MAIMON RESEARCH LLC

ARTIFICIAL INTELLIGENCE LARGE LANGUAGE MODEL INTERROGATION

REPRESENTATIONAL MEASUREMENT FAILURE IN HEALTH TECHNOLGY ASSESSMENT

ITALY: THE ENDORSEMENT OF CURRICULUM INVERSION

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

LOGIT WORKING PAPER No 1480 JULY 2026

www.maimonresearch.com

Tucson AZ

ABSTRACT

Previous large language model (LLM) interrogations of the Italian health technology assessment (HTA) knowledge base have demonstrated the pervasive presence of measurement inversion. Across national methodological guidance, regional HTA agencies, academic research, and professional practice, the scientific principles required for lawful quantitative measurement receive little recognition, while utilities, QALYs, cost-effectiveness analysis, and reference-case simulation modelling are accepted as though they provide scientifically valid measures of therapy impact. The present study examines the complementary question of how this methodological framework has become institutionalized and sustained. It argues that the answer lies in curriculum inversion.

The Italian HTA curriculum knowledge base was interrogated using ten canonical statements representing the accepted principles of representational measurement. These statements encompass 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, independently replicable, and capable of empirical falsification. Together, these statements define the minimum scientific foundations required for a measurement-based approach to HTA.

The interrogation demonstrates a consistent pattern of curriculum inversion. Fundamental concepts underpinning quantitative science receive uniformly weak endorsement, while educational emphasis is directed toward comparative effectiveness assessment, evidence synthesis, economic evaluation, utilities, QALYs, cost-effectiveness analysis, and decision modelling. The curriculum therefore teaches practitioners how to apply established HTA methodologies before equipping them with the scientific principles necessary to determine whether those methodologies support lawful quantitative claims. In particular, the interrogation identifies the absence of any coherent distinction between manifest and latent attributes and the near-complete absence of Rasch measurement as the scientific framework for measuring latent constructs.

The findings indicate that curriculum inversion provides the educational mechanism through which measurement inversion is reproduced within Italian HTA. Successive generations of practitioners inherit an analytical framework in which methodological convention takes precedence over measurement science. The paper concludes that reconstruction of Italian HTA must begin with educational reconstruction. Representational measurement should become the foundation of HTA teaching, with every assessment beginning by identifying the target attribute, distinguishing between manifest and latent attributes, applying either linear ratio or Rasch logit ratio measurement as appropriate, and supporting all therapy-impact claims through prospective protocols capable of independent evaluation, replication, and empirical falsification.

INTRODUCTION

A series of large language model (LLM) interrogations of the Italian health technology assessment (HTA) knowledge base has consistently demonstrated strong endorsement of measurement inversion [1] [2] . Across national methodological guidance, regional HTA agencies, academic research, and professional practice, the same pattern emerges: the concepts required for lawful quantitative measurement are either weakly represented or absent, while utilities, QALYs, cost-effectiveness analysis, and reference-case simulation modelling are accepted as though they provide scientifically valid measures of therapy impact. These findings indicate that measurement inversion is not confined to individual institutions but characterizes the Italian HTA knowledge base as a whole.

The present study examines whether this national endorsement of measurement inversion is accompanied by curriculum inversion. This is a critical question because evidence from Australia, Canada, France, Germany, New Zealand, Spain, the United Kingdom, and the United States indicates that measurement inversion is sustained through the educational framework that prepares successive generations of HTA practitioners. Although Italy operates a decentralized healthcare system in which the regions play a major role in HTA implementation and decision making, these organizations draw upon a common national methodological and educational knowledge base. The purpose of this interrogation is therefore to determine whether that national curriculum knowledge base provides students and practitioners with the scientific foundations of representational measurement before introducing the methods of economic evaluation, utilities, QALYs, and reference-case modelling. If the concepts required for quantitative science are absent from the curriculum, then curriculum inversion provides the educational mechanism through which measurement inversion is reproduced throughout Italian HTA.

The interrogation reveals a consistent and unmistakable pattern of curriculum inversion within the Italian 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 throughout Italian HTA.

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 [3] [4] [5] . 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 ITALIAN HTA CURRICULUM KNOWLEDGE BASE

The Italian HTA curriculum knowledge base comprises the body of educational, methodological, and professional resources through which the principles and practice of health technology assessment (HTA) are taught, interpreted, and disseminated throughout Italy. It extends beyond formal university teaching to include postgraduate education, professional training programs, national and regional methodological guidance, publications produced by HTA agencies, conference proceedings, continuing professional development activities, and the methodological literature that informs assessment practice. Collectively, these resources establish the conceptual framework through which successive generations of researchers, clinicians, pharmacists, health economists, policy analysts, consultants, and decision makers acquire their understanding of HTA.

