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ARTIFICIAL INTELLIGENCE LARGE LANGUAGE MODEL INTERROGATION

REPRESENTATIONAL MEASUREMENT FAILURE IN HEALTH TECHNOLGY ASSESSMENT

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

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LOGIT WORKING PAPER No 6700 AUGUST 2026

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ABSTRACT

Health technology assessment (HTA) depends upon quantitative claims whose scientific legitimacy requires measurement to precede arithmetic. The properties of the measurement scale determine which mathematical operations are admissible; in particular, multiplication and division require appropriate ratio properties, while dimensional homogeneity and admissible transformations must be respected. Contemporary HTA, however, has developed around utilities, QALYs, cost-effectiveness analysis and decision modelling without necessarily establishing these prior measurement requirements.

This study examines whether representational measurement provides the scientific foundation for the publicly available program content of six major German university-based health-economics and HTA research environments: HCHE Hamburg, BerlinHECOR, CHERH Hannover, CINCH Duisburg-Essen, IZPH Erlangen-Nürnberg and M-CHEP. A fixed 37-topic framework contrasts 17 topics representing the requirements of representational measurement with 20 topics representing contemporary health economics and HTA. The unit of analysis is the composite German program-content knowledge base rather than individual investigators or institutions.

The findings demonstrate a striking program-content inversion. None of the 17 representational-measurement topics was explicitly identified as providing the scientific foundation for quantitative claims (0/17). *By contrast, 19 of 20 contemporary HTA topics were explicitly represented* (19/20*). The German knowledge base extensively represents economic evaluation, utilities, QALYs, cost-effectiveness and cost-utility analysis, ICERs, preference measurement, decision analysis, Markov modelling, simulation and uncertainty analysis, while the measurement standards required to establish the admissibility of their arithmetic are absent from the publicly represented framework.*

The implications are foundational rather than curricular. A sophisticated quantitative discipline cannot compensate for a prior failure of measurement through increasingly elaborate modelling. Ratio properties must be established before multiplication and division; numerical assignment cannot manufacture measurement; and manifest and latent attributes require distinct measurement pathways. For therapy-impact claims, these are linear ratio measurement for manifest attributes and Rasch measurement for latent attributes.

Germany therefore possesses an extensive and sophisticated academic infrastructure for contemporary HTA, but the program-content evidence reveals no corresponding infrastructure establishing representational measurement as its scientific foundation. The required transition is from arithmetic preceding measurement to attribute → measurement requirements → scale → admissible arithmetic → empirically evaluable claim. Germany's academic HTA community consequently faces a choice between reproducing the inherited framework and leading its reconstruction around lawful measurement, admissible arithmetic, replication and falsification.

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 appropriate ratio properties; 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 and program-content assessments by examining a composite German academic HTA and health-economics program-content knowledge base. Germany provides an especially important setting because of the size, maturity and European influence of its academic health-economics and HTA infrastructure. The knowledge base examined comprises six major university-based research environments: the Hamburg Center for Health Economics (HCHE), University of Hamburg/University Medical Center Hamburg-Eppendorf; BerlinHECOR, Technische Universität Berlin/Charité; the Center for Health Economics Research Hannover (CHERH), Leibniz University Hannover/Hannover Medical School; CINCH – Health Economics Research Center, University of Duisburg-Essen; the Interdisciplinary Center for Health Technology Assessment and Public Health (IZPH), Friedrich-Alexander-Universität Erlangen-Nürnberg; and the Munich Center for Health Economics and Policy (M-CHEP).

Collectively, these environments encompass health economics, HTA, economic evaluation, cost-effectiveness and cost-utility analysis, preference research, outcomes research, health-services research, health policy, decision analysis and modelling. They also provide substantial geographical coverage across northern, central, western, eastern and southern Germany. Germany therefore offers an unusually rich academic environment in which to examine the scientific measurement 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 composite German academic HTA and health-economics knowledge base is expressed and reproduced. This includes teaching and training materials, program and course descriptions, research priorities, methodological statements, projects, publications, seminars and other publicly available descriptions of what the six research environments investigate, apply and teach. The purpose is therefore to characterize the German academic program-content knowledge base rather than to infer what individual faculty members may know, teach informally or address outside that publicly represented 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 [1] [2] [3] . The second comprises 20 topics representing contemporary health economics and HTA, including health economics, HTA, 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 German academic 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.

Germany provides a particularly demanding test of this proposition. The six environments included in the interrogation represent substantial concentrations of academic expertise. Several explicitly identify economic evaluation, HTA, preference research, decision modelling and health-economic methodology as core research activities, while the Erlangen-Nürnberg environment includes an interdisciplinary university center explicitly devoted to Health Technology Assessment and Public Health. The issue is therefore emphatically not whether German universities possess quantitative expertise. They clearly do. The question is whether representational measurement has been incorporated into this sophisticated academic environment as the governing scientific standard for quantitative claims.

This distinction is fundamental. Representational measurement is not simply another methodology that can be appended to an existing HTA curriculum alongside economic evaluation, econometrics, decision modelling or sensitivity analysis. It establishes the scientific rules governing the admissibility of the arithmetic itself. Once those rules are applied, every numerical construct must satisfy them before subsequent mathematical operations can be justified.

