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REPRESENTATIONAL MEASUREMENT FAILURE IN HEALTH TECHNOLGY ASSESSMENT

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

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LOGIT WORKING PAPER No 3010 JULY 2026

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ABSTRACT

Health technology assessment (HTA) depends upon quantitative claims, yet arithmetic is scientifically admissible only after measurement has been established and the properties of the resulting scale shown to support the mathematical operations performed. Representational measurement therefore provides the necessary scientific gatekeeper: measurement must precede arithmetic, multiplication and division require ratio measurement, admissible transformations and dimensional homogeneity must be respected, and manifest and latent attributes require distinct measurement approaches.

This study assesses whether the educational program-content knowledge base of the International Society for Pharmacoeconomics and Outcomes Research (ISPOR) establishes these requirements before introducing the methods of contemporary health economics and outcomes research (HEOR) and HTA. Publicly available ISPOR educational, training and competency content was assessed using the frozen 37-topic framework previously applied to national and regional HTA program-content knowledge bases. Seventeen topics represented the requirements of representational measurement and 20 represented contemporary HEOR and HTA. The result was categorical: 0/17 representational-measurement topics versus 20/20 contemporary HEOR and HTA topics. ISPOR provides extensive education in economic evaluation, utilities, QALYs, cost-effectiveness and cost-utility analysis, patient-reported outcomes, decision analysis, simulation modelling, uncertainty analysis, value-of-information analysis, budget impact and value assessment, yet no explicit program foundation was identified establishing the representational-measurement requirements governing whether the arithmetic underlying these methods is admissible. The two findings cannot be treated as equivalent dimensions of methodological competence.

The 17 representational-measurement requirements constitute the scientific gatekeeper for what follows. Failure at 0/17 therefore closes the gate to the 20/20 framework: downstream statistical, modelling or computational sophistication cannot compensate for an upstream failure to establish lawful measurement. For therapy-impact assessment, representational measurement recognizes two measurement pathways consistent with normal quantitative science: linear ratio measurement for manifest attributes and Rasch measurement for latent attributes. The ISPOR result therefore represents complete program-content inversion and a foundational scientific failure rather than a curriculum imbalance.

Representational measurement cannot simply be added to the existing ISPOR framework as another competency. Acceptance of measurement as the gatekeeper requires the existing educational structure to be reassessed from its foundations and those elements unable to satisfy the measurement requirements to be rejected or reconstructed. The question raised by the analysis is consequently whether ISPOR has the scientific willingness and institutional capacity to reconstruct HEOR and HTA around lawful measurement and credible, evaluable, replicable and falsifiable claims.

INTRODUCTION

Health technology assessment presents itself as a quantitative scientific discipline. Its conclusions influence reimbursement, formulary decisions, pricing, resource allocation and judgments concerning the comparative value of therapies. That status carries a fundamental obligation. Quantitative claims must satisfy the requirements of measurement before arithmetic is undertaken [1 2] . Numbers do not become measures merely because they are assigned to observations, entered into equations, subjected to statistical analysis or incorporated into increasingly sophisticated models. The attribute must first be defined, measurement properties established, and a scale constructed that supports the mathematical operations subsequently performed. Measurement must precede arithmetic.

This requirement provides the starting point for assessing the program-content knowledge base of the International Society for Pharmacoeconomics and Outcomes Research (ISPOR). The importance of ISPOR makes this a particularly consequential test. ISPOR occupies a central international position in health economics and outcomes research (HEOR), with extensive activities in professional education, methodological guidance, competency development, economic evaluation, patient-centered outcomes research, health technology assessment and healthcare decision making. Its influence extends across universities, pharmaceutical and medical-technology industries, HTA agencies, healthcare systems, consulting organizations and the wider professional community. ISPOR does not merely participate in contemporary HEOR. Through its competencies, educational programs, short courses, task forces and methodological guidance, it has helped define and transmit the intellectual architecture of the discipline.

The scientific question is therefore straightforward: what measurement foundations accompany that architecture?

Previous interrogations of HTA knowledge bases have identified measurement inversion: weak recognition of the requirements of representational measurement accompanied by strong endorsement of the numerical methods of contemporary HTA [3 4]. Curriculum interrogations identified the corresponding educational phenomenon. Students can become proficient in economic evaluation, utilities, QALYs, cost-effectiveness analysis, decision modelling and uncertainty analysis without first being taught the measurement principles required to determine whether the arithmetic underlying these methods is admissible. More recent program-content assessments in Australia, New Zealand and California have sharpened this finding. When publicly presented teaching and research content was assessed directly using a fixed framework, the result was categorical: 0/17 topics representing the foundations of representational measurement against 20/20 topics representing contemporary health economics and HTA.

The present study applies the identical frozen 17 + 20 framework to ISPOR. The first 17 topics address the scientific foundations required for lawful quantitative measurement: representational measurement, measurement preceding arithmetic, scales of measurement as constraints upon arithmetic, axioms of measurement, ratio measurement, true zero and equal units, admissible transformations, dimensional homogeneity, the distinction between manifest and latent attributes, linear ratio measurement, Rasch measurement, person-item conjoint measurement, specific objectivity and invariance, and possession of latent attributes. The remaining 20 topics represent

the established methodological content of contemporary HEOR and HTA, including economic evaluation, cost-effectiveness and cost-utility analysis, utilities, QALYs, ICERs, patient-reported outcomes, decision analysis, Markov and simulation models, probabilistic sensitivity analysis, value-of-information analysis, budget impact and value assessment.