Although responsibility for healthcare delivery and many aspects of technology assessment is distributed across the Italian regions, HTA education is supported by a common national methodological tradition. Universities, regional assessment organizations, national agencies, scientific societies, and professional organizations draw upon broadly similar concepts, analytical methods, and educational resources. While individual institutions naturally differ in emphasis and specialization, they share a common understanding of what constitutes accepted HTA methodology. Consequently, the Italian HTA curriculum knowledge base functions as a coherent national educational framework despite the administrative diversity of the healthcare system.

The significance of this curriculum knowledge base extends well beyond education. It defines the intellectual assumptions that underpin HTA practice. Students entering postgraduate programs, practitioners undertaking professional development, manufacturers preparing submissions, consultants advising reimbursement authorities, and researchers contributing to the methodological literature are all introduced to a common analytical framework. This framework establishes the accepted language of HTA, including comparative effectiveness assessment, evidence synthesis, economic evaluation, utilities, QALYs, cost-effectiveness analysis, budget impact analysis, and decision modelling. In doing so, it shapes not only how technologies are assessed but also how practitioners understand the nature of quantitative evidence itself.

The purpose of identifying the curriculum knowledge base is therefore to distinguish between the methods that practitioners are taught and the scientific principles that should underpin those methods. The broader Italian HTA knowledge base encompasses legislation, methodological guidance, reimbursement procedures, assessment reports, and professional practice. Nested within this broader framework is the curriculum knowledge base, whose function is educational. It determines which concepts are introduced to future practitioners, the order in which they are presented, and the assumptions regarded as fundamental to HTA. The present interrogation is directed toward this educational framework rather than toward individual assessment reports or reimbursement decisions.

Specifically, the interrogation asks whether the Italian curriculum introduces practitioners first to the accepted principles of representational measurement before presenting the analytical methods of contemporary HTA. These principles include specification of the target attribute, the principal scales of measurement, the axioms of representational measurement, admissible arithmetic, unidimensionality, the distinction between manifest and latent attributes, the corresponding requirements for linear ratio and Rasch logit ratio measurement, and the requirement that quantitative therapy-impact claims be prospectively evaluable, independently replicable, and capable of empirical falsification. If these scientific foundations are absent, then the curriculum cannot provide students with the conceptual framework necessary to determine whether accepted HTA methods support lawful quantitative claims.

The importance of this distinction cannot be overstated. Educational frameworks do more than transmit technical skills; they define the intellectual boundaries of a discipline. If representational measurement is absent from the curriculum, successive generations of practitioners will naturally accept established HTA methods without questioning their measurement foundations. Curriculum inversion therefore becomes the educational mechanism through which measurement inversion is reproduced. The interrogation of the Italian HTA curriculum knowledge base is consequently directed not toward evaluating individual educational programs but toward determining whether the scientific foundations of quantitative measurement occupy their proper place within the educational framework that underpins contemporary Italian health technology assessment.

INTERROGATING THE ITALIAN 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.

ITALY AND CURRICULUM INVERSION

The interrogation of the Italian HTA curriculum knowledge base demonstrates a pattern of curriculum inversion that closely mirrors those identified in other European jurisdictions (Table 1). The educational framework gives substantial emphasis to comparative effectiveness, evidence synthesis, economic evaluation, reimbursement processes, and methodological guidance, while the scientific principles governing quantitative measurement receive little or no explicit attention. The result is an educational system in which practitioners are taught how to undertake HTA before they are taught the scientific conditions that determine whether quantitative claims are lawful.

TABLE 1: CURRICULUM CONTENT ENDORSEMENT: ITALIAN 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 interrogation indicates weak endorsement of the proposition that every therapy assessment should begin with specification of the target attribute. Instead, educational emphasis is placed upon evidence appraisal, comparative clinical assessment, and health economic evaluation. Consequently, the attribute itself is rarely presented as the primary object of scientific measurement. Similarly, there is little indication that the curriculum systematically distinguishes among nominal, ordinal, interval, and ratio scales or explains how those scale properties constrain admissible arithmetic. The requirement that measurement must precede arithmetic receives very weak endorsement.

The weakest endorsement is observed for the axioms of representational measurement. Concepts such as unidimensionality, admissible transformations, dimensional homogeneity, and the relationship between measurement and arithmetic are largely absent from the educational framework. Likewise, the distinction between manifest and latent attributes receives little explicit recognition, and there is no systematic treatment of the fundamentally different measurement requirements associated with each. Rasch measurement is not presented as the scientific framework for measuring latent attributes, while linear ratio measurement for manifest attributes is not established as the prerequisite for lawful quantitative claims.

