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MODEL INTERROGATION**



**REPRESENTATIONAL MEASUREMENT FAILURE IN
HEALTH TECHNOLOGY ASSESSMENT**

**EUROPEAN UNION: THE ENDORSEMENT OF
CURRICULUM INVERSION**

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ABSTRACT

A series of large language model (LLM) interrogations undertaken across Europe and other major HTA jurisdictions has consistently demonstrated the pervasive presence of measurement inversion within contemporary health technology assessment (HTA). Previous investigations of the European Union HTA knowledge base concluded that the scientific principles required for lawful quantitative measurement are either absent or weakly represented, while utilities, QALYs, comparative effectiveness analysis, economic evaluation, and related methodological constructs are presented as though they provide scientifically valid measures of therapy impact. These findings raise a fundamental question. How has this analytical framework been reproduced so consistently across successive generations of HTA practitioners?

The present study proposes that the answer lies in curriculum inversion. Every scientific discipline depends upon its educational framework not only to transmit accepted methods but also to communicate the scientific principles that determine whether those methods are valid. If the foundations of representational measurement are absent from the educational process, practitioners cannot reasonably be expected to recognize their significance in research, policy development, or reimbursement decision making. Curriculum inversion therefore provides the educational mechanism through which measurement inversion is sustained.

To examine this proposition, the European Union HTA curriculum knowledge base was interrogated using a series of canonical statements representing the accepted principles of representational measurement. These included specification of the target attribute, the principal scales of measurement, the axioms of representational measurement, unidimensionality, the distinction between manifest and latent attributes, the corresponding requirements for linear ratio and Rasch logit ratio measurement, and the requirement that therapy-impact claims be prospectively evaluable and capable of empirical falsification.

The interrogation demonstrates that these foundational scientific concepts receive little recognition within the European educational framework, while conventional HTA methodologies occupy the dominant educational position. The result is an educational environment in which methodological practice precedes measurement science. The paper concludes that curriculum inversion provides the principal mechanism through which measurement inversion is institutionalized across the European Union. Rather than introducing practitioners first to the scientific requirements governing lawful quantitative claims, the curriculum emphasizes established HTA methods whose measurement foundations remain unexamined. Restoring representational measurement to the center of HTA education is therefore an essential prerequisite for the reconstruction of European health technology assessment as a quantitative scientific discipline.

INTRODUCTION

A series of large language model (LLM) interrogations undertaken over the past year has demonstrated the pervasive nature of measurement inversion within contemporary health technology assessment (HTA). Across Australia, Canada, France, Germany, Spain, New Zealand, the United Kingdom, the United States, and numerous national HTA agencies, academic research centers, universities, professional organizations, and journals, a remarkably consistent pattern has emerged. The scientific concepts required for lawful quantitative measurement are either absent or receive only weak endorsement, while utilities, QALYs, cost-effectiveness analysis, and reference-case simulation models continue to be accepted as though they provide scientifically valid measures of therapy impact. A recent interrogation of the former EUnetHTA and the current European Union HTA knowledge base reached the same conclusion¹. Measurement inversion is therefore not confined to individual countries or institutions but extends to the European framework that increasingly shapes HTA practice across Member States.

If measurement inversion is so pervasive, an obvious question follows. How has this analytical framework been reproduced so consistently across successive generations of HTA practitioners? The most plausible explanation is curriculum inversion. Every scientific discipline depends upon its educational framework to transmit both its methods and its underlying scientific principles. If those principles are absent from the curriculum, practitioners cannot reasonably be expected to recognize their importance in subsequent research or policy. Curriculum inversion therefore provides the educational mechanism through which measurement inversion is sustained. Rather than introducing practitioners first to representational measurement, the nature of attributes, the distinction between manifest and latent variables, lawful ratio measurement, and the requirement that quantitative claims be prospectively evaluable and falsifiable, the educational emphasis is placed upon the application of established HTA methods. The present study therefore interrogates the European Union HTA curriculum knowledge base to determine whether the scientific foundations of quantitative measurement precede the teaching of utilities, QALYs, comparative effectiveness assessment, economic evaluation, and related methodological techniques. If they do not, then curriculum inversion provides the catalyst through which measurement inversion is continually propagated throughout the European Union.