The result could scarcely be more stark. Across the publicly available ISPOR program-content knowledge base examined, no explicit evidence was identified for any of the 17 representational-measurement topics as foundations of HEOR and HTA education: 0/17. All 20 topics representing contemporary health economics and HTA were identified: 20/20. This is complete program-content inversion under the fixed assessment framework.

The significance of this dichotomy should not be understated. ISPOR demonstrates extraordinary methodological breadth and apparent sophistication. The issue is not an absence of mathematics, statistics, psychometrics, modelling expertise or professional competence as conventionally understood within HEOR. Indeed, the 20/20 finding demonstrates precisely the opposite. The problem is the scientific ordering of that knowledge. The program-content framework moves extensively through arithmetic, economic evaluation and modelling without explicitly establishing the prior representational-measurement requirements that determine whether the quantities involved support the operations performed upon them.

This is not the first time ISPOR has been assessed. These earlier studies focused on measurement inversion and the epistemic basis of ISPOR's claims [5] [6] [7] [8] They did not address the more substantive issue of program content and the gatekeeper role of representational measurement.

This places the ISPOR finding directly against the requirements of normal quantitative science. If multiplication requires ratio measurement, that requirement cannot be suspended when constructing a QALY. If arithmetic is constrained by scale properties, established professional practice cannot provide an exemption. If latent attributes require measurement rather than numerical assignment, psychometric sophistication alone cannot establish the required quantitative properties. And if an upstream numerical construction fails the requirements for measurement, downstream modelling, probabilistic analysis and computational refinement cannot restore what was absent at the beginning. Scientific legitimacy cannot be conferred retrospectively by analytical sophistication.

The 0/17 versus 20/20 result therefore identifies more than a gap in an educational program. It exposes a fundamental separation between the measurement requirements of normal quantitative science and the professional knowledge framework through which contemporary HEOR and HTA are taught and transmitted. Representational measurement is not a missing specialist technique that can simply be added to the existing ISPOR curriculum. It establishes the rules by which that curriculum itself must be judged. Once measurement precedes arithmetic is accepted as the governing principle, every subsequent quantitative construct must demonstrate that its arithmetic is admissible.

This makes ISPOR a critical case. If a professional organization with global influence over HEOR education and methodological practice exhibits complete program-content inversion, the issue cannot be dismissed as an isolated curricular omission. It concerns the foundations upon which

generations of practitioners have been trained to make quantitative claims. The central question raised by this interrogation is therefore unavoidable: can contemporary HTA claim conformity with normal quantitative science when its leading professional educational framework comprehensively represents the methods of arithmetic and modelling while failing to establish the representational-measurement principles required to determine whether that arithmetic is scientifically admissible? The ISPOR 0/17 versus 20/20 finding places that question at the center of the analysis that follows.

FOUNDATIONS OF QUANTITATIVE ANALYSIS

Before examining ISPOR program content, it is important to identify the scientific principles against which that content is assessed. These are not matters of methodological preference or competing schools of health economics. They are 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 apply irrespective of the sophistication of subsequent statistical analysis, economic evaluation or decision modelling.

These principles establish the boundary between numerical manipulation and lawful quantitative measurement. Contemporary HEOR and HTA, as represented within ISPOR's educational environment, are organized around economic evaluation, utilities, QALYs, cost-effectiveness and cost-utility analysis, patient-reported outcomes, decision analysis, health-economic modelling, uncertainty analysis, value assessment and related methods. Over more than four decades, these approaches have become embedded in the international HEOR community and in the methods taught to successive generations of practitioners. Their widespread professional acceptance, however, does not determine their measurement status. The prior scientific question remains whether the quantities entering these analyses possess the measurement properties required for the arithmetic performed.

ISPOR provides a particularly important setting in which to ask this question. Unlike a single university or national HTA system, ISPOR operates internationally through competency development, professional education, short courses, methodological training, conferences and other educational activities. Its program content therefore helps define what practitioners across academia, industry, consulting, HTA agencies and healthcare decision-making organizations are expected to understand and apply. The scientific foundations incorporated into that educational framework consequently have implications extending well beyond ISPOR itself.

The present program-content review therefore asks a straightforward question: does the publicly available ISPOR educational knowledge base explicitly recognize representational measurement as the foundation for quantitative claims before introducing the methods and arithmetic of

contemporary HEOR and HTA? Specifically, are measurement preceding arithmetic, ratio measurement, admissible transformations, dimensional homogeneity and the distinct measurement requirements of manifest and latent attributes established before learners encounter utilities, QALYs, cost-effectiveness analysis and decision modelling? Or does the educational framework proceed directly to these established methods without first establishing their measurement admissibility?

This is the criterion governing the analysis that follows. The issue is not whether ISPOR education is extensive, technically sophisticated or internationally influential; clearly it is. The question is logically prior**:** does that education first provide the scientific measurement framework required to determine whether the quantitative operations it subsequently teaches are admissible?

MEASUREMENT BEFORE ARITHMETIC

Before students and practitioners 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 legitimately be manipulated 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. Statistical sophistication cannot compensate for failure to establish measurement at the outset.

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 summing 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. Conventional psychometric procedures cannot substitute for demonstrating these measurement requirements.