Manifest clinical outcomes such as mortality, hospitalization, adverse events, and resource utilization naturally receive greater emphasis because they are central to clinical assessment. However, these outcomes are generally discussed as clinical endpoints rather than as manifest attributes requiring ratio measurement. The curriculum therefore recognizes observation more readily than measurement.

The requirement that therapy-impact claims be prospectively evaluable, independently replicable, and capable of falsification also receives weak endorsement. Educational emphasis is directed toward evidence appraisal, reimbursement methodology, and decision support rather than toward the development of empirically testable scientific claims. As a consequence, the curriculum prepares practitioners to apply established HTA methods without first establishing the scientific legitimacy of the quantities upon which those methods depend.

Taken together, the interrogation demonstrates that the Italian HTA curriculum knowledge base exhibits curriculum inversion. The educational framework introduces practitioners to utilities, QALYs, comparative effectiveness assessment, economic evaluation, and associated methodological techniques before introducing the scientific principles of representational measurement. Curriculum inversion therefore provides the educational mechanism through which measurement inversion is reproduced within Italian HTA. The findings are consistent with those reported for other European jurisdictions, suggesting that curriculum inversion is a systemic characteristic of contemporary European HTA rather than a feature unique to any individual country.

Statement-by-Statement Review of the Italian HTA Curriculum Knowledge Base

1. An attribute is the specific outcome of interest in a therapy assessment (Probability 0.20; Logit –1.50)

The interrogation indicates only weak endorsement of the concept that every HTA begins with specification of the target attribute. Educational material focuses primarily on clinical evidence, comparative effectiveness, reimbursement processes, and economic evaluation rather than identifying precisely what is to be measured. The attribute is generally treated implicitly through clinical endpoints rather than explicitly as the object of scientific measurement.

2. Every therapy assessment begins with specification of the target attribute (Probability 0.10; Logit –2.00)

This proposition receives very weak endorsement. The curriculum emphasizes evidence appraisal, systematic reviews, clinical effectiveness, and health economic analysis before establishing the attribute that the assessment is intended to measure. The scientific requirement that measurement begins with specification of the attribute is largely absent.

3. The principal scales of measurement have different properties and support different forms of analysis (Probability 0.15; Logit –1.75)

Recognition of the principal scales of measurement is limited. Although quantitative methods receive considerable attention, there is little indication that practitioners are taught how nominal, ordinal, interval, and ratio scales constrain the arithmetic that may legitimately be performed. Numerical analysis therefore precedes measurement theory.

4. The measurement status of a target attribute must be established before quantitative claims can be advanced (Probability 0.10; Logit –2.00)

The interrogation indicates that measurement is generally assumed rather than demonstrated. Educational emphasis is directed toward analytical methods and evidence synthesis rather than establishing whether the quantities entering an analysis satisfy the accepted requirements of representational measurement.

5. The axioms of representational measurement underpin quantitative claims (Probability 0.05; Logit –2.50)

This receives the weakest endorsement of all statements. The curriculum provides little evidence that the axioms governing lawful quantitative measurement are introduced as the scientific foundation of HTA. Concepts such as admissible arithmetic, dimensional homogeneity, cancellation, and representational measurement are largely absent.

6. Attributes must be demonstrated to be unidimensional before measurement is possible (Probability 0.10; Logit –2.00)

The requirement for unidimensionality receives very weak endorsement. Composite measures and multidimensional constructs are widely accepted within contemporary HTA without prior demonstration that they represent a single measurable attribute. The scientific distinction between measurement and numerical aggregation is not emphasized.

7. A manifest attribute is directly observable and capable of supporting empirical observation (Probability 0.25; Logit –1.25)

This statement receives the strongest endorsement within the interrogation. Clinical outcomes such as mortality, hospital admissions, adverse events, and treatment persistence are central to HTA practice. However, these outcomes are generally discussed as clinical endpoints rather than as manifest attributes requiring lawful linear ratio measurement.

8. A latent attribute is not directly observable and requires a measurement model to estimate possession of the attribute (Probability 0.10; Logit –2.00)

Recognition of latent measurement is minimal. The curriculum provides little indication that latent constructs require a measurement model capable of estimating possession of the attribute. Patient-reported outcomes and quality-of-life measures are introduced without systematic consideration of their measurement requirements.

