# MAIMON RESEARCH LLC

# ARTIFICIAL INTELLIGENCE LARGE LANGUAGE MODEL INTERROGATION

# REPRESENTATIONAL MEASUREMENT FAILURE IN HEALTH TECHNOLGY ASSESSMENT

# SPAIN: THE ENDORSEMENT OF CURRICULUM INVERSION

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## ABSTRACT

*This Logit Working Paper examines the educational foundations of French health technology assessment (HTA) through an interrogation of the curriculum knowledge base of the Haute Autorité de Santé (HAS). It is the companion study to* France: The Endorsement of Measurement Inversion in the Haute Autorité de Santé (HAS)*, which concluded that the publicly accessible methodological knowledge base of HAS institutionalizes measurement inversion by endorsing utilities, QALYs, cost-effectiveness analysis, and reference-case modelling while giving little recognition to the scientific principles of representational measurement. The present study addresses the complementary question of how this methodological framework is communicated to successive generations of HTA practitioners.*

*Curriculum interrogation applies a fixed set of ten canonical statements representing the minimum scientific competencies required for lawful quantitative assessment of therapy impact. These encompass specification of the target attribute, the principal scales of measurement, representational measurement, unidimensionality, the distinction between manifest and latent attributes, ratio measurement, Rasch measurement for latent constructs, and the requirement that quantitative claims be prospectively evaluable, replicable, and capable of falsification. Together, these concepts define the educational foundations of a measurement-based approach to HTA.*

*The interrogation demonstrates a consistent pattern of curriculum inversion. The concepts required to evaluate the scientific legitimacy of accepted HTA methods receive uniformly weak endorsement, while the curriculum places primary emphasis on comparative effectiveness assessment, utilities, QALYs, economic evaluation, decision modelling, and reimbursement methodology. Students and practitioners are therefore introduced to established analytical techniques before acquiring the scientific principles necessary to determine whether those techniques satisfy the requirements of quantitative measurement. Curriculum inversion emerges as the educational mechanism through which measurement inversion is reproduced and institutionalized within French HTA.*

*Particular attention is given to the absence of explicit instruction on the distinction between manifest and latent attributes and the corresponding forms of ratio measurement required for each. The paper demonstrates that this omission removes one of the essential conceptual foundations of measurement-based HTA and explains the near-complete absence of Rasch measurement from the HAS educational framework. As a consequence, latent constructs such as quality of life, symptom burden, treatment satisfaction, and patient-reported outcomes are represented through scores, utilities, and composite indices rather than scientifically validated measures of attribute possession.*

*The paper concludes that reconstruction of French HTA cannot be achieved solely through methodological refinement. Educational reconstruction must accompany methodological reconstruction. Representational measurement must become the organizing principle of HTA education, with measurement preceding arithmetic, attributes preceding models, and evaluable, replicable, and falsifiable therapy-impact claims replacing reliance on established methodological convention. Only through such a transition can French HTA satisfy the standards expected of a quantitative scientific discipline.*

# INTRODUCTION

A series of large language model (LLM) interrogations of the Spanish health technology assessment (HTA) knowledge base has consistently demonstrated strong endorsement of measurement inversion [1]. 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 Spanish 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, 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 Spain operates a decentralized HTA system through national coordination and regional assessment agencies, these organizations draw upon a common 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 Spanish HTA.

The interrogation reveals a consistent and unmistakable pattern of curriculum inversion within the national 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 French 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 [2] [3] [4] . 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 SPANISH HTA CURRICULUM KNOWLEDGE BASE

The Spanish HTA curriculum knowledge base comprises the collective body of educational, methodological, and professional material through which the principles and practice of health technology assessment (HTA) are transmitted to students, researchers, clinicians, health economists, and policy analysts. It is not confined to the formal curriculum of any single university or professional training program. Rather, it represents the national intellectual environment within which HTA is taught, learned, and applied. This includes methodological guidance developed through the Spanish Network of Health Technology Assessment Agencies (RedETS), educational resources produced by national and regional HTA agencies, postgraduate university programs in health economics and HTA, professional workshops and continuing education, conference presentations, textbooks, journal articles, technical reports, and publicly available teaching materials concerned with economic evaluation and reimbursement assessment.