The educational requirement can therefore be stated simply. Claims concerning manifest attributes require linear ratio measurement; claims concerning latent attributes require Rasch measurement. ISPOR participants should understand these requirements before being introduced to utilities,

QALYs, cost-effectiveness ratios, health-economic models or simulation methods. Numerical constructions do not acquire measurement properties merely through arithmetic, statistical analysis, professional consensus or incorporation into increasingly sophisticated models.

This sequence provides the criterion for assessing ISPOR's educational program-content knowledge base. The question is not how extensive or sophisticated its teaching of health economics, economic evaluation, outcomes research and modelling may be. Nor is it whether these methods have become accepted conventions across the international HEOR community. The question is whether ISPOR first provides students and practitioners with the measurement principles required to determine whether the arithmetic they subsequently perform is admissible.

If representational measurement, ratio measurement, admissible arithmetic and the distinction between manifest and latent attributes are absent while economic evaluation, utilities, QALYs, cost-effectiveness analysis and modelling are comprehensively represented, the result is program-content inversion. In the ISPOR setting, this is particularly consequential because its educational reach extends beyond a single university or national HTA system. ISPOR contributes to the methodological education of researchers, health economists, outcomes researchers, industry professionals, consultants and decision makers internationally. Program-content inversion within this environment therefore has the capacity to reproduce the same reversal of scientific order across the wider HEOR and HTA community: arithmetic and modelling are learned first, while the measurement requirements that should determine whether that arithmetic is permissible remain outside the educational foundation.

THE CRITICAL ROLE OF RATIO SCALES

The ISPOR 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. These requirements are properties of measurement and cannot be waived by professional convention, consensus or methodological guidance.

This requirement has immediate consequences for the methods represented throughout ISPOR education. 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, resource quantities and other numerical inputs. ISPOR provides extensive education and methodological training in precisely these areas. Where the quantities involved lack the measurement properties required for the operations performed, however, the arithmetic is inadmissible. Subsequent statistical analysis, sensitivity analysis, modelling or simulation cannot

correct that prior failure. Greater computational sophistication merely carries the original measurement problem further downstream.

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. It also distinguishes measurement from the assignment, aggregation or statistical transformation of numerical scores. A number produced by an instrument or model does not become a measure merely because it can be subjected to arithmetic.

The ISPOR assessment therefore applies a straightforward criterion. Does the publicly available ISPOR educational 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 HEOR and HTA? Or does it proceed directly to economic evaluation, utilities, QALYs, cost-effectiveness analysis, decision modelling and uncertainty analysis without first establishing the measurement properties required for their arithmetic?

This question is particularly important for ISPOR because its educational activities reach beyond students entering the discipline. They provide continuing methodological education for health economists, outcomes researchers, industry professionals, consultants, academics and healthcare decision makers. ISPOR therefore contributes to defining the quantitative competencies expected of HEOR practitioners internationally. If ratio measurement and the restrictions it imposes upon arithmetic are absent from that educational foundation, practitioners can become highly proficient in performing established analyses without acquiring the prior scientific criteria required to determine whether those analyses are quantitatively admissible.

Ratio measurement is therefore not simply another topic that might be added to an ISPOR course or competency framework. It establishes the boundary between admissible quantitative analysis and the manipulation of numbers without the measurement properties required to support that analysis. For ISPOR, the question is consequently foundational: whether its educational framework begins with the scientific conditions governing quantitative claims or begins downstream with methods whose arithmetic has already been assumed to be legitimate.

THE ISPOR KNOWLEDGE BASE: PROGRAM CONTENT AND COVERAGE

The present assessment uses the large language model interrogation framework applied in previous studies of measurement inversion, curriculum inversion and program-content inversion. The program-content analysis differs from the earlier probabilistic interrogations in one important respect. Rather than estimating categorical probabilities representing the expected endorsement of particular propositions, it examines whether specified scientific and methodological topics are explicitly represented in the publicly available educational knowledge base. The question is therefore not what individual ISPOR members might know or believe, but what ISPOR formally presents to students and practitioners as the knowledge, competencies and methodological skills

relevant to contemporary health economics and outcomes research (HEOR) and health technology assessment (HTA).

For this purpose, the ISPOR educational knowledge base comprises publicly accessible material associated with its education, training and professional competency activities. This includes the HEOR Competencies Framework, short courses, Education Center and Learning Lab resources, webinars, conference educational programs, methodological training and other formal educational material through which ISPOR communicates the knowledge and skills expected of HEOR practitioners. Particular weight is attached to the HEOR Competencies Framework because it provides an explicit statement of the domains and capabilities considered relevant to professional practice and is intended to support curriculum development, professional education and continuing development. The assessment therefore addresses an organized professional knowledge base rather than an arbitrary collection of ISPOR publications.

This distinction is important. ISPOR is not a university and does not offer a conventional degree curriculum. Its educational reach is potentially much broader. Participants include health economists, outcomes researchers, statisticians, modelers, patient-reported outcomes specialists, academics, pharmaceutical and medical-technology professionals, consultants and individuals involved in HTA and healthcare decision making. Its educational activities consequently operate across institutional and national boundaries. Whereas a university curriculum principally influences its own students and graduates, ISPOR provides a common methodological environment through which established HEOR concepts and practices can be transmitted internationally.