This becomes particularly important where contemporary HTA requires multiplication and division. The existence of a numerical value does not establish ratio measurement, and the need to perform a mathematical operation cannot confer upon a number the properties required to make that operation admissible. The measurement status of the quantities must be established **before**, rather than inferred from, the arithmetic performed upon them.

The German review therefore asks whether lawful measurement provides the scientific foundation for its academic HTA and health-economics program content or whether the inherited analytical framework of contemporary HTA occupies that space without it. The distinction is between two fundamentally different scientific sequences: attribute → measurement requirements → scale →

admissible arithmetic → quantitative claim and required analytical output → selected numbers → assumed mathematical properties → arithmetic → modelled claim. The former places measurement before arithmetic. The latter constitutes measurement inversion.

Given the scale, maturity and European standing of the German academic health-economics environment, the assessment provides an unusually demanding test of whether contemporary HTA program content is grounded in the measurement requirements of normal quantitative science. If representational measurement is absent even from such an extensive and methodologically sophisticated knowledge base while the methods of contemporary HTA are comprehensively represented, the finding cannot readily be explained by lack of expertise or insufficient methodological development. It would instead point to a more fundamental failure in the scientific organization of the knowledge base itself.

FOUNDATIONS OF QUANTITATIVE ANALYSIS

Before examining German 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 the appropriate ratio properties. 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 German HTA and health economics, by contrast, are organized around economic evaluation, utilities, QALYs, cost-effectiveness and cost-utility analysis, preference measurement, decision analysis and modelling. Over several decades, these methods have become deeply embedded within Germany's extensive university and research environment. The composite knowledge base examined here encompasses major academic research environments in Hamburg, Berlin, Hannover, Duisburg-Essen, Erlangen-Nürnberg and Munich/Bavaria, representing a substantial concentration of German expertise in health economics, HTA, outcomes research, health-services research, health policy and quantitative healthcare evaluation.

Institutional acceptance, methodological sophistication and longevity, however, do not determine measurement status. Nor does the reputation of a university or research center confer measurement properties upon the numbers employed in its analyses. The prior scientific question remains whether the quantities entering those analyses possess the measurement properties required for the arithmetic performed.

The German program-content review therefore asks a straightforward question: does the publicly available German academic 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 the appropriate ratio properties, 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.

This distinction is particularly important for German HTA because its academic knowledge base demonstrates considerable expertise in precisely those methods that depend upon quantitative operations. Economic evaluation, cost-effectiveness analysis, cost-utility analysis, QALYs, preferences, decision analysis, Markov modelling, simulation, uncertainty analysis and policy-oriented evaluation are all represented across the six-center knowledge base. The question is not whether German researchers know how to perform these operations. They clearly do. The question is whether the measurement requirements that determine whether those operations are scientifically admissible have first been established.

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 and the required measurement properties are satisfied, 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. Nor does transforming those scores statistically create the required measurement properties. 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 distinction is critical because contemporary health economics frequently treats numerical outputs as though the act of numerical assignment itself establishes quantitative measurement. It does not. A number is not necessarily a measure**.** A preference score does not acquire ratio properties because it is bounded between zero and one. A questionnaire total does not become an interval measure because its items have been added together. A numerical construct does not acquire the properties required for multiplication or division merely because an economic model requires those operations.

The educational requirement can therefore be stated simply. Claims concerning manifest attributes require appropriate 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 through arithmetic, statistical analysis, professional convention or incorporation into increasingly sophisticated models.

This ordering is especially important because once arithmetic is allowed to precede measurement, the analytical framework can become self-reinforcing. Students learn how to calculate utilities, QALYs and ICERs; researchers refine model structures and parameter estimates; sensitivity and uncertainty analyses become increasingly sophisticated; and the resulting methods acquire legitimacy through repeated professional application. Yet none of these developments answers the logically prior question of whether the quantities being manipulated possess the measurement properties required for those operations.

The scientific sequence must therefore remain: defined attribute → measurement requirements → scale of measurement → admissible arithmetic → quantitative claim. It cannot legitimately be reversed to: required analytical output → selected numbers → assumed measurement properties → arithmetic → modelled claim. The latter sequence is the basis of measurement inversion.

This sequence provides the criterion for assessing the German academic 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 HCHE Hamburg, BerlinHECOR, CHERH Hannover, CINCH Duisburg-Essen, IZPH Erlangen-Nürnberg, M-CHEP and their associated university environments. 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, scale theory, ratio measurement, admissible transformations, dimensional homogeneity and the distinction between manifest and latent measurement are absent while economic evaluation, utilities, QALYs, cost-effectiveness analysis and modelling are extensively represented, the result is program-content inversion.

In Germany, the significance of such a finding is heightened by the size, maturity and European influence of its academic health-economics and HTA infrastructure. The issue therefore concerns much more than the content of a single course, department or university. It concerns whether a substantial national academic knowledge base has developed an extensive capability for performing the arithmetic of contemporary HTA without establishing, as its prior scientific foundation, the measurement requirements that determine whether that arithmetic is lawful. That is the standard against which the German program-content knowledge base is assessed.

