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**ARTIFICIAL INTELLIGENCE LARGE LANGUAGE**  
**MODEL INTERROGATION**



**REPRESENTATIONAL MEASUREMENT FAILURE IN**  
**HEALTH TECHNOLOGY ASSESSMENT**

**NORWAY: THE ENDORSEMENT OF CURRICULUM**  
**INVERSION**

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## ABSTRACT

*This study examines curriculum inversion within the Norwegian health technology assessment (HTA) knowledge base. It is a companion analysis to a prior interrogation of measurement inversion in Norwegian HTA, which found that utilities, quality-adjusted life years (QALYs), cost-effectiveness analysis and reference-case modelling are treated as though they provide valid quantitative measures of therapy impact despite failing the requirements of representational measurement. The present study addresses the educational mechanism through which this framework is created, sustained and transmitted. Its central argument is that measurement inversion persists because it is reproduced through curriculum inversion.*

*The analysis applies a standardized large language model interrogation based on ten canonical curriculum statements derived from representational measurement. These statements address the minimum scientific requirements for lawful quantitative claims: specification of the target attribute, recognition of nominal, ordinal, interval and ratio scales, establishment of measurement status before arithmetic, 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 falsifiability of therapy impact claims. Each statement is assigned a categorical probability and normalized logit to assess its visibility within the Norwegian curriculum knowledge base.*

*The findings demonstrate consistently weak endorsement across all ten statements. Probabilities range from 0.05 to 0.20, with the lowest endorsement assigned to the axioms of representational measurement and the requirement that manifest and latent attributes require different forms of ratio measurement. Even the strongest endorsements, concerning attributes and manifest observation, remain weak. These results indicate that Norwegian HTA education gives priority to evidence synthesis, economic evaluation, utilities, QALYs and decision modelling while giving little systematic attention to the measurement conditions required to justify quantitative claims.*

*The study concludes that Norwegian HTA education exhibits curriculum inversion. Students and practitioners are taught the arithmetic and modelling procedures of contemporary HTA before they are taught how to determine whether the quantities entering those procedures are lawful measures. The absence of the manifest-latent distinction and the near absence of Rasch measurement are particularly consequential. Without educational reconstruction grounded in representational measurement, Norwegian HTA will continue to reproduce measurement inversion across successive generations of researchers, analysts and policy decision makers.*

## INTRODUCTION

The present study examines the Norwegian health technology assessment (HTA) curriculum through the application of a standardized interrogation based on the principles of representational measurement. Its objective is not to evaluate individual universities, academic departments or researchers, but to determine whether the scientific concepts required for lawful quantitative measurement are embedded within the educational knowledge base that prepares future HTA

practitioners. It is a companion piece to the evaluation of measurement inversion in Norway <sup>1</sup>. That earlier assessment demonstrated that Norwegian HTA accepts utilities, QALYs, cost-effectiveness analysis and reference-case modelling as though they provide valid quantitative measures of therapy impact, despite the absence of the measurement conditions required to support those claims. The present curriculum analysis explains how that situation is created and sustained. Measurement inversion does not persist by accident; it is reproduced through curriculum inversion. Students and practitioners are taught the arithmetic, modelling and decision frameworks of contemporary HTA before they are taught the principles of representational measurement, scale type, unidimensionality, manifest and latent attributes, Rasch measurement, dimensional homogeneity and falsifiability. As a result, the quantities used in HTA are accepted as measures before their measurement status has been established. Curriculum inversion therefore provides the educational mechanism through which measurement inversion becomes normalized within Norwegian HTA.

The large language model (LLM) interrogation is based upon ten canonical curriculum statements that define the minimum scientific foundations required for quantitative evaluation. These statements encompass specification of the target attribute, the principal scales of measurement, representational measurement, unidimensionality, the distinction between manifest and latent attributes, the corresponding requirements for ratio measurement, and the principle that therapy impact claims should be prospectively evaluable and capable of empirical falsification. Collectively, they provide a systematic framework for determining whether Norwegian HTA education is grounded in the scientific conditions that must precede quantitative analysis.

Each canonical statement is assigned a categorical probability representing the extent to which the concept is embedded within the Norwegian curriculum knowledge base. These probabilities are transformed to normalized logits, providing a common linear metric that allows direct comparison of curriculum coverage across concepts and between national HTA knowledge bases. High probabilities indicate that a concept occupies a central position within educational programs, methodological guidance, professional training and the broader research literature. Low probabilities indicate that the concept receives little systematic attention and is therefore unlikely to be encountered by students, researchers and practitioners during their professional education. Because the same interrogation framework has been applied internationally, the Norwegian findings can be compared directly with corresponding assessments undertaken in Australia, Canada, Denmark, Spain, New Zealand, the United Kingdom and the United States.