The interrogation examines two sharply contrasting bodies of content using the same frozen framework applied in the preceding program-content studies. The first comprises 17 topics representing the requirements of representational measurement. These include representational measurement itself; scales of measurement as constraints upon arithmetic; measurement preceding arithmetic; the axioms of representational measurement; ratio measurement as a prerequisite for multiplication and division; true zero and equal units; admissible transformations; admissible arithmetic by scale type; dimensional homogeneity; the distinction between manifest and latent attributes; linear ratio measurement for manifest attributes; possession of latent attributes; Rasch measurement; person-item conjoint measurement; specific objectivity and invariance; Rasch logit ratio measurement; and recognition of the two forms of ratio measurement required for therapy-impact claims.

The second body comprises the 20 topics representing contemporary health economics and HTA. These include health economics, HTA, economic evaluation, cost-effectiveness and cost-utility analysis, pharmacoeconomics, utilities and preference-based outcomes, QALYs, ICERs, patient-reported outcomes and health-outcomes measurement, decision analysis, decision trees, Markov models, simulation and microsimulation, probabilistic sensitivity and uncertainty analysis, value-of-information analysis, budget impact, priority setting and resource allocation, value assessment, and the policy, reimbursement and decision use of economic evaluation. Together these topics provide a broad representation of the analytical framework conventionally associated with contemporary HEOR and HTA.

The criterion for classification is deliberately demanding. A topic is recorded as represented only where explicit publicly available ISPOR program content supports that classification. General references to measurement, psychometrics, validity or outcomes assessment are not treated as evidence of representational measurement unless the specific scientific requirement identified by the frozen topic is present. Similarly, the presence of Rasch analysis in a conference abstract submitted by an individual researcher would not establish that Rasch measurement forms part of ISPOR's educational foundation. The purpose is to characterize the framework ISPOR itself presents through its educational and competency activities, not the entire range of ideas that may have appeared somewhere within the broader ISPOR community.

This distinction is particularly important for outcomes measurement. ISPOR has substantial educational content concerned with patient-reported outcomes, psychometric assessment, health-related quality of life, preference elicitation and health-state utilities. These activities demonstrate extensive interest in what contemporary HEOR commonly describes as measurement. They do not, however, automatically establish recognition of representational measurement. The interrogation asks the more fundamental questions of whether scale properties constrain arithmetic, whether multiplication and division require ratio measurement, whether admissible transformations and dimensional homogeneity are explicitly recognized, and whether manifest and latent attributes are assigned their distinct measurement requirements. Psychometric sophistication and representational measurement cannot simply be treated as interchangeable.

The ISPOR knowledge base is especially valuable for this assessment because its coverage is extensive. Contemporary HEOR methods are represented from introductory through advanced levels. Participants can encounter economic evaluation and cost-effectiveness analysis and then progress to decision modelling, simulation, uncertainty analysis, value-of-information methods, budget impact, patient-centered outcomes and HTA applications. The educational structure therefore provides a particularly strong test of whether increasing methodological sophistication is preceded by an equally explicit foundation establishing the measurement conditions governing the quantitative operations involved.

The interrogation consequently asks one narrow but fundamental question: **does the ISPOR educational knowledge base establish representational measurement before arithmetic, or does it proceed directly to the analytical framework of contemporary HEOR and HTA?** The issue is not whether ISPOR teaches sophisticated quantitative methods; the breadth of its educational activities makes that clear. Nor is the assessment intended to judge the competence or scientific intentions of individual ISPOR members, instructors or Task Force participants. It concerns the architecture of the publicly presented educational knowledge base itself.

This focus also separates the present study from the interrogation of ISPOR Good Practices Reports. Good Practices represent ISPOR's formal methodological recommendations and constitute a separate standards knowledge base. The present analysis is concerned specifically with education: what ISPOR identifies, organizes and transmits as professional knowledge and competency. Keeping the two knowledge bases separate permits independent assessment of what ISPOR **teaches** and what ISPOR subsequently identifies as **Good Practice**.

Program-content inversion is identified where the contemporary HEOR and HTA framework is extensively represented while the prior requirements of representational measurement are absent. The significance lies in the ordering of knowledge. If measurement precedes arithmetic, representational measurement should occupy the foundation of the educational structure, determining which subsequent quantitative operations are permissible. If it is absent while arithmetic, economic evaluation and modelling are extensively taught, the scientific sequence is reversed. The ISPOR knowledge-base interrogation therefore provides a direct test of whether one of the world's most influential HEOR educational environments begins with the requirements governing quantitative measurement or begins downstream with the analytical methods whose measurement legitimacy should first have been established.

ASSESSMENT FRAMEWORK

For this assessment, the ISPOR program-content knowledge base was defined as the publicly available material describing relevant education and training in health economics, health technology assessment (HTA), outcomes research, pharmacoeconomics and related fields. Sources included the HEOR Competencies Framework, educational programs, short courses, learning resources, webinars, workshops, conference educational activities and associated methodological training materials. The purpose was to establish what students, researchers and practitioners are expected to encounter through ISPOR's educational environment, not what individual ISPOR members, instructors or researchers may know or address independently.

The relationship between the two components of the assessment is the critical issue. Contemporary HEOR and HTA methods cannot be taught independently of the measurement requirements governing their arithmetic. If participants are first taught that measurement precedes arithmetic, that mathematical operations are constrained by scale properties, 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 quantitative methods are admissible. Where these foundations are absent, utilities, QALYs, cost-effectiveness ratios, decision models and simulation methods can be introduced without confronting the prior question of whether the quantities involved possess the measurement properties required for the arithmetic performed.