SCALES OF MEASUREMENT AND RATIO MEASUREMENT

The German 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, the scale properties demonstrated, and the proposed arithmetic shown to 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. Ratio scales possess both equal units and a non-arbitrary zero and therefore permit meaningful ratio comparisons and the multiplicative arithmetic required for many quantitative claims. Their admissible transformations are similarity transformations of the form $x' = ax$, $a > 0$, under which ratios are preserved. Ratio status is therefore not established merely by the presence of a zero or by assigning numerical values to observations. The required measurement structure must first be demonstrated.

This requirement has immediate consequences for German 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, costs and other numerical inputs through sequences of arithmetic operations. These methods are extensively represented across the German academic health-economics and HTA environments examined in Hamburg, Berlin, Hannover, Duisburg-Essen, Erlangen-Nürnberg and Munich/Bavaria.

The scientific question, however, precedes their application: do the quantities entering these operations possess the measurement properties required for the arithmetic performed upon them? Where they do not, the arithmetic is inadmissible. The fact that an operation can be executed mathematically or computationally does not establish that it has empirical meaning. Nor can subsequent statistical analysis, probabilistic sensitivity analysis, modelling or simulation correct a measurement failure that occurred before the arithmetic began. Increasing the sophistication of a model cannot manufacture measurement properties that its inputs do not possess.

The QALY provides the clearest example. Its familiar construction,

$$QALY = U \times T$$

requires multiplication. Time can satisfy the requirements for linear ratio measurement. The critical question is therefore whether the utility value possesses the measurement properties required to operate as a dimensionless proportional adjustment to time. The need for the multiplication cannot itself confer those properties upon utility. They must be demonstrated independently before the operation is undertaken.

The same principle applies downstream. If the QALY has not been established as a legitimate quantitative measure, subtraction to create an incremental QALY does not repair the problem. Nor can division of incremental costs by an inadmissible ΔQALY create a scientifically meaningful cost-per-QALY ICER. Arithmetic cannot rescue a failure of measurement by adding further arithmetic.

For claims of therapy impact, two forms of ratio measurement are relevant. Manifest attributes require appropriate linear ratio measurement. These include directly observable attributes such as survival time, hospital days, treatment administrations and walking distance where the required unit, zero and measurement properties can be established. Latent attributes—including pain, fatigue, physical function and need fulfilment—require a different measurement pathway. Rasch measurement provides person-item conjoint measurement, specific objectivity, invariance and a logit continuum for establishing possession of a defined unidimensional latent attribute.

The distinction between these two measurement pathways is fundamental. A manifest attribute cannot simply be treated as though any numerical representation of it were a ratio measure, and a latent attribute does not become a measure because questionnaire responses have been assigned numbers, summed or transformed statistically. Measurement status must be demonstrated rather than assumed.

The German assessment therefore applies a straightforward criterion. Does the publicly available composite German academic HTA and health-economics program-content knowledge base recognize scales of measurement, ratio measurement, admissible transformations, 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 and cost-utility analysis, preference measurement and decision modelling without first establishing the measurement properties required for their arithmetic?

This question is particularly important because the German knowledge base is highly sophisticated by conventional HTA standards. HCHE Hamburg, BerlinHECOR, CHERH Hannover, CINCH Duisburg-Essen, IZPH Erlangen-Nürnberg and M-CHEP collectively represent substantial expertise in health economics, HTA, economic evaluation, preferences, outcomes research, health-services research, modelling and healthcare policy. The issue is not whether these centers possess advanced quantitative expertise. They clearly do. The issue is whether that expertise begins with the scientific requirements governing what can legitimately be quantified and what arithmetic can subsequently be performed**.**

Ratio measurement is therefore not simply another topic that might usefully be added to a German HTA curriculum or research program. It establishes a boundary between lawful quantitative analysis and the manipulation of numbers that lack the measurement properties required to support the operations performed upon them.

This is why the absence of ratio measurement from the German program-content knowledge base would be substantially more consequential than the absence of one additional methodological topic. If students are taught cost-effectiveness analysis, QALYs, ICERs and modelling without first being taught why multiplication and division require appropriate ratio properties, they are being introduced to the arithmetic before the scientific conditions governing the arithmetic. For

Germany, therefore, the program-content interrogation asks a foundational rather than a methodological question. Across one of Europe's most mature academic environments for health economics and HTA, are researchers and students being taught first how to measure, or first how to manipulate the numbers required by the inherited HTA framework? The distinction is the difference between measurement preceding arithmetic and arithmetic preceding measurement. It is the distinction upon which the German program-content assessment rests.

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 probabilities of endorsement, it examines whether specified scientific and methodological topics are explicitly represented in the publicly available program content of the German academic HTA and health-economics knowledge base.

The German knowledge base comprises publicly accessible teaching, research and training content associated with six major university-based research environments: the Hamburg Center for Health Economics (HCHE); BerlinHECOR; Center for Health Economics Research Hannover (CHERH); CINCH – Health Economics Research Center, University of Duisburg-Essen; Interdisciplinary Center for Health Technology Assessment and Public Health (IZPH), Friedrich-Alexander-Universität Erlangen-Nürnberg; and Munich Center for Health Economics and Policy (M-CHEP).