9. Manifest and latent attributes require different forms of ratio measurement (Probability 0.05; Logit –2.50)

This proposition receives virtually no endorsement. The curriculum does not distinguish between the fundamentally different scientific requirements governing observable and latent attributes. The respective roles of linear ratio measurement for manifest attributes and Rasch logit ratio measurement for latent attributes are absent from the educational framework.

10. Therapy impact claims must be falsifiable (Probability 0.15; Logit –1.75)

The interrogation indicates weak endorsement of falsification as a defining characteristic of scientific inquiry. Educational emphasis is placed upon evidence appraisal, reimbursement methodology, and decision support rather than on prospectively specified, empirically testable claims capable of independent replication and refutation. Consequently, the curriculum prepares practitioners to evaluate evidence but provides limited guidance regarding the scientific conditions required for cumulative, falsifiable knowledge.

MANIFEST AND LATENT ATTRIBUTES

A central finding of the Italian 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 Italian HTA 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 Italian 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 Italy 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 the Italian curriculum data base 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 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 Italian 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 ITALY

The companion interrogation of the Italian HTA knowledge base demonstrated that contemporary health technology assessment in Italy is characterized by measurement inversion. The accepted principles of representational measurement receive little recognition, while utilities, QALYs, cost-effectiveness analysis, and reference-case modelling continue to be accepted as though they provide scientifically valid 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 continues to reproduce itself. The answer is curriculum inversion.

The interrogation demonstrates that the Italian HTA curriculum knowledge base introduces future practitioners to the methods of contemporary HTA before introducing them to the scientific principles required to evaluate those methods. Educational emphasis is placed upon comparative effectiveness, health economic evaluation, utilities, QALYs, decision modelling, evidence synthesis, and reimbursement methodology 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 quantitative claims be prospectively evaluable, independently replicable, and capable of falsification. Graduates therefore learn how to undertake HTA without first acquiring the scientific framework necessary to determine whether the quantities entering those analyses satisfy the accepted requirements of quantitative measurement.

This finding explains the remarkable stability of the Italian HTA paradigm. Measurement inversion has not persisted because its scientific foundations have been critically examined and confirmed. It has persisted 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 university graduates, researchers, regional HTA analysts, consultants, manufacturers, and policy advisers inherit an analytical framework in which the measurement assumptions underlying utilities, QALYs, and reference-case analyses remain largely invisible. Curriculum inversion therefore becomes the principal mechanism through which measurement inversion is transmitted from one generation of practitioners to the next.

The implications extend beyond individual universities and regional health authorities. Italy operates a decentralized health system in which the regions exercise substantial responsibility for healthcare delivery and reimbursement, yet HTA education is shaped by a common national methodological tradition. National guidance, postgraduate teaching, professional societies, methodological publications, conferences, and agency documentation collectively define what constitutes HTA competence throughout Italy. Although regional practice may differ in administrative detail, the scientific assumptions underpinning HTA remain remarkably consistent. Curriculum inversion is therefore not a regional phenomenon but a national characteristic of Italian HTA.

The implications are profound. The challenge facing Italy is no longer one of refining economic models, expanding evidence synthesis, incorporating additional real-world evidence, or improving decision models. These initiatives leave untouched the more fundamental scientific question of whether the quantities entering those 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 applied to quantities that are not measures.

The future of HTA in Italy therefore depends upon breaking the educational 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 therapy assessment should begin with explicit 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 after lawful measurement has been established can arithmetic proceed and therapy-impact claims become capable of empirical evaluation, independent replication, and falsification.

Taken together, the companion papers on measurement inversion and curriculum inversion point to a single conclusion. The present educational framework cannot continue to serve as the scientific foundation of Italian HTA because it reproduces a methodology that fails the accepted standards governing quantitative measurement. The task facing Italy is therefore not incremental methodological refinement but intellectual reconstruction. Curriculum inversion must give way to an educational framework in which measurement once again precedes arithmetic and every quantitative claim is founded upon lawful measurement. Only then can Italian HTA claim to meet the standards expected of a modern quantitative scientific discipline.

To facilitate this transition, Maimon Research LLC has developed a comprehensive nine-unit HTA Reconstruction Program [6]. 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.

ACKNOWLEDGEMENT

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

REFERENCES

[1] Italy: Measurement failure in national health technology assessment coordination. Logit Working Paper No 115. https://maimonresearch.com/logit-working-paper-no-115/

[2] Italy: Measurement failure in regional health technology assessment implementation. Logit Working Paper No 116. https://maimonresearch.com/logit-working-paper-no-116/

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

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

[5] Bond T, Zi Yan, Heene M. Applying the Rasch Model: Fundamental Measurement in the Human Sciences (4th Ed). New York Routledge, 2021

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