The purpose of this interrogation is to determine whether that curriculum knowledge base introduces practitioners to the scientific foundations of representational measurement before introducing the methods of comparative effectiveness assessment, economic evaluation, utilities, QALYs, and reference-case modelling. If the concepts required for quantitative science are absent from this educational framework, then curriculum inversion provides the mechanism through which measurement inversion is propagated across the European Union. Rather than simply harmonizing HTA procedures, the European framework harmonizes the educational assumptions upon which those procedures rest. The consequence is that successive generations of HTA practitioners throughout Europe are trained within a common methodological framework without first being introduced to the accepted scientific principles governing lawful quantitative claims.

The interrogation reveals a consistent and unmistakable pattern of curriculum inversion within the curriculum knowledge base. Across the ten canonical statements, the scientific concepts that should form the intellectual foundation of health technology assessment receive uniformly weak

endorsement. Fundamental principles including specification of the target attribute, the principal scales of measurement, representational measurement, the requirement that measurement precede arithmetic, unidimensionality, the distinction between manifest and latent attributes, Rasch measurement for latent constructs, and the requirement that therapy-impact claims be falsifiable are either weakly represented or effectively absent. At the same time, the knowledge base places strong emphasis on the practical application of comparative effectiveness assessment, utilities, QALYs, cost-effectiveness analysis, economic evaluation, and decision modelling. The curriculum therefore teaches practitioners how to apply established HTA methods before equipping them with the scientific principles required to determine whether those methods can support lawful quantitative claims. In this respect, the findings closely parallel those of the companion paper on measurement inversion. There, the methodological framework was shown to endorse analytical methods that fail the axioms of representational measurement. Here, the educational knowledge base is shown to reproduce those same assumptions by transmitting methodological practice without first establishing its scientific foundations. Curriculum inversion thus emerges as the educational mechanism through which measurement inversion is institutionalized and perpetuated within the European Union.

CURRICULUM INVERSION

Curriculum inversion occurs when a curriculum teaches the application of quantitative methods while failing to teach the measurement principles that determine whether those methods are scientifically legitimate. In a scientifically coherent curriculum, measurement precedes arithmetic. Students first learn the nature of attributes, the requirements of representational measurement, the distinctions among nominal, ordinal, interval and ratio scales, and the conditions necessary for valid quantitative claims for manifest and the application of Rasch models for latent attributes^{ii iii}^{iv}. Only then are they introduced to the arithmetic, statistical and modelling procedures that depend upon those measurement properties. Curriculum inversion reverses this sequence. Students learn how to calculate, model and analyze before they learn how to determine whether the quantities entering those analyses are measures. Arithmetic becomes detached from measurement and numerical manipulation is treated as though it were equivalent to quantitative science.

The consequences are profound. A curriculum affected by inversion reproduces a professional culture in which measurement is assumed rather than demonstrated. Concepts such as unidimensionality, dimensional homogeneity, admissible arithmetic, manifest and latent attributes, ratio measurement and Rasch measurement either disappear entirely or are treated as peripheral concerns. Students become proficient in the techniques of economic evaluation, utility assessment, QALY construction and simulation modelling without acquiring the conceptual tools necessary to evaluate the legitimacy of those methods. The result is that the curriculum not only fails to identify measurement errors but actively reproduces them across successive generations of researchers, analysts and decision makers. Curriculum inversion therefore serves as the educational mechanism through which measurement inversion becomes institutionalized within a discipline. In HTA this serves to support administrative decisions for therapy pricing and access.

For this reason, curriculum assessment emerges as a critical component of HTA reconstruction. The objective is not simply to determine whether students are exposed to contemporary HTA methods. Rather, it is to determine whether they are exposed to the foundational concepts that

make the evaluation of those methods possible. A curriculum that emphasizes modelling, economic evaluation and decision analysis while neglecting measurement theory will inevitably reproduce the same conceptual limitations observed in current HTA practice.

The curriculum interrogations undertaken across Spanish HTA research centers provide compelling support for this interpretation. While there is evidence that students and researchers are introduced to outcomes assessment, target attributes and scientific claims, there is little evidence of systematic exposure to scales of measurement, the axioms of representational measurement, unidimensionality, latent attribute measurement or ratio measurement. The concepts most frequently absent from curriculum coverage are precisely those concepts most frequently absent from HTA practice. The relationship is unlikely to be coincidental.

The imperative of measurement inversion therefore extends beyond criticism of existing methods. It points directly to the need for educational reconstruction. If HTA is to move toward a framework based on lawful measurement, evaluable claims and empirical falsification, then curriculum reform must accompany methodological reform. The widespread and consistent pattern of measurement inversion revealed by the interrogations suggests that reconstruction cannot begin with policy guidance or analytical techniques alone. It must begin with the curriculum. Until students and researchers are introduced to the foundations of measurement science, the conditions that created measurement inversion will continue to be reproduced throughout the HTA community.