Material considered includes program and course descriptions, research priorities, methodological statements, projects, publications, seminars and training activities. The objective is not to evaluate individual investigators, courses or institutions, but to characterize the composite German academic HTA and health-economics program-content knowledge base**.**

Two contrasting groups of content are examined using the fixed 37-topic framework. The first comprises 17 topics representing representational measurement, including measurement preceding arithmetic, scales of measurement, axioms of representational measurement, ratio measurement, admissible transformations and arithmetic, dimensional homogeneity, manifest and latent attributes, linear ratio measurement and Rasch measurement.

The second comprises 20 topics representing contemporary health economics and HTA, including economic evaluation, cost-effectiveness and cost-utility analysis, pharmacoeconomics, utilities, QALYs, ICERs, patient-reported outcomes, decision analysis, Markov and simulation modelling, uncertainty analysis, value-of-information analysis, budget impact and value assessment.

The interrogation asks a single question: does the German academic HTA and health-economics program-content knowledge base establish representational measurement as the foundation for quantitative claims before presenting or applying the analytical methods of contemporary HTA?

A topic is classified as explicitly represented where identifiable public evidence demonstrates its presence within the research, teaching or methodological knowledge base. Failure to identify such evidence is reported as “No evidence identified.” This does not imply that individual German researchers are unfamiliar with the topic. It means that the topic was not identified as part of the publicly represented program-content framework examined.

Importantly, references to *measurement*, *outcome measurement*, *preference measurement* or *psychometrics* do not by themselves establish recognition of representational measurement. Similarly, numerical ratios or values with a zero do not establish recognition of ratio measurement. The criterion is whether the measurement principles themselves, and their implications for admissible arithmetic, are explicitly represented.

If representational measurement is absent while contemporary HTA methods 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 scientific framework determining whether those operations are admissible.

The German assessment therefore asks whether lawful measurement provides the scientific foundation for quantitative HTA or whether the legacy framework is represented without the measurement standards required to establish the admissibility of its arithmetic. Given the breadth and methodological sophistication of the six academic environments examined, Germany provides a demanding test of that question.

ASSESSMENT RESULTS PROGRAM CONTENT REVIEW

Jurisdiction

Germany

Knowledge Base

German Academic Health Technology Assessment and Health Economics Knowledge Base (Program Content)

Purpose

This review evaluates the publicly available program content associated with health technology assessment (HTA), health economics, pharmacoeconomics, outcomes research, health-services research, economic evaluation, healthcare policy and related quantitative health research across six major German university-based research environments 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 researched, taught or applied.

The composite German academic knowledge base comprises the Hamburg Center for Health Economics (HCHE), University of Hamburg/UKE; BerlinHECOR, Technische Universität Berlin/Charité; Center for Health Economics Research Hannover (CHERH), Leibniz University Hannover/Hannover Medical School; CINCH – Health Economics Research Center, University of Duisburg-Essen; Interdisciplinary Center for Health Technology Assessment and Public Health

(IZPH), Friedrich-Alexander-Universität Erlangen-Nürnberg; and Munich Center for Health Economics and Policy (M-CHEP).

These centers provide substantial geographical and institutional coverage of German academic health economics and HTA. HCHE describes itself as one of Europe's largest health-economics research institutions and explicitly undertakes cost-effectiveness, cost-utility, decision-tree, Markov and probabilistic modelling. BerlinHECOR combines health-economic research at TU Berlin and Charité and explicitly includes cost-effectiveness analysis and HTA. CHERH identifies HTA, health-economic evaluation of technologies, preferences and methodological development among its principal research areas. IZPH is explicitly an interdisciplinary university center for HTA and Public Health. CINCH is a major university health-economics research center, while M-CHEP brings together 15 chairs and professorships across several Bavarian universities.

Topic results are presented in Table 1 for representational measurement.

TABLE 1: REPRESENTATIONAL MEASUREMENT

Topic	Explicitly recognized	German 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	—

Topic	Explicitly recognized	German program evidence
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 the scientific foundation of the publicly available German academic HTA and health-economics program-content knowledge base reviewed.

The finding is particularly noteworthy because the six-center knowledge base is neither small nor methodologically unsophisticated. HCHE alone reports more than 90 economists and physicians and explicitly emphasizes methodological expertise in economic evaluation. Its research program includes cost-effectiveness, cost-utility and cost-benefit analysis, decision trees, Markov processes, Monte Carlo and probabilistic simulation. Hannover explicitly identifies methodological development in health-economic evaluation and HTA, while Erlangen-Nürnberg has maintained a university center explicitly devoted to HTA since 2001.

The result therefore does not indicate an absence of quantitative sophistication. It indicates that, within the public knowledge base reviewed, the scientific framework determining whether numerical representations qualify as measures, which scale has been achieved, and which arithmetic operations that scale permits is not explicitly established before contemporary analytical methods are applied.

Topic results for contemporary HTA are presented in Table 2.

TABLE 2: CONTEMPORARY HEALTH ECONOMICS AND HTA FRAMEWORK

Topic	Explicitly represented	German program evidence
Health economics	Yes	HCHE, BerlinHECOR, CHERH, CINCH and M-CHEP explicitly identify health economics as central research activity.
Health technology assessment	Yes	CHERH, Berlin/TU and IZPH explicitly identify HTA.