Program-content inversion is therefore identified where contemporary health economics and HTA methods are comprehensively represented across the fixed framework (20/20 topics) while the prior requirements of representational measurement are absent (0/17 topics). This is more than an imbalance in educational content. It reverses the scientific sequence. Arithmetic, economic evaluation and modelling are introduced without first establishing the conditions governing their admissibility. Instead of measurement determining what arithmetic may legitimately follow, the arithmetic is taught as established methodology without the corresponding representational-measurement framework required to judge it.

For ISPOR, this finding is particularly consequential because its educational activities are directed not simply toward students entering a discipline but toward an international community of established professionals. Health economists, outcomes researchers, modelers, academics, consultants, industry professionals and individuals involved in HTA and healthcare decision

making look to ISPOR for education, competency development and methodological training. Program-content inversion within this environment therefore has the potential to reinforce the same scientific reversal across the wider HEOR community.

Program-content inversion also places the assessed ISPOR educational framework in direct conflict with the standards of normal quantitative science. A discipline does not establish scientific legitimacy merely by generating numbers, employing sophisticated statistical procedures, constructing increasingly complex models or supporting important healthcare decisions. Quantitative science requires lawful measurement, arithmetic admissible for the measures involved, 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 taught without first demonstrating that their arithmetic is admissible, the resulting framework operates outside those requirements.

The 0/17 versus 20/20 finding should therefore not be interpreted simply as evidence that ISPOR could expand its educational offerings by adding more material on measurement. The problem is one of scientific ordering. The 20/20 component comprises methods whose quantitative legitimacy must first be established by the requirements represented in the 17-topic component. If those prior requirements are absent, methodological sophistication downstream cannot substitute for the missing measurement foundation upstream. A model may be internally consistent, computationally elaborate and subjected to extensive uncertainty analysis while still depending upon quantities that do not support the arithmetic performed upon them.

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 constructs cannot be exempted merely because they are long-established components of HEOR, incorporated into professional education, recommended by methodological guidelines or widely used by HTA agencies. Institutional acceptance and professional consensus cannot create measurement properties that the quantities themselves do not possess.

Conversely, where representational measurement is absent from the educational foundation, there is no corresponding constraint requiring established quantitative constructs to demonstrate their measurement admissibility before they are taught and applied. This provides the mechanism through which program-content inversion can reproduce itself. Practitioners can become increasingly proficient in utilities, QALYs, economic evaluation, decision modelling and uncertainty analysis without ever being required to confront the logically prior question: are the quantities entering these procedures measures capable of supporting the arithmetic being performed?

In this sense, the ISPOR result is more than an educational deficiency. It identifies a separation between the methodological framework taught within contemporary HEOR and the measurement standards required by normal quantitative science. The 0/17 versus 20/20 dichotomy indicates that the publicly available educational knowledge base examined comprehensively represents the downstream methods of contemporary HEOR and HTA while failing to establish explicitly the upstream measurement requirements that would determine their scientific admissibility.

The assessment therefore applies a simple but non-negotiable criterion. Either measurement determines admissible arithmetic, or arithmetic proceeds without first satisfying measurement requirements. Both positions cannot provide coherent foundations for quantitative science. For an organization with ISPOR's international educational reach, resolving that contradiction is fundamental to determining whether its program content prepares practitioners merely to reproduce the established methods of contemporary HEOR or equips them to evaluate whether the quantitative claims those methods generate satisfy the standards of normal science.

ASSESSMENT RESULTS

PROGRAM CONTENT REVIEW

Organization
ISPOR — The Professional Society for Health Economics and Outcomes Research

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

Purpose

This review evaluates the publicly available educational and methodological program content associated with ISPOR against a single scientific criterion: whether representational measurement is explicitly recognized as the foundation for quantitative claims before the methods of contemporary health economics and HTA are taught or applied.

The interrogation uses the identical frozen 37-topic framework applied in the California, Australian and New Zealand assessments: 17 topics representing the requirements of representational measurement and 20 representing contemporary health economics and HTA.

Program Content Reviewed

The ISPOR knowledge base was defined to include formal publicly available content describing what ISPOR identifies as necessary knowledge and skills for HEOR professionals. This includes the HEOR Competencies Framework, Education and Training program, short-course curriculum, Education Center, Learning Lab, webinars, HTA education and methodological training, together with ISPOR good-practice and task-force material where it directly supports those educational programs. ISPOR describes education and training as a core strategic pillar, while its short courses are organized into tracks including Economic Evaluation, Patient-Centered Research, Health Policy and Regulatory, and Health Technology Assessment. Particular weight was given to the HEOR Competencies Framework because ISPOR describes it as a comprehensive specification of knowledge and skills relevant to HEOR professionals and as a resource for educators developing HEOR curricula. Its 13 domains include Economic Evaluation, HTA, Patient-Centered Research, Statistics and Data Science, Health Policy and Study Approaches.

TABLE 1: REPRESENTATIONAL MEASUREMENT

Topic	Explicitly recognized	ISPOR 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	—
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	—

Table 1 Result: 0/17 representational-measurement topics explicitly recognized as foundations of the publicly available ISPOR program-content knowledge base reviewed.

This classification requires an important qualification. ISPOR explicitly includes psychometrics, PRO development and utility/QOL measurement within its competencies. Its Patient-Centered Research domain expects professionals to understand development and psychometric evaluation of PRO measures and to design and analyze utility and quality-of-life studies, including time trade-off and standard gamble methods. What was not identified is the different and much narrower content specified by the frozen 17-topic instrument: representational measurement as the governing framework, Rasch measurement as the required basis for latent measurement, person-item conjoint measurement, specific objectivity, or ratio-scale constraints upon arithmetic.