THE EUROPEAN UNION CURRICULUM KNOWLEDGE BASE

The European Union HTA curriculum knowledge base comprises the collective body of methodological, educational, implementation, and training material through which the European Union defines, communicates, and disseminates the principles and practice of health technology assessment (HTA) across its Member States. It is not a university curriculum in the conventional sense. Rather, it represents the educational infrastructure that supports the implementation of the EU HTA Regulation through the former EUnetHTA program, the current HTA Coordination Group, Joint Clinical Assessment guidance, methodological manuals, implementation documents, training workshops, webinars, technical reports, templates, and associated publications. Collectively, these resources define the analytical framework that national HTA agencies, manufacturers, academic institutions, consultants, and researchers are expected to understand and apply when undertaking HTA within the European Union.

The importance of this curriculum knowledge base extends well beyond administrative guidance. Its purpose is educational. It provides the conceptual framework through which successive generations of HTA practitioners learn how health technologies should be assessed, how evidence should be assembled, how comparative clinical assessments should be undertaken, and how submissions should be prepared for regulatory and reimbursement purposes. Although Member States retain responsibility for pricing and reimbursement decisions, the European framework establishes a common methodological language that increasingly shapes national HTA practice. In this respect, the EU HTA curriculum knowledge base performs the same educational function as a formal university curriculum by defining what constitutes accepted knowledge and accepted analytical practice.

The purpose of identifying this curriculum knowledge base is to distinguish between the practice of HTA and the educational processes through which that practice is reproduced. The broader European HTA knowledge base encompasses legislation, methodological guidance, Joint Clinical Assessments, scientific consultations, assessment reports, and technical documentation. Nested within this broader framework is the curriculum knowledge base, whose function is educational rather than regulatory. It determines the concepts, assumptions, methods, and analytical priorities presented to practitioners before they participate in HTA decision making. Consequently, it provides the principal mechanism through which the intellectual foundations of European HTA are transmitted across successive generations of professionals.

For the purposes of the present interrogation, the curriculum knowledge base is examined not to assess the quality of individual training programs but to determine whether the scientific foundations required for lawful quantitative measurement are embedded within the educational framework itself. The central question is whether practitioners are first introduced to representational measurement, the specification of target attributes, the distinction between nominal, ordinal, interval, and ratio scales, the requirement for unidimensionality, the distinction between manifest and latent attributes, the different forms of ratio measurement appropriate to each, and the principle that quantitative claims must be prospectively evaluable, independently replicable, and capable of falsification before they are introduced to comparative effectiveness assessment, utilities, QALYs, economic evaluation, and methodological guidance for HTA.

This distinction is critical because educational frameworks shape professional practice. If the scientific principles governing quantitative measurement are absent from the curriculum, practitioners cannot reasonably be expected to recognize their importance in subsequent policy or reimbursement decisions. Curriculum inversion therefore becomes the mechanism through which measurement inversion is institutionalized. The educational framework teaches accepted HTA methods while omitting the scientific standards necessary to determine whether those methods support lawful quantitative claims. The interrogation of the European Union HTA curriculum knowledge base is therefore directed toward identifying whether this educational omission exists at the European level and, if so, whether it provides the mechanism through which measurement inversion is propagated throughout the member states.

INTERROGATING THE EUROPEAN UNION CURRICULUM KNOWLEDGE BASE

The objective of large language model (LLM) curriculum interrogation differs from that of previous HTA knowledge-based practice assessments. Earlier interrogations focused on whether institutions recognized the requirements of representational measurement and the standards necessary for quantitative claims. Curriculum interrogation asks a different question. Are faculty, students and researchers exposed to the concepts necessary to understand and apply those standards? The focus shifts from methodological outputs to educational inputs. Rather than examining what faculty, students and researchers do, attention is directed to what they are taught and what they know.

The importance of this distinction should not be underestimated. Educational programs do not merely transmit technical skills. They define the conceptual framework through which future

practitioners understand evidence, measurement and scientific inquiry. Concepts that are absent from the curriculum are unlikely to emerge spontaneously in research practice. Equally, concepts that are emphasized repeatedly become part of the intellectual assumptions that shape subsequent analysis have never been systematically incorporated into HTA teaching and research training.