Topic	Explicitly represented	German program evidence
Economic evaluation	Yes	HCHE and CHERH explicitly undertake health-economic evaluation.
Cost-effectiveness analysis	Yes	HCHE, TU Berlin and CHERH.
Cost-utility analysis	Yes	HCHE explicitly identifies cost-utility analysis; Hannover materials report incremental cost/QALY analysis.
Pharmacoeconomics	Yes	HCHE publications include pharmacoeconomics/outcomes research; Hannover identifies pharmacoeconomics activity.
Utilities and preference-based outcomes	Yes	HCHE identifies preference measurement; CHERH explicitly studies preferences.
Quality-adjusted life-years (QALYs)	Yes	HCHE explicitly models QALYs; Hannover reports QALY-based economic evaluation.
Incremental cost-effectiveness ratios (ICERs)	Yes	Hannover publicly reports incremental cost per QALY; HCHE reports ICER/QALY economic evaluation.
Measurement and valuation of health outcomes / patient-reported outcomes	Yes	HCHE includes quality-of-life and PRO research; TU Berlin explicitly uses patient-reported outcomes.
Decision analysis	Yes	HCHE explicitly identifies decision analysis supported by economic modelling.
Decision-tree modelling	Yes	HCHE explicitly identifies decision trees in health-economic evaluation.
Markov modelling	Yes	HCHE explicitly uses Markov processes; Berlin identifies Markov-chain modelling and microsimulation in student research.
Simulation and microsimulation modelling	Yes	HCHE reports Monte Carlo and microsimulation economic evaluation; TU Berlin explicitly lists microsimulation.
Probabilistic sensitivity and uncertainty analysis	Yes	HCHE explicitly uses probabilistic simulation and publishes deterministic sensitivity analysis.
Value-of-information analysis	**No explicit evidence identified**	No sufficiently explicit representation identified in the reviewed public six-center material.
Budget impact analysis	Yes	HCHE explicitly discusses budget impact and includes published budget-impact/Markov modelling.
Health care priority setting and resource allocation	Yes	HCHE explicitly frames evaluation around scarce resources and decision making; IZPH addresses

Topic	Explicitly represented	German program evidence
		policy advice and health-system resource constraints.
Value-for-money / value assessment	Yes	HCHE explicitly presents cost-effectiveness analysis as determining value for money.
Policy, reimbursement and decision use of economic evaluation	Yes	HCHE explicitly links evidence to policy and decision makers; BerlinHECOR is designed to provide evidence for health policy; IZPH provides scientific policy advice and identifies German statutory HTA institutions.

Result: 19/20 contemporary health-economics and HTA topics explicitly represented in the publicly available German academic program-content knowledge base reviewed.

The breadth of this representation is substantial. HCHE publicly describes cost-effectiveness, cost-utility, QALYs, long-term modelling, budget impact, decision trees, Markov models, probabilistic simulation and value-for-money assessment. TU Berlin explicitly supports model-based economic evaluation, cost-effectiveness research, Markov chains and microsimulation. Hannover explicitly identifies health-economic evaluation of health technologies, preferences, HTA and methodological development as core activities.

GERMAN PROGRAM-CONTENT ASSESSMENT

The German program-content result presents a stark picture of **program-content inversion**. Across six major university-based health-economics and HTA environments, none of the seventeen topics defining the scientific foundations of representational measurement was explicitly identified as the organizing basis for quantitative claims, while nineteen of the twenty topics defining contemporary health economics and legacy HTA were clearly represented.

The resulting profile of **0/17 versus 19/20** cannot reasonably be dismissed as a matter of emphasis, terminology or curricular preference. It represents a reversal of the scientific sequence. The German academic knowledge base is rich in economic evaluation, cost-effectiveness analysis, QALYs, preference measurement, modelling, simulation, policy analysis and HTA methodology. What it does not publicly establish is the logically prior framework that determines whether the numbers entering those analyses qualify as measures and whether the arithmetic subsequently performed upon them is admissible. That distinction is decisive.

A quantitative discipline cannot begin with arithmetic. It must begin with the attribute. The attribute must be defined and unidimensional. Its empirical structure must satisfy the relevant axioms of representational measurement. The resulting numerical representation must then be assigned to the correct scale of measurement, and only after that can the admissible transformations and arithmetic operations be determined.

The German program-content knowledge base, as publicly represented, largely begins downstream of this sequence.

Students and researchers are exposed to methods requiring addition, subtraction, multiplication, division, aggregation and probabilistic modelling, yet the public knowledge base does not first establish the measurement conditions under which these operations are legitimate. There is no explicit programmatic representation of measurement preceding arithmetic, ratio measurement as a prerequisite for multiplication and division, dimensional homogeneity, admissible transformations, specific objectivity, Rasch measurement for latent attributes or the distinction between the lawful measurement pathways required for manifest and latent therapy-impact attributes.

This is not a trivial omission. It goes directly to the legitimacy of the quantitative framework being taught and applied.

The most consequential failure concerns ratio measurement. Much of contemporary HTA depends upon multiplication, division and proportional interpretation. Those operations cannot be justified simply because a model requires them or because software can execute them. Appropriate ratio properties must first be demonstrated. A numerical zero, a decimal bounded between zero and one, or the mathematical possibility of forming a quotient does not establish ratio measurement.