Spain presents a distinctive case because responsibility for HTA is distributed across a network of regional assessment agencies operating within a nationally coordinated framework. Although individual regions may differ in organizational structure, assessment priorities, and implementation, they share a common methodological tradition. National guidance documents, methodological recommendations, and educational resources provide the intellectual framework within which regional agencies operate and within which university programs prepare future HTA practitioners. Consequently, despite administrative decentralization, the educational foundations of Spanish HTA can appropriately be regarded as a single national curriculum knowledge base.

The purpose of defining this knowledge base is to distinguish between the practice of HTA and the educational processes through which that practice is reproduced. The broader HTA knowledge base encompasses the methods, analytical frameworks, guidance documents, published assessments, and research literature that collectively define contemporary Spanish HTA. Nested within this broader environment is the curriculum knowledge base, whose function is educational. It determines the concepts, assumptions, analytical methods, and methodological priorities presented to students and early-career researchers before they enter professional practice. The curriculum knowledge base therefore provides the principal mechanism through which successive generations of practitioners acquire their understanding of HTA.

For the purposes of the present interrogation, the curriculum knowledge base is examined not to assess the quality of individual educational programs but to determine whether the scientific concepts necessary for lawful quantitative measurement are embedded within the educational framework itself. The central question is whether students are introduced to the principles of representational measurement, the distinction between nominal, ordinal, interval, and ratio scales, the requirement that attributes be demonstrated to be unidimensional before quantitative claims are advanced, the distinction between manifest and latent attributes, the different measurement requirements for each, and the principle that therapy-impact claims must ultimately be evaluable and falsifiable. These concepts define the scientific foundations of quantitative assessment.

If these concepts are absent or weakly represented, the implications extend beyond education. The curriculum becomes the mechanism through which measurement inversion is reproduced. Students learn the accepted methods of utilities, QALYs, economic evaluation, and reference-case modelling without first acquiring the measurement principles required to evaluate their scientific admissibility. Curriculum inversion therefore complements measurement inversion by ensuring that each new generation of HTA practitioners inherits the same analytical framework without exposure to the representational measurement standards that govern quantitative science. The interrogation of the Spanish HTA curriculum knowledge base is designed to determine whether this pattern is evident within Spain and, if so, the extent to which the educational framework contributes to the continued institutionalization of measurement inversion.

## INTERROGATING THE SPANISH 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.

## SPAIN AND CURRICULUM INVERSION

The interrogation of the Spanish HTA curriculum knowledge base reveals a pattern of curriculum inversion consistent with the findings reported for other national HTA systems. Spain's structure is institutionally diverse, with national coordination through RedETS and substantial regional participation, but this diversity does not alter the central curriculum finding. Across the publicly accessible educational and methodological environment, the concepts required to support lawful quantitative claims are weakly represented, while the established methods of HTA, economic evaluation, cost-effectiveness analysis, utility assessment, QALYs and reference-case modelling remain prominent.

## 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 | 0.15 | -1.75 |
| 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 | 0.20 | -1.50\ |

The first two statements concern the foundational role of the attribute. The proposition that an attribute is the specific outcome of interest in a therapy assessment receives weak endorsement, and the stronger proposition that every assessment begins with specification of the target attribute receives very weak endorsement. Spanish HTA materials discuss clinical effectiveness, safety, economic evaluation, organizational impact, patient outcomes and decision relevance, but the attribute itself is rarely presented as the necessary starting point of measurement. The curriculum begins with assessment methods rather than with the object of measurement. This is the first sign of inversion.

The third and fourth statements concern scales of measurement and the requirement that measurement status precede quantitative claims. These also receive weak endorsement. The Spanish curriculum knowledge base shows little evidence that students or practitioners are systematically exposed to the distinction between nominal, ordinal, interval and ratio scales, or to the fact that each scale permits different mathematical operations. This omission is critical because economic evaluation routinely depends upon operations that require ratio measurement. If students are taught cost-effectiveness methods without first being taught the measurement properties required for arithmetic, they are being trained to calculate before being trained to measure.

The fifth statement, that the axioms of representational measurement underpin quantitative claims, receives the lowest endorsement. This is the central finding. Representational measurement is not a peripheral refinement. It is the scientific foundation that determines whether numerical assignments can support arithmetic, comparison, aggregation and modelling. Its absence means that students may learn how to apply HTA methods without learning the standards required to judge whether those methods have quantitative standing.