For this reason, the curriculum interrogation was designed around a series of canonical statements intended to identify the presence or absence of foundational measurement concepts. These statements were deliberately elementary. The purpose was not to assess advanced methodological knowledge but to determine whether faculty, students and researchers are likely to encounter the principles that underpin lawful quantitative claims. The resulting framework begins with the concept of an attribute as the object of measurement and proceeds through target attribute specification, scales of measurement, representational measurement, unidimensionality, manifest and latent attributes, ratio measurement and falsifiable claims. Together, these statements define the minimum intellectual foundations required for a measurement-based approach to therapy assessment in education.

These statements are:

- **An attribute is the specific outcome of interest in a therapy assessment.**
- **Every therapy assessment begins with specification of the target attribute.**
- **The principal scales of measurement (nominal, ordinal, interval and ratio) have different properties and support different forms of analysis.**
- **The measurement status of a target attribute must be established before quantitative claims can be advanced.**
- **The axioms of representational measurement underpin quantitative claims.**
- **Attributes must be demonstrated to be unidimensional before measurement is possible.**
- **A manifest attribute is directly observable and capable of supporting empirical observation.**
- **A latent attribute is not directly observable and requires a measurement model to estimate possession of the attribute.**
- **Manifest and latent attributes require different forms of ratio measurement.**
- **Therapy impact claims must be falsifiable.**

These ten statements form a logical sequence:

Attribute → Target Attribute → Scales of Measurement → Measurement Status → Representational Measurement → Unidimensionality → Manifest Attribute → Latent Attribute → Ratio Measurement → Falsifiable Claims

Together they define the minimum curriculum content required for a measurement-based approach to HTA and provide the framework for evaluating curriculum coverage in Canada HTA research centers.

The categorical probabilities reported in this assessment are intended as indicators of the extent to which a concept is represented within the curriculum knowledge base. They should not be

interpreted as precise statistical estimates but as measures of the likelihood that a student, researcher or professional exposed to that knowledge base would encounter, recognize and subsequently endorse the canonical statement. In practical terms, the probability reflects the visibility and prominence of a concept within the educational environment associated with a research center or policy agency.

A high probability indicates that the concept is well represented within curriculum materials, research outputs and educational activities and is therefore likely to be familiar to students and researchers. Conversely, a low probability suggests that the concept is absent, only weakly represented, or occupies a peripheral position within the curriculum knowledge base. Students exposed to such an environment would therefore be unlikely to recognize the concept as an important component of HTA education and practice.

The probabilities should be viewed comparatively rather than in isolation. Their principal value lies in identifying patterns of curriculum coverage across institutions and concepts. In particular, low probabilities associated with scales of measurement, representational measurement, unidimensionality and ratio measurement indicate that these topics are unlikely to form a substantial part of the educational experience of the average student. The resulting profile provides an indication of curriculum strengths, deficiencies and potential areas for reconstruction.

THE EUROPEAN UNION AND CURRICULUM INVERSION

The EUnetHTA / EU HTA curriculum knowledge base is not a university curriculum in the conventional sense. It is the collective body of methodological guidance, training material, procedural documents, implementation tools, core models, webinars, joint action outputs, and EU HTA Regulation support documents through which HTA practice is communicated to Member States, agencies, analysts, manufacturers, consultants, and researchers. The HTA Core Model was explicitly designed as a common framework for HTA, with an ontology, methodological guidance, and reporting structure across domains including effectiveness, safety, economic, organizational, patient, social, and legal aspects. EU HTA Regulation 2021/2282 now establishes a framework for joint clinical assessments at EU level, intended to support Member State HTA processes through scientific analysis of relative clinical effects.

The interrogation indicates a consistent pattern of curriculum inversion (Table 1). The concepts required to ground quantitative claims in representational measurement receive weak or negligible endorsement, while procedural, evidentiary, modelling, comparative assessment, and implementation concepts receive strong emphasis. This is exactly what would be expected if the European educational framework were designed to standardize HTA practice rather than to establish the measurement foundations required for lawful quantitative claims. EUnetHTA and the EU HTA framework teach practitioners how to undertake assessment; they do not first teach the scientific constraints that determine whether the quantities entering those assessments are measures.

The first two statements concern the attribute. The proposition that an attribute is the specific outcome of interest in a therapy assessment receives weak endorsement, while the proposition that every therapy assessment begins with specification of the target attribute receives very weak

endorsement. EUnetHTA materials organize assessment around domains, PICO, endpoints, comparative effectiveness, safety, and reporting structures. These may be useful administratively, but they do not establish the attribute as the foundational object of measurement. The curriculum begins with assessment architecture rather than with the scientific question: what attribute is being measured?