TABLE 2: CONTEMPORARY HEALTH ECONOMICS AND HTA FRAMEWORK

Topic	Explicitly represented	ISPOR program evidence
Health economics	Yes	ISPOR HEOR education; introductory HEOR course
Health technology assessment	Yes	HEOR Competency Domain 9; dedicated HTA education track
Economic evaluation	Yes	Competency Domain 5; Economic Evaluation short-course track
Cost-effectiveness analysis	Yes	Economic Evaluation competencies; introductory HEOR education
Cost-utility analysis	Yes	Economic Evaluation competencies; introductory HEOR course
Pharmacoeconomics	Yes	ISPOR program tradition; BIA and economic-evaluation training
Utilities and preference-based outcomes	Yes	Utility and QOL competency; health-state utility courses
Quality-adjusted life-years (QALYs)	Yes	Economic Evaluation competency; value-assessment education
Incremental cost-effectiveness ratios (ICERs)	Yes	Cost-effectiveness/value-assessment program content
Measurement and valuation of health outcomes / patient-reported outcomes	Yes	Patient-Centered Research and PRO competencies
Decision analysis	Yes	HTA Competency 9.4; introductory HEOR course
Decision-tree modelling	Yes	Decision-analysis and modelling education
Markov modelling	Yes	Applied Cost-Effectiveness Modeling courses
Simulation and microsimulation modelling	Yes	Health Economic Models competency; modelling short courses
Probabilistic sensitivity and uncertainty analysis	Yes	Economic Evaluation competencies; modelling courses

Topic	Explicitly represented	ISPOR program evidence
Value-of-information analysis	Yes	Dedicated VOI course and ISPOR Task Force
Budget impact analysis	Yes	Economic Evaluation competency; dedicated BIA courses
Health care priority setting and resource allocation	Yes	Economic evaluation/value/VOI program content
Value-for-money / value assessment	Yes	Dedicated Value Assessment Framework courses
Policy, reimbursement and decision use of economic evaluation	Yes	HTA and Pricing, Reimbursement and Access competencies

Table 2 Result: 20/20 contemporary health-economics and HTA topics represented in the publicly available ISPOR program-content knowledge base.

The evidence for the 20/20 classification is unusually direct. ISPOR's current HEOR Competencies Framework explicitly requires knowledge of cost-effectiveness, cost-utility and budget-impact analyses; health-economic model construction; decision analysis; uncertainty and sensitivity analysis; QALYs; utilities and QOL; PROs; HTA evidence development; reimbursement and access. educational program then operationalizes those competencies. ISPOR's introductory HEOR course teaches cost-minimization, cost-effectiveness, cost-benefit, cost-utility and budget-impact analysis together with decision analysis and sensitivity analysis. applied cost-effectiveness modelling course includes Markov cohort models, semi-Markov individual-patient simulations, probabilistic sensitivity analysis, structural uncertainty and value-of-information analysis. et-impact analysis has dedicated introductory and advanced courses. OR also provides dedicated value-of-information education and Task Force guidance, explicitly linking VOI to uncertainty, research prioritization and healthcare decision making. value-assessment courses explicitly teach cost-effectiveness as an approach to resource allocation and discuss the standard cost-per-QALY framework, thresholds and opportunity costs.

ASSESSMENT OF THE ISPOR RESULT

The 20/20 side of the ISPOR interrogation initially presents an impressive picture of methodological sophistication. Economic evaluation, cost-effectiveness and cost-utility analysis, utilities, QALYs, ICERs, decision analysis, Markov modelling, microsimulation, probabilistic sensitivity analysis, value-of-information analysis, budget impact and value assessment are represented across an educational continuum extending from introductory instruction to advanced specialist training. Viewed entirely from within the contemporary HEOR framework, this breadth can readily be interpreted as evidence of a mature quantitative discipline.

That interpretation changes fundamentally once the requirements of representational measurement are recognized. Methodological sophistication has scientific significance only when the quantities being manipulated possess the measurement properties required for the arithmetic performed. If multiplication requires ratio measurement, then no amount of subsequent statistical or

computational sophistication can legitimize multiplication of a quantity that lacks ratio properties. If admissible arithmetic is determined by scale type, mathematical operations cannot be justified merely because they are conventional within health economics. If dimensional homogeneity is required, elaborate modelling cannot compensate for its violation. The prior measurement question determines whether the subsequent analytical structure has a legitimate quantitative foundation.

The apparent sophistication represented by the ISPOR 20/20 finding must therefore be interpreted in relation to the 0/17 finding. The two results cannot be considered independently. The 20 contemporary HEOR topics describe what ISPOR teaches practitioners to do with numbers. The 17 representational-measurement topics establish whether those numbers are measures and what arithmetic they legitimately support. If the first framework is absent, sophistication in the second cannot establish scientific legitimacy. It may demonstrate considerable technical competence in manipulating, modelling and analyzing numerical values, but technical complexity is not a substitute for measurement.