Yet the publicly represented German knowledge base contains extensive evidence of precisely those analytical methods whose legitimacy depends on ratio properties while providing no explicit evidence that ratio measurement is taught as the prerequisite for those operations.

That is program-content inversion in its clearest form.

The problem becomes especially visible with the QALY. The conventional construction requires a utility score to operate as a proportional adjustment to ratio-scaled time. For that operation to be lawful, the utility value must possess the appropriate measurement structure. The German knowledge base clearly represents QALYs, cost-utility analysis, ICERs and related modelling, but the representational-measurement topics necessary to establish whether the utility score can lawfully perform that proportional role are absent from the program-content profile.

The same issue applies to latent attributes. German research environments clearly engage with preferences, patient-reported outcomes, quality of life and related health-status constructs. Yet the knowledge base does not explicitly establish the distinction between observing responses and measuring possession of a latent attribute. There is no corresponding representation of Rasch measurement as the necessary framework for constructing invariant quantitative measures of defined latent attributes, nor of person-item conjoint measurement, specific objectivity or the Rasch logit ratio structure.

The result is a particularly troubling asymmetry: the academic system teaches and researches the outputs of legacy HTA without publicly establishing the measurement theory required to determine whether those outputs are legitimate quantitative objects.

The strength of the German case lies partly in the institutions included. This is not an interrogation of marginal programs or isolated departments. The composite knowledge base includes major university research centers in Hamburg, Berlin, Hannover, Duisburg-Essen, Erlangen-Nürnberg and Munich/Bavaria. These environments possess substantial expertise in health economics, HTA, economic evaluation, modelling, preferences, health policy and outcomes research. \The finding therefore cannot plausibly be attributed to lack of technical capability.

If anything, the result is more concerning precisely because these centers are sophisticated. Methodological sophistication has developed while the logically prior measurement foundation remains publicly absent.

That is an important distinction. A field can become increasingly sophisticated within an inherited set of assumptions without ever returning to test whether those assumptions were scientifically admissible in the first place. Indeed, sophistication can make reassessment more difficult. Once methods become embedded in courses, research programs, careers, journals, consultancy practice and policy processes, familiarity begins to substitute for proof.

Germany appears to illustrate this problem particularly clearly.

The 0/17 result also has implications for the intellectual independence of university research. Universities should not merely reproduce the analytical requirements of national HTA and reimbursement systems. Their scientific responsibility is broader. They should provide the environment in which established methods are subjected to the standards most capable of falsifying them.

If representational measurement and the scales of measurement are absent from the public program-content knowledge base, then one of the principal scientific frameworks capable of challenging legacy HTA is itself missing from the educational and research environment.

The result is a closed epistemic system. Within such a system, the questions asked are framed by the existing paradigm. Researchers investigate utility algorithms, model structures, uncertainty, preferences, QALYs and economic evaluation because these are established objects of HTA inquiry. What is largely absent is the prior challenge: What is the attribute? Is it unidimensional? What scale has been achieved? Are ratios meaningful? Are the proposed transformations admissible? Is the arithmetic lawful?

When those questions are missing, the system can refine its methods indefinitely without ever confronting the possibility that the quantitative foundations themselves are defective.

The near-complete 19/20 representation of contemporary HTA makes this contrast even sharper. The German knowledge base does not appear incomplete in any conventional sense. It contains almost every topic that a contemporary HTA or health-economics program would be expected to contain. Only value-of-information analysis was not explicitly identified in the public material reviewed.

That is precisely the problem. The missing material is not peripheral. It is the framework that should determine whether the other nineteen topics are quantitatively defensible. A 0/17 versus 19/20 profile therefore cannot be interpreted as “measurement theory receives less attention than modelling.” It indicates something more fundamental: the entire architecture of contemporary HTA is publicly represented while the scientific standards capable of determining whether that architecture is measurement-theoretically admissible are not.

The educational implications are substantial. Students entering these programs may become highly proficient in economic evaluation, QALY construction, decision modelling, ICER interpretation, preference analysis and simulation. They may graduate able to reproduce the professional methods expected by agencies, consultants and manufacturers.

But technical proficiency is not the same as scientific understanding. If students are not taught the measurement requirements that precede these operations, they are not equipped to determine whether the methods they are learning are lawful. They are trained to reproduce an analytical framework without necessarily possessing the tools required to challenge its quantitative foundations.

That raises an academic responsibility. Faculty may reasonably argue that they themselves were educated within the same international HTA framework and were never exposed to representational measurement, scale theory or the specific constraints of ratio measurement. That may explain how the omission occurred. It cannot justify its continuation once the problem has been identified.

Once the measurement critique is explicit, another generation of students cannot simply be taught QALYs, ICERs and reference-case modelling as though their quantitative legitimacy had never been challenged. At minimum, students should be given the representational-measurement principles required to test those methods themselves. That means more than adding a lecture entitled “measurement theory.”

Once students understand that measurement precedes arithmetic, that scale properties determine permissible operations, that multiplication and division require appropriate ratio properties, and that multidimensional preference scores cannot acquire unidimensional ratio status merely because an algorithm produces a single number, the implications spread throughout the remainder of the HTA curriculum.

