QALYs and economic models have been useful, widely adopted or employed for decades. Longevity and institutional acceptance do not establish quantitative validity. Once the requirements governing admissible arithmetic are applied, the problem becomes transparent. Multiplication requires ratio measurement. Arithmetic operations are constrained by scale properties. Dimensional homogeneity must be respected. Numerical assignment cannot substitute for measurement. Where these requirements are violated, the resulting arithmetic is inadmissible. No subsequent modelling, sensitivity analysis or computational sophistication can reverse that conclusion.

The challenge is consequently one of transformation: how should Florida HTA be reconstructed to meet the requirements of lawful measurement? Florida universities and research centers have an important responsibility because they educate future practitioners, undertake methodological research and contribute to healthcare policy, outcomes research and health-economic evaluation throughout the state and beyond. The 0/17 versus 20/20 program-content finding provides an opportunity to reconsider not simply what students are taught, but the scientific order in which they are taught it. The issue is not the technical sophistication of Florida's academic programs, but whether that sophistication rests upon a scientifically defensible foundation.

The starting point is straightforward. Representational measurement must become the foundation of HTA rather than an optional addition to the existing curriculum. Students must first learn to define the target attribute, distinguish manifest from latent attributes, establish the appropriate form of ratio measurement, determine which arithmetic operations are admissible, and formulate claims capable of empirical evaluation, replication and falsification. Only after these requirements have been satisfied should statistical analysis, economic evaluation or other quantitative procedures be undertaken.

This transformation does not abandon HTA. It brings HTA within the requirements of normal quantitative science. Florida universities and research centers face a clear choice: continue reproducing a legacy framework whose arithmetic fails the representational-measurement test, or lead the reconstruction of HTA around lawful measurement. Given Florida's extensive university system and its growing role in health economics, pharmaceutical economics, outcomes research, health services research and healthcare policy, such a transformation would extend well beyond individual courses or programs. The same measurement standards must govern quantitative claims whether they originate in academic research, industry-sponsored analysis, technology assessment or healthcare decision making.

Faculty necessarily have the leading educational role. This does not require an assumption that instructors have knowingly disregarded representational measurement. Most have themselves been educated within contemporary HTA and teach the methodological framework transmitted through universities, textbooks, journals, professional organizations and established research practice. The 0/17 finding indicates the extent to which representational measurement is absent from the publicly presented program-content framework examined. Transformation must therefore begin by providing faculty with the knowledge and practical tools required to reconsider the scientific foundations of what they teach and to reconstruct HTA education around measurement, admissible arithmetic, claims assessment and the standards of normal science.

It is precisely this gap that the Maimon Research nine-unit transformation program is intended to address It is precisely this gap that the Maimon Research nine-unit transformation program is intended to address [3]. The Maimon Research program is designed as more than a sequence of educational materials. It provides a structured template for faculty, researchers and practitioners seeking to understand and implement the transition from legacy HTA to a framework grounded in representational measurement. The program comprises 45,000 words of structured instructional material with the nine units moving progressively from measurement preceding arithmetic through attributes, scales of measurement, admissible arithmetic and dimensional homogeneity to the distinction between manifest and latent attributes, linear ratio measurement, Rasch measurement,

attribute possession and the construction of empirically evaluable therapy-impact claims. The program can therefore be used for individual faculty preparation, as a framework for reconsidering existing graduate teaching, or as the foundation for developing a new postgraduate course in HTA organized around the requirements of lawful measurement and normal science.

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

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

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

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

The required transformation therefore does not have to begin with each university independently reconstructing the measurement framework from first principles. The framework already exists. The immediate question is whether faculty and graduate programs are prepared to use it as the

starting point for a post-legacy HTA curriculum grounded in lawful measurement, admissible arithmetic and the standards of normal science.

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