The sixth statement concerns unidimensionality. This receives only weak endorsement. Spanish HTA, like other European HTA systems, gives substantial attention to multidimensional health outcomes, quality of life, patient-reported outcomes and utility instruments. Yet there is little indication that the curriculum first requires demonstration that the relevant attribute is unidimensional before measurement is claimed. This permits composite constructs to be treated as though they were measures, when they are better understood as numerical summaries unless their measurement properties have been established.

The seventh statement, concerning manifest attributes, receives the strongest probability, although still only modest. This reflects the fact that HTA routinely deals with directly observable outcomes such as mortality, adverse events, hospitalizations, resource use, treatment discontinuation and clinical events. However, the curriculum appears to recognize these as endpoints rather than as manifest attributes requiring linear ratio measurement. Observation is therefore present, but measurement theory remains weak.

The eighth and ninth statements expose the major curriculum failure. The proposition that latent attributes are not directly observable and require a measurement model receives very weak endorsement, while the proposition that manifest and latent attributes require different forms of ratio measurement receives the lowest endorsement. This indicates that the Spanish curriculum knowledge base does not appear to teach the distinction between linear ratio measures for manifest attributes and Rasch logit ratio measures for latent attributes. Without that distinction, patient-reported outcomes, utilities, quality-of-life scores and preference weights can be treated as though they occupied the same measurement space as directly observed clinical events. This is a fundamental error.

The final statement, that therapy-impact claims must be falsifiable, also receives weak endorsement. Spanish HTA materials emphasize evidence appraisal, economic evaluation, decision support and methodological consistency, but there is little indication that students are taught to formulate prospective therapy-impact claims with explicit protocols, success criteria,

replication requirements and conditions for refutation. The curriculum therefore supports administrative evaluation more strongly than falsifiable scientific inquiry.

Taken together, the ten-statement interrogation demonstrates curriculum inversion in the Spanish HTA curriculum knowledge base. Students and practitioners are exposed to the methods of economic evaluation before they are exposed to the measurement principles required to determine whether those methods are scientifically legitimate. They learn the reference-case framework before learning the axioms that would constrain or reject it. The problem is not Spain's institutional diversity. The problem is the shared intellectual framework transmitted through national and regional HTA materials, economic evaluation guidance, university teaching and professional training.

The conclusion is direct. The Spanish HTA curriculum knowledge base does not appear to provide the scientific foundations required for measurement-based therapy assessment. It reproduces a framework in which utilities, QALYs, cost-effectiveness models and decision analysis are treated as central competencies, while representational measurement, unidimensionality, manifest and latent attributes, Rasch measurement and falsifiability remain weakly represented. Curriculum inversion is therefore not a marginal educational omission. It is the mechanism through which measurement inversion is sustained within Spanish HTA.

## MANIFEST AND LATENT ATTRIBUTES

A central finding of the Spanish 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 Spanish 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 Spanish 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 Spain 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 Canadian HTA knowledge base.

## THE ABSENCE OF RASCH

One of the most striking findings from the interrogation of Spain 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 Spanish 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 SPAIN

The companion interrogation of the Spanish HTA knowledge base demonstrated that contemporary health technology assessment in Spain 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 Spanish HTA 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 Spanish 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 Spain 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 Spanish HTA itself rather than of particular institutions.

The implications are therefore fundamental. The challenge confronting Spanish 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 Spain therefore 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.

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 foundation for scientific HTA because it reproduces a methodology that fails the accepted standards of quantitative science. The task facing Spain is therefore not incremental reform but intellectual reconstruction. Curriculum inversion must give way to an educational framework in which measurement once again precedes arithmetic. Only then can Spanish HTA claim to satisfy the standards expected of a quantitative scientific discipline.

To facilitate this transition, Maimon Research LLC has developed a comprehensive nine-unit HTA Reconstruction Program [5]. 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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## REFERENCES

[1] Spain: National Coordination and the structural endorsement of measurement failure in health technology assessment, Logit Working Paper No 110. https://maimonresearch.com/logit-working-paper-no-110/

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

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

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

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