Measurement cannot be taught seriously and then quarantined from the methods it calls into question.

The German finding also has broader European significance. Germany is one of the largest and most methodologically developed academic health-economics environments in Europe. If a six-center German composite knowledge base demonstrates 0/17 representational measurement against 19/20 contemporary HTA, it becomes increasingly difficult to explain the absence of lawful measurement as a peculiarity of one agency, one university or one national tradition.

Instead, the result is consistent with the possibility that European academic HTA has inherited a common closed epistemic architecture: highly developed methods for manipulating numerical constructs combined with little public representation of the measurement standards required to establish that those constructs are measures of the necessary kind.

The appropriate response is not to add more sophistication to the legacy framework. It is to reverse the sequence. Quantitative therapy-impact assessment should begin with a defined unidimensional attribute, establish the relevant axiomatic requirements, determine whether the attribute is manifest or latent, construct the appropriate linear ratio or Rasch logit measurement structure, and only then undertake arithmetic admissible for the scale achieved. On the evidence of this program-content interrogation, that scientific sequence is not currently visible as the organizing foundation of the German academic HTA knowledge base.

The implications extend beyond the responsibility of individual faculty members. These six research environments operate within universities that confer degrees, supervise doctoral research and represent the education they provide as meeting the standards of scientific scholarship. The 0/17 versus 19/20 finding therefore raises an institutional question. What responsibility does a university have to students when the quantitative methods it teaches are comprehensively represented while the scientific measurement principles required to determine whether their arithmetic is admissible are absent from the publicly represented program-content knowledge base?

The answer cannot simply be that utilities, QALYs, ICERs and reference-case modelling constitute accepted professional practice. A university has a responsibility that extends beyond reproducing prevailing practice. Its responsibility is to provide students with the intellectual means to determine whether prevailing practice is scientifically defensible. Students should not merely learn how to construct a QALY or calculate an ICER; they should be capable of asking whether the quantities involved possess the measurement properties required for those operations in the first place.

This creates what may reasonably be described as an academic duty of care to students. That is not intended here as a claim concerning a particular German legal obligation. It is a statement about the responsibilities inherent in scientific education. Students commit substantial time to graduate and doctoral training on the reasonable expectation that the university will expose them not only to established methods but also to the scientific standards against which those methods can be challenged. A curriculum that teaches the arithmetic of legacy HTA while omitting the measurement principles capable of demonstrating that the arithmetic may be inadmissible fails that expectation.

Historical ignorance provides only a temporary defense. Faculty may themselves have been educated within precisely the same epistemic environment. The German 0/17 finding helps explain how this could occur: representational measurement was simply not part of the publicly represented knowledge framework through which successive generations were trained. That explains the inheritance; it does not justify its continued transmission**.** Once the measurement failure has been identified and communicated, the position changes. Another generation of students cannot simply be taught the same 19/20 legacy framework as though the missing 17 measurement requirements had never been exposed.

Universities therefore face a consequential choice. They can subject the established HTA framework to the requirements of representational measurement and allow faculty and students to determine whether its central quantitative claims survive that examination. Or they can continue to reproduce the inherited framework without the scientific knowledge required to challenge it. The first is normal academic inquiry. The second would convert an inherited epistemic failure into an institutional decision to perpetuate it.

The conclusion is therefore difficult to avoid: Germany possesses a sophisticated academic infrastructure for legacy HTA, but not, on the publicly represented program-content evidence reviewed, an equivalent infrastructure for establishing whether the quantitative operations of legacy HTA satisfy the requirements of lawful measurement. That is not a minor curricular omission. It is a foundational scientific problem.

CONCLUSION: THE CHALLENGE OF TRANSFORMATION

Now that the measurement problem has been exposed, the challenge facing German 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 German program-content findings, together with the accompanying evidence of measurement and program-content inversion, identify a foundational problem: the central analytical framework of contemporary HTA depends upon arithmetic operations whose admissibility has not first been established under the requirements of representational measurement and the scales of measurement. The measurement cat is now out of the contemporary HTA litter box. It cannot simply be put back**.**

There is therefore no scientific basis for defending the status quo simply by appealing to established German or international practice. The relevant question is no longer whether utilities, QALYs, cost-effectiveness models and related methods have proved useful, achieved widespread professional acceptance or been employed for decades in research and healthcare decision-making. Longevity, institutional acceptance and methodological sophistication do not establish quantitative validity. Once the requirements governing admissible arithmetic are applied, the problem becomes transparent. Multiplication and division require the appropriate ratio properties. Arithmetic operations are constrained by scale properties. Dimensional homogeneity must be maintained. Numerical assignment cannot substitute for measurement. Where these requirements are violated, the resulting arithmetic is inadmissible. No degree of statistical sophistication, simulation modelling, uncertainty analysis or methodological refinement can repair a measurement failure that occurs before the arithmetic begins.

The challenge for Germany is therefore one of transformation: how should the German academic HTA knowledge base be reconstructed to satisfy the requirements of lawful measurement?