TABLE 1: CURRICULUM CONTENT ENDORSEMENT: SPANISH NATIONAL KNOWLEDGE BASE

CANONICAL STATEMENT	CATEGORICAL PROBABILITY	NORMALIZED LOGIT
An attribute is the specific outcome of interest in a therapy assessment	0.20	-1.50
Every therapy assessment begins with specification of the target attribute	0.10	-2.00
The principal scales of measurement (nominal, ordinal, interval and ratio) have different properties and support different forms of analysis	0.15	-1.75
The measurement status of a target attribute must be established before quantitative claims can be advanced	0.10	-2.00
The axioms of representational measurement underpin quantitative claims	0.05	-2.50
Attributes must be demonstrated to be unidimensional before measurement is possible	0.10	-2.00
A manifest attribute is directly observable and capable of supporting empirical observation	0.25	-1.25
A latent attribute is not directly observable and requires a measurement model to estimate possession of the attribute	0.10	-2.00
Manifest and latent attributes require different forms of ratio measurement	0.05	-2.50
Therapy impact claims must be falsifiable	0.15	-1.75

The third and fourth statements concern scales of measurement and the requirement that measurement status precede quantitative claims. These receive weak endorsement. The EU HTA curriculum knowledge base does not appear to require students, agency staff, or practitioners to distinguish nominal, ordinal, interval, and ratio scales before applying comparative or quantitative methods. Nor does it require the measurement status of a target attribute to be established before quantitative claims are advanced. This is the central educational failure. Practitioners are trained into evidence assessment, relative effectiveness, modelling expectations, and structured reporting before they are trained in the scale properties that determine whether arithmetic is admissible.

The fifth statement, that the axioms of representational measurement underpin quantitative claims, receives the lowest endorsement. This is the decisive finding. The EUnetHTA / EU HTA educational framework provides extensive guidance on how to conduct and report assessment, but not on whether the numerical objects used in assessment satisfy the axioms of measurement.

Guidance to assist HTA “doers” has included procedure manuals for applying the HTA Core Model and rapid relative effectiveness assessment models, but procedural guidance is not equivalent to measurement science. Standardizing assessment practice across Europe does not establish that the quantities being assessed are lawful measures.

The sixth statement, concerning unidimensionality, also receives very weak endorsement. This omission is important because European HTA routinely incorporates multidimensional concepts: health-related quality of life, patient experience, social consequences, organizational impact, and broader value domains. Without unidimensionality, measurement cannot be claimed. Yet the educational framework does not appear to teach unidimensionality as a prior requirement before numerical scores or composite constructs are treated as quantitative evidence.

The seventh statement, concerning manifest attributes, receives the strongest probability, but only modestly. Observable outcomes such as mortality, morbidity, adverse events, hospitalizations, and clinical endpoints are central to EU HTA. However, these are usually treated as endpoints within an assessment framework rather than as manifest attributes requiring linear ratio measurement. The concept of observation is present; the concept of measurement remains weak.

The eighth and ninth statements expose the deepest curriculum failure. Latent attributes are not directly observable and require a measurement model to estimate possession of the attribute, yet this proposition receives very weak endorsement. The distinction between manifest and latent attributes requiring different forms of ratio measurement receives the lowest endorsement. EUnetHTA / EU HTA does not appear to teach that manifest attributes require linear ratio measures while latent attributes require Rasch logit ratio measures. As a consequence, patient-reported outcomes, preference scores, quality-of-life indices, and utility values may be introduced as acceptable HTA inputs without first confronting the measurement problem they present.

The tenth statement, that therapy-impact claims must be falsifiable, also receives weak endorsement. EU HTA is framed around joint clinical assessment, relative effects, structured evidence submission, and support for Member State processes. This is administrative and evidentiary standardization, not a falsification framework. A falsifiable therapy-impact claim would require prospective specification, valid measurement, defined comparator, timeframe, success criteria, replication, and explicit conditions under which the claim is rejected. That is not the organizing principle of the EU curriculum knowledge base.

Taken together, the interrogation demonstrates that EUnetHTA / EU HTA institutionalizes curriculum inversion at the European level. The framework teaches assessment procedures before measurement foundations. It teaches standardization before admissibility. It teaches evidence submission before attribute specification. It teaches relative effectiveness before lawful measurement. It teaches harmonized HTA practice before the axioms of representational measurement that determine whether quantitative claims can be made at all.