The QALY provides the clearest example. Once ratio measurement is recognized as the required prerequisite for multiplication, the relevant question is not how sophisticated the subsequent QALY construct may be. The first question is whether the health-state value that discounts time, itself a ratio measure, is itself a ratio measure. If it is not, the calculation fails at that point. Everything downstream is consequentially compromised. Calculating incremental QALYs, constructing ICERs, fitting complex decision models, assigning probability distributions, conducting thousands of Monte Carlo simulations, undertaking probabilistic sensitivity analysis and calculating value of information cannot confer retrospectively the measurement properties absent from the original quantity. Computational sophistication cannot rescue inadmissible arithmetic. Unfortunately, there is no evidence that utilities are ratio measures. The QALY is then a meaningless construct.

This is why the ISPOR result is considerably more serious than the absence of 17 topics from an otherwise sophisticated curriculum. Once the standards of representational measurement are recognized, much of the apparent quantitative sophistication of the legacy framework becomes scientifically beside the point. The decisive issue is no longer how well a model has been constructed, how thoroughly uncertainty has been explored or how advanced the statistical methodology may be. The decisive question comes first: are the quantities measures, and do those measures permit the arithmetic being performed? Where the answer is no, downstream sophistication cannot convert the resulting numerical construct into a lawful quantitative claim.

Representational measurement does not, however, leave HTA without a basis for assessing therapy impact. It does the opposite: it establishes the measurement requirements that therapy-impact claims must satisfy. Under the framework applied in this assessment, there are two admissible forms of measurement for therapy impact, corresponding to the two fundamentally different classes of attributes.

For manifest attributes, therapy impact requires unidimensional linear ratio measurement. Manifest attributes are directly observable and include quantities such as survival time, hospital days, emergency department visits, treatment administrations and walking distance. Where the attribute has a defined unit, equal intervals and a non-arbitrary zero, meaningful ratios can be

formed and the arithmetic permitted by ratio measurement can legitimately be undertaken. Therapy-impact claims can then be specified prospectively, evaluated empirically and replicated.

For latent attributes, therapy impact requires Rasch measurement. Pain, fatigue, physical function, need fulfilment and similar attributes cannot be observed directly. Numerical assignment to questionnaire responses and the summation of item scores do not create measurement. Rasch measurement provides the required person-item conjoint framework, unidimensional continuum, invariance and specific objectivity through which possession of the latent attribute can be assessed. Therapy impact can then be expressed through changes on the resulting Rasch logit measurement possession continuum rather than through arbitrary summed or preference-weighted scores.

The consequence is a radical simplification of the measurement problem. Representational measurement does not invite an expanding catalogue of competing quantitative constructions. For therapy-impact assessment, it establishes two measurement pathways: linear ratio measurement for manifest attributes and Rasch measurement for latent attributes. Both begin with a defined attribute. Both require measurement before arithmetic. Both constrain subsequent operations by the properties of the measure. Both are intended to support claims that can be evaluated empirically, replicated and exposed to falsification. They therefore provide the measurement foundation required for therapy-impact assessment within normal science.

Seen from this perspective, the ISPOR 0/17 versus 20/20 result becomes even more consequential. The problem is not simply that ISPOR has omitted an important body of measurement theory while developing an otherwise impressive quantitative curriculum. The 17-topic framework supplies the scientific criteria by which the legitimacy of much of the 20-topic framework must first be judged. Once those criteria are applied, methodological complexity no longer provides a defense. A sophisticated analysis founded upon inadmissible arithmetic remains inadmissible.

The appropriate comparison is therefore not between a sophisticated contemporary HEOR paradigm and a competing representational-measurement paradigm. There are not two equivalent scientific frameworks. There is a substantive measurement framework that establishes the conditions under which quantitative therapy-impact claims are possible, and there is a legacy framework that has developed an extensive apparatus of arithmetic, modelling and simulation without incorporating those conditions as its foundation. The 0/17 versus 20/20 finding captures that separation with unusual clarity.

The relationship between the 0/17 and 20/20 findings must therefore be understood correctly. They are not two parallel scores describing different areas of methodological competence**.** The 17 representational-measurement topics constitute the scientific gatekeeper for everything that follows**.** They establish whether measurement has been achieved, whether the resulting scale possesses the required properties, and whether the arithmetic proposed for those measures is admissible. Only after these conditions have been satisfied is there a legitimate basis for proceeding to further quantitative analysis. Yet representational measurement has never been established as this prior gatekeeper within the ISPOR program-content knowledge base examined. Nor, despite three decades of extensive professional engagement with ISPOR involving thousands of researchers, educators and practitioners, does it appear to have been raised as a foundational requirement capable of challenging the legitimacy of the contemporary HEOR framework.

Failure at the 0/17 gatekeeper ends the scientific sequence. There is no legitimate next step in quantitative therapy-impact assessment until the measurement problem has been resolved. One cannot bypass the failure and proceed to economic evaluation, QALYs, ICERs, decision models, probabilistic sensitivity analysis or value-of-information analysis in the expectation that methodological sophistication downstream will compensate for the missing measurement foundation. It cannot. If the quantities entering an analysis do not possess the properties required for the arithmetic performed upon them, every subsequent procedure dependent upon that arithmetic is scientifically beside the point. The calculation may still generate numbers, models and probability distributions, but it cannot establish a lawful quantitative claim concerning therapy impact.

This makes the interpretation of ISPOR's 0/17 versus 20/20 finding especially stark. The 20/20 result cannot be invoked as evidence balancing the 0/17 result. There is nothing to balance. The relationship is hierarchical. The representational-measurement requirements come first and determine whether entry into the subsequent quantitative framework is permissible. Fail the gatekeeper and the analytical journey stops. The extraordinary breadth of ISPOR's downstream methodology cannot compensate for failure at the point of entry.