German universities and research centers occupy an important position within European health economics, HTA, outcomes research, health-services research and healthcare policy. The six environments included in the present interrogation—Hamburg, Berlin, Hannover, Duisburg-Essen, Erlangen-Nürnberg and Munich/Bavaria—demonstrate the geographical and institutional breadth of this infrastructure. Through graduate education, doctoral supervision, methodological research, professional training and collaborations with healthcare institutions, government bodies and industry, these centers contribute to the analytical framework employed within Germany and more widely across European HTA.

The 0/17 versus 19/20 program-content finding therefore provides an opportunity to reconsider not simply what is included in German academic HTA, but the scientific sequence in which that knowledge is organized. The imbalance is extraordinary. Almost the complete apparatus of contemporary HTA is publicly represented, while none of the seventeen topics defining representational measurement is explicitly established as its scientific foundation. Measurement must now become the foundation upon which subsequent quantitative methods are built rather than an omitted prerequisite.

The starting point is straightforward. Representational measurement must become the organizing scientific principle for quantitative therapy evaluation rather than an optional supplement to the existing HTA curriculum**.** Students and researchers must first learn to identify and define the target attribute, establish unidimensionality, distinguish manifest from latent attributes, determine the appropriate measurement pathway, establish the scale achieved and identify the arithmetic operations admissible for that scale. They must understand why multiplication and division impose ratio requirements, why dimensional homogeneity matters, and why the assignment of numbers cannot manufacture measurement properties that have not been demonstrated empirically.

For manifest attributes, the appropriate pathway is linear ratio measurement**.** For latent attributes, the alternative is Rasch logit measurement, with its requirements for conjoint measurement, invariance and specific objectivity. These two measurement pathways provide the foundation for constructing attribute-specific therapy-impact claims that can be empirically evaluated, replicated and potentially falsified. Only after these measurement requirements have been satisfied should arithmetic, statistical analysis, economic evaluation or other quantitative procedures be undertaken.

This transformation does not abandon HTA. It rescues therapy evaluation from a legacy analytical framework and places it within the accepted standards of normal quantitative science.

German universities and research centers therefore face a clear choice. They can continue reproducing an inherited international framework in which utilities, QALYs, ICERs and modelled reference-case claims are accepted without first demonstrating that their constituent quantities support the arithmetic required of them. Or they can lead the reconstruction of HTA around defined attributes, lawful measurement, admissible arithmetic and empirically evaluable claims.

The German situation is particularly important because the country does not exist in methodological isolation. German academic researchers contribute to national decision processes, European methodological debates and the wider development of health-economic research. The scientific standards governing measurement cannot change according to institutional setting. The same requirements must apply whether a quantitative claim originates in a German university, an industry submission, an HTA assessment, a healthcare evaluation or a European collaborative framework. Institutional authority cannot confer measurement properties upon numbers that do not possess them**.**

Faculty necessarily have the leading educational role in this transition. This does not imply that German investigators have knowingly disregarded representational measurement. A more plausible explanation is historical and international. Most faculty were themselves educated within the contemporary health-economics and HTA paradigm. They learned the methods transmitted through universities, textbooks, journals, professional organizations, methodological guidelines and established research practice. If representational measurement and the scales of measurement were absent from that education, there was little reason for investigators subsequently to recognize that the arithmetic they had inherited rested upon unexamined measurement assumptions.

The German 0/17 finding demonstrates how complete that omission remains within the publicly represented program-content knowledge base. It explains how the legacy could have been transmitted from one generation of researchers to another. It cannot justify transmitting it again.

Once the measurement problem has been explicitly identified, faculty and universities acquire a different responsibility. Students entering German health economics and HTA programs should not simply be trained to reproduce methods because those methods are professionally established. They should be given the scientific knowledge necessary to determine whether those methods are quantitatively admissible. Faculty who believe that utilities support multiplication by time, that QALYs constitute legitimate quantitative measures, or that cost-per-QALY ICERs possess the properties attributed to them should be free to defend those propositions. But students must equally be provided with the principles of representational measurement and scale theory necessary to evaluate whether those propositions can be sustained.

Transformation must therefore begin with faculty. German universities and research centers need to introduce the scientific knowledge and practical tools required for faculty themselves to reconsider the measurement foundations of what they research and teach. This cannot be accomplished merely by inserting a lecture on measurement into an otherwise unchanged curriculum. Once measurement precedes arithmetic, the implications extend throughout economic evaluation, utility measurement, QALY construction, cost-effectiveness analysis, outcomes measurement and decision modelling.

The **0/17 versus 19/20** finding should consequently be treated not as a criticism of German quantitative expertise but as a warning about its scientific foundations. Germany has developed an impressive infrastructure for contemporary health economics and HTA. What is now required is an equally serious commitment to establishing whether the numbers manipulated within that infrastructure are measures and whether the arithmetic performed upon them is lawful.

The opportunity is therefore considerable. Germany can continue as a sophisticated participant in an inherited legacy HTA paradigm, or its universities can help lead the transition to a post-legacy framework in which measurement precedes arithmetic, ratio properties precede multiplication and division, and empirically evaluable claims replace assumption-driven numerical storytelling.

That is the reconstruction now required.

It is precisely this gap that the Maimon Research nine-unit transformation program is intended to address [4]. 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.

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.

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