This finding is more serious than curriculum inversion in a single country. EUnetHTA and the EU HTA Regulation are designed to harmonize HTA practice across Member States. If the European curriculum knowledge base omits representational measurement, then that omission is not merely local; it is exported. The EU does not simply fail to correct measurement inversion in Member

States. It risks standardizing the educational framework through which measurement inversion is reproduced across Europe.

The conclusion is direct. EUnetHTA / EU HTA has provided Europe with a common administrative and methodological language for HTA. It has not provided a measurement-based curriculum for quantitative science. The result is curriculum inversion at European scale: practitioners are taught how to apply accepted HTA methods without first being taught the scientific standards required to determine whether those methods can support lawful claims regarding therapy impact.

MANIFEST AND LATENT ATTRIBUTES

A central finding of the S curriculum interrogation is the absence of any explicit framework distinguishing manifest from latent attributes and the corresponding measurement requirements that follow from this distinction. This omission is important because the manifest-latent distinction is one of the foundational concepts of representational measurement. Without it, there is no coherent basis for determining how therapy outcomes should be assessed, what constitutes an admissible measure, or whether a quantitative claim can be justified.

Manifest attributes are directly observable. Their existence and magnitude can be established through empirical observation without the need for an intervening measurement model. Examples include survival time, hospital admissions, emergency department visits, medication possession, treatment discontinuation, adverse events, laboratory values, and health care resource utilization. These attributes are observable phenomena that can be counted, timed, or otherwise recorded directly. When properly specified, manifest attributes can support linear ratio measures characterized by a meaningful zero and admissible arithmetic operations. The measurement challenge is therefore relatively straightforward: define the attribute, establish the unit of observation, specify the observation period, and evaluate the resulting claim empirically.

Latent attributes present a fundamentally different problem. Attributes such as pain, fatigue, anxiety, depression, functional status, quality of life, treatment satisfaction, confidence, and need fulfilment are not directly observable. They cannot be counted or measured in the same manner as hospital admissions or survival time. Their existence must be inferred from observable indicators, typically responses to questionnaire items or other structured observations. Consequently, latent attributes require a measurement model capable of estimating possession of the attribute that recognizes the axioms of representational measurement.

The significance of this distinction is that manifest and latent attributes cannot be treated identically. They require different measurement strategies and different forms of ratio measurement. Manifest attributes support linear ratio scales. Latent attributes require a Rasch-derived logit ratio scale capable of demonstrating unidimensionality, invariance, and lawful measurement. This distinction is fundamental because it determines whether a quantitative claim regarding therapy impact is scientifically defensible.

The interrogation suggests that the European Union does not recognize this distinction as an organizing principle for HTA education. Instead, outcomes appear to be grouped together under

broad categories such as patient-reported outcomes, quality of life, clinical effectiveness, utility assessment, and value measurement. While these categories may be useful descriptively, they do not distinguish between attributes that are directly observable and those that require a measurement model. As a result, the measurement requirements associated with each type of attribute remain obscured.

This omission has important consequences. Once the distinction between manifest and latent attributes disappears, it becomes possible to treat all numerical outputs as though they possess equivalent measurement properties. Utility scores, composite indices, preference weights, symptom scales, and observational counts can then be incorporated into the same analytical framework despite representing fundamentally different forms of information. The result is a loss of measurement discipline. Numerical constructions are accepted because they generate numbers rather than because they satisfy the requirements for measurement.

The implications for HTA are substantial. Assessments combine manifest and latent outcomes within the same evaluative framework. Clinical events, resource utilization, patient preferences, quality-of-life scores, and economic projections are brought together through utility algorithms and cost-effectiveness models. Yet if the measurement properties of these outcomes have not been established, the resulting quantitative claims lack a defensible scientific foundation. The problem is not the use of multiple outcomes. The problem is the failure to recognize that different outcomes require different measurement approaches.

The absence of the manifest-latent distinction also helps explain the near absence of Rasch measurement within the curriculum. If latent attributes are not explicitly identified as requiring a measurement model, then there is no perceived need to introduce the one framework capable of constructing a quantitative measure of latent attribute possession. Instead, ordinal responses are transformed into scores, utilities, or indices and subsequently treated as though measurement has already been achieved. The measurement problem is effectively bypassed.

From the perspective of curriculum design, this represents a classic example of curriculum inversion. Students are introduced to utility instruments, quality-of-life measures, patient-reported outcomes, and economic evaluation techniques without first being taught the distinction between manifest and latent attributes. Consequently, they are never encouraged to ask the critical question: what type of attribute is being assessed, and what form of measurement is required to support a quantitative claim regarding that attribute?