Representational measurement nevertheless provides a positive route forward. For therapy-impact assessment, the framework applied here recognizes two measurement pathways consistent with the required standards of normal quantitative science: linear ratio measurement for manifest attributes and Rasch measurement for latent attributes. The attribute must first be defined and classified. The appropriate measurement requirements must then be satisfied. Only after a defensible measure has been established can admissible arithmetic and subsequent empirical analysis begin. Claims can then be formulated so that they are credible, evaluable, replicable and open to falsification.

To facilitate this transition to normal science, Maimon Research has developed a comprehensive nine-unit program that reconstructs health technology assessment from the foundations of representational measurement. Its purpose is not to supplement contemporary HTA with another methodological topic, but to provide the scientific framework required to replace a legacy system founded upon inadmissible arithmetic.

The Maimon Research program begins with the non-negotiable principle that measurement precedes arithmetic and develops systematically the requirements for lawful quantitative claims: attribute specification, scales of measurement, admissible transformations, dimensional homogeneity, the distinction between manifest and latent attributes, linear ratio measurement for manifest attributes, Rasch measurement and possession for latent attributes, and the formulation of credible, evaluable and falsifiable claims of therapy impact. It then demonstrates how these principles reshape therapy evaluation, health economics and formulary assessment. The program therefore provides faculty, researchers and students with both the scientific foundation and the practical pathway required to move HTA into conformity with the standards of normal science.

To our knowledge, this is the only program developed specifically to support this transition from contemporary HTA to a representational measurement paradigm. A complete description of the

nine-unit program, together with supporting materials and implementation guidance, is detailed on the Maimin Research website [9] .

CONCLUSION

The ISPOR finding can only be described as the foundational scientific failure rather than a curriculum imbalance. ISPOR has constructed an extensive educational apparatus concerned with what analysts should do after numbers have been generated, but the interrogation identifies no explicit program foundation establishing the measurement conditions that determine whether those numbers permit the proposed arithmetic in the first place. Under the fixed assessment standard, 0/17 closes the gate to the 20/20 framework. Increasing methodological, statistical or computational sophistication beyond that point does not reopen it.

This conclusion changes fundamentally the question that follows from the present investigation. It is no longer whether ISPOR should add representational measurement to an otherwise intact HEOR curriculum. If the 17 requirements are accepted, the existing sequence cannot remain intact. Representational measurement must become the entry condition governing everything that follows. For therapy-impact assessment, this means establishing either linear ratio measurement for manifest attributes or Rasch measurement for latent attributes before subsequent arithmetic is undertaken. Those elements of the existing 20-topic framework that cannot pass this measurement gatekeeper cannot continue to be represented as legitimate quantitative methods for therapy-impact assessment.

The next question is consequently much larger and more difficult: can ISPOR itself be rescued? ISPOR possesses enormous professional resources: an international membership, extensive educational infrastructure, competency frameworks, Task Forces, Good Practices Reports, journals and substantial influence over the development and dissemination of HEOR. These assets could make ISPOR an exceptionally powerful vehicle for reconstruction. Yet they are also deeply embedded in the legacy framework exposed by the 0/17 finding. Rescue therefore cannot mean preserving that framework while adding a course or competency in measurement. It would require ISPOR to accept representational measurement as the scientific gatekeeper, reassess its educational and methodological corpus against that standard, withdraw or reconstruct practices that cannot pass it, and rebuild therapy-impact assessment around lawful measurement and claims that are credible, evaluable, replicable and open to falsification.

The issue that follows from this paper is therefore not whether the existing framework can be refined. Failure at the 0/17 gatekeeper means that the scientific sequence stops**.** What follows cannot repair what was never established at the beginning. The question for ISPOR is whether it has the scientific willingness and institutional capacity to recognize that failure, abandon those elements of the legacy framework that cannot satisfy the measurement standard, and use its considerable international resources to reconstruct HEOR and HTA within the requirements of normal quantitative science. The challenge is no longer one of methodological improvement. It is whether ISPOR is prepared to undertake scientific reconstruction.

ACKNOWLEDGEMENT

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

REFERENCES

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

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

[3] United States: Paradigm failure and measurement inversion in health technology assessment. Logit Working Paper No 657. https://maimonresearch.com/logit-working-paper-no-657-june-2026/

[4] United States. Paradigm failure and curriculum inversion in health technology assessment. Logit Working Paper No 658. https://maimonresearch.com/logit-working-paper-no-658-june-2026/

[5] United States: The International Society for Pharmacoeconomics and Outcomes Research as the guardian of the memeplex of false measurement. Logit Working Paper No 8. https://maimonresearch.com/logit-working-paper-no-8-january-2026-rev-8/

[6] United States: ISPOR and CHEERS 2022. Endorsing the official guide to reference case numerical storytelling. Logit Working Paper No 9. https://maimonresearch.com/logit-working-paper-no-9-january-2026-rev-8/

[7] United States: False measurement is not good research practice -An epistemic audit of ISPOR. Logit Working Paper No 10. https://maimonresearch.com/logit-working-paper-no-10-january-2026-rev-8/

[8] United States*: Value in Health* and the absence of measurement. Logit Working Paper No 19. https://maimonresearch.com/logit-working-paper-no-19/

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