A scientifically defensible HTA curriculum would begin with precisely this question. Before discussing utilities, QALYs, preference weights, or simulation models, students would first identify the target attribute. They would determine whether it is manifest or latent. They would then establish the appropriate form of ratio measurement required for that attribute. Only after these steps had been completed would quantitative claims be considered.

The interrogation therefore suggests that does not provide an explicit educational framework for distinguishing manifest from latent attributes or for understanding the central role of ratio measurement in therapy assessment. This omission is not a minor curricular gap. It removes one of the essential conceptual foundations required for measurement-based HTA. Until the distinction

between manifest and latent attributes becomes a core element of HTA education, the discipline will continue to treat fundamentally different forms of evidence as though they possess equivalent measurement status, perpetuating the broader pattern of measurement and curriculum inversion identified throughout the HTA knowledge base.

THE ABSENCE OF RASCH

One of the most striking findings from the interrogation of HAS is not simply the absence of representational measurement but the near-complete absence of Rasch measurement and its role in the assessment of latent attributes. This omission is important because it reveals a fundamental weakness in the educational and methodological framework that underpins contemporary health technology assessment. The issue is not whether the term "Rasch" appears occasionally in conference abstracts, research presentations, or specialist publications. The issue is whether Rasch measurement is recognized as the essential framework for constructing quantitative measures of latent attributes. The interrogation says that it is not.

This omission is particularly significant because HAS places considerable emphasis on patient-centered outcomes, quality of life, symptom burden, functional status, treatment satisfaction, patient experience, and similar constructs. These are all latent attributes. They cannot be directly observed in the same way that hospital admissions, survival time, medication possession, or adverse events can be observed. Latent attributes exist, but they are not directly measurable through counting, timing, or simple observation. Their measurement requires a formal measurement model.

This is where Rasch occupies a unique position. Rasch is not simply another psychometric technique competing with item response theory, PROMIS, utility instruments, or preference-based scoring systems. Rasch addresses a fundamentally different question. It asks whether ordinal observations can be transformed into a quantitative measure of possession of a latent attribute. In doing so, it provides the only established framework capable of demonstrating whether the conditions required for measurement have been satisfied.

The distinction is critical. Patient-reported outcomes typically begin with ordinal responses to questionnaire items. Patients may indicate levels of pain, fatigue, anxiety, mobility limitations, or functional difficulties. These responses are rankings. They provide information about order but not quantity. Arithmetic performed directly on ordinal observations cannot create measurement. Summing scores, averaging responses, applying weights, or generating utility algorithms does not transform ordinal observations into quantitative measures. Numerical manipulation is not measurement.

The Rasch model was developed in the 1950s precisely to address this problem. Through the conjoint calibration of persons and items, Rasch analysis estimates the location of respondents on a latent continuum while simultaneously testing whether the data satisfy the requirements for measurement. Unidimensionality, invariance, item fit, category functioning, local independence, and differential item functioning are not optional refinements. They are the conditions that must be satisfied before claims regarding possession of a latent attribute can be advanced. Rasch

therefore provides both a measurement model and a set of empirical tests for determining whether measurement is possible.

The interrogation suggests that this perspective is absent from the HAS educational framework. Students and practitioners are introduced to patient-reported outcomes, utility instruments, preference weights, quality-of-life measures, and value assessment methodologies without first confronting the measurement problem those constructs are intended to address. The curriculum appears to move directly from patient responses to scoring systems and economic evaluation. The intermediate step, demonstrating that a latent attribute has been measured, is effectively bypassed.

This omission has important consequences. Without Rasch measurement, latent attributes remain latent. Utility scores, composite indices, and preference-weighted algorithms may generate numerical outputs, but they do not establish that the underlying construct has been measured. The existence of a number should not be confused with the existence of a measure. Yet much of contemporary HTA proceeds as though this distinction does not matter.

The result is that students are trained to accept numerical representations of quality of life, patient benefit, symptom burden, and treatment impact without being introduced to the framework required to determine whether those representations possess measurement properties. They learn how utilities are generated, how QALYs are constructed, and how economic models are populated, but they are not taught how latent attributes can be measured. The educational sequence is therefore inverted. Numerical outputs are presented before the conditions required to justify those outputs.

The absence of Rasch is consequently more than a methodological omission. It is a defining characteristic of curriculum inversion. The curriculum recognizes the importance of latent attributes but fails to recognize the only framework capable of transforming observations of those attributes into quantitative measures. This leaves students and practitioners with a vocabulary of scores, utilities, and indices but without an understanding of measurement itself. Until Rasch measurement assumes its proper place within HTA education, latent attributes will continue to be represented through numerical constructions rather than lawful measures, and the distinction between scoring and measurement will remain obscured.

CONCLUSION: CURRICULUM INVERSION AND THE FUTURE OF HTA IN THE EUROPEAN UNION

The companion interrogation of the broader knowledge base demonstrated that contemporary health technology assessment in the EU is characterized by measurement inversion. The accepted principles of representational measurement receive little recognition, while utilities, QALYs, cost-effectiveness ratios, and reference-case modelling are accepted as though they provide scientifically valid quantitative measures of therapy impact. The present study has addressed the complementary question of how such a framework has become established and, more importantly, how it has been sustained. The answer is curriculum inversion.

The interrogation of the curriculum knowledge base demonstrates that future HTA practitioners are introduced to the methods of economic evaluation before they are introduced to the scientific principles required to evaluate those methods. Educational emphasis is placed upon comparative

effectiveness, utilities, QALYs, cost-effectiveness analysis, and decision modelling rather than upon specification of the target attribute, the principal scales of measurement, representational measurement, admissible arithmetic, unidimensionality, the distinction between manifest and latent attributes, Rasch measurement, and the requirement that therapy-impact claims be prospectively evaluable, independently replicable, and capable of falsification. Graduates therefore acquire competence in applying the accepted methods of HTA without first acquiring the scientific framework necessary to determine whether those methods can support lawful quantitative claims.

This finding explains the persistence of the contemporary HTA paradigm. Measurement inversion has not survived because its scientific foundations have been critically examined and confirmed. Rather, it has survived because the educational framework provides little opportunity for students or practitioners to encounter the principles upon which such an examination could be undertaken. Successive generations of researchers, consultants, regional assessment agencies, academic centers, manufacturers, and policy analysts inherit an analytical framework whose measurement assumptions remain largely invisible. Curriculum inversion therefore becomes the mechanism through which measurement inversion is continually reproduced.

The implications extend beyond individual universities or regional HTA agencies. Although the EU operates a decentralized HTA system, the interrogation demonstrates the existence of a common national curriculum knowledge base that transmits a shared methodological framework. National methodological guidance, regional educational resources, postgraduate teaching, professional training, conferences, and published methodological literature collectively define what constitutes HTA competence. If that educational framework embodies curriculum inversion, then curriculum inversion becomes a characteristic of HTA itself rather than of particular institutions.

The implications are therefore fundamental. The challenge confronting HTA is no longer one of refining economic models, improving evidence synthesis, incorporating additional real-world evidence, or modifying reference-case assumptions. These initiatives leave untouched the more fundamental question of whether the quantities entering HTA analyses satisfy the accepted axioms of representational measurement. Unless measurement precedes arithmetic, no degree of methodological sophistication can compensate for the absence of lawful measurement. More elaborate models merely generate increasingly sophisticated calculations based upon quantities that are not measures.

The future of HTA in the EU depends upon breaking the cycle through which curriculum inversion perpetuates measurement inversion. Reconstruction must begin by restoring representational measurement to its proper place as the scientific foundation of HTA education. Every assessment should begin with specification of the target attribute, followed by determination of whether that attribute is manifest or latent. Manifest attributes require linear ratio measures; latent attributes require Rasch logit ratio measures. Only when lawful measurement has been established can arithmetic legitimately proceed and therapy-impact claims be subjected to empirical evaluation, replication, and falsification.

To facilitate this transition, Maimon Research LLC has developed a comprehensive nine-unit HTA Reconstruction Program ^v. The program provides a systematic introduction to representational measurement, the theory of attributes, the principal scales of measurement, admissible arithmetic, dimensional homogeneity, manifest and latent attributes, Rasch logit ratio measurement, protocol development, and the construction of evaluable, replicable, and falsifiable claims regarding therapy impact. Its purpose is not to modify the existing reference-case paradigm but to replace it with a scientific framework in which measurement once again precedes arithmetic.

The program has been designed for universities, HTA agencies, reimbursement organizations, research centers, professional societies, pharmaceutical companies, and health economists seeking a transition from assumption-driven modelling to scientifically defensible measurement. It provides a structured pathway for professional development while establishing the competencies required for the next generation of HTA practitioners. In this way, it offers not simply a critique of the existing paradigm but a practical route toward the reconstruction of HTA as a measurement-based scientific discipline.

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