The purpose of the present investigation is to determine whether Norwegian HTA education satisfies the scientific prerequisites for quantitative claims or whether it exhibits the pattern of curriculum inversion identified elsewhere. Curriculum inversion occurs when students are introduced to utilities, quality-adjusted life years (QALYs), cost-effectiveness analysis, evidence synthesis and decision-analytic modelling before they are introduced to the principles governing lawful measurement. Arithmetic consequently precedes measurement, and methodological convention replaces scientific validation. If the concepts underpinning representational measurement receive consistently weak endorsement while downstream analytical methods dominate the curriculum, the conclusion is that the educational framework reproduces measurement inversion rather than providing the scientific foundations necessary for quantitative evaluation. The Norwegian interrogation therefore provides an objective assessment of whether

the national HTA curriculum prepares future practitioners to undertake lawful measurement or simply perpetuates the existing reference-case paradigm.

## **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<sup>2 3</sup><sup>4</sup>. 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 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 NORWEGIAN HTA CURRICULUM KNOWLEDGE BASE**

The Norwegian health technology assessment (HTA) curriculum knowledge base comprises the educational, methodological, and professional resources through which the principles and practice of HTA are taught, interpreted, and disseminated throughout Norway. It extends well beyond formal university curricula to encompass postgraduate education, continuing professional development, methodological guidance issued by national health authorities, publications from research institutes, professional society activities, conference proceedings, textbooks, and the extensive academic literature in health economics, outcomes research, epidemiology, and evidence-based medicine. Collectively, these resources establish the conceptual framework through which successive generations of clinicians, pharmacists, economists, epidemiologists, health services researchers, policy analysts, consultants, manufacturers, and healthcare administrators acquire their understanding of HTA and its role in healthcare decision making.

Norway has established an international reputation for the quality of its publicly funded healthcare system, evidence-based medicine, registry research, clinical epidemiology, and health services research. Norwegian universities, research centres, and public agencies have made important contributions to comparative effectiveness research, economic evaluation, patient-reported outcomes, and healthcare policy. HTA occupies an increasingly important role within national decisions regarding the adoption, reimbursement, and evaluation of pharmaceuticals, medical devices, diagnostic technologies, and clinical interventions. Consequently, the Norwegian curriculum knowledge base is important not only because it shapes professional education within Norway but because it contributes to the broader Scandinavian and European dialogue concerning evidence-based resource allocation and health policy.

The purpose of identifying the Norwegian curriculum knowledge base is to distinguish the educational framework through which HTA concepts are transmitted from the broader Norwegian HTA knowledge base that encompasses technology assessment reports, reimbursement recommendations, methodological guidance, clinical practice guidelines, and policy implementation. Embedded within this broader knowledge base is an educational structure whose principal purpose is the transmission of accepted analytical methods and professional assumptions. It determines the concepts regarded as fundamental, the sequence in which they are introduced, the analytical methods considered appropriate, and the standards by which future practitioners evaluate evidence and formulate claims regarding therapy impact. The present interrogation is directed toward this educational framework rather than toward the conclusions reached in individual reimbursement decisions or HTA reports.

The central question addressed by this interrogation is whether Norwegian HTA education introduces students and practitioners first to the scientific principles of representational

measurement before presenting the established 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, dimensional homogeneity, 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 should be prospectively evaluable, independently replicable, and capable of empirical falsification. These concepts are not optional methodological refinements but constitute the scientific foundations upon which all lawful quantitative claims ultimately depend.

The importance of interrogating the Norwegian curriculum knowledge base therefore extends beyond national educational practice. If these scientific foundations are absent from the educational framework responsible for preparing Norwegian HTA practitioners, researchers, and policy analysts, the implications extend directly to the future development of HTA within Norway. Curriculum inversion would indicate that students are introduced to utilities, quality-adjusted life years (QALYs), cost-effectiveness analysis, evidence synthesis, and decision-analytic modelling before they are taught the measurement principles required to determine whether those methods are scientifically legitimate. The interrogation therefore seeks to establish whether Norwegian HTA education is grounded in the accepted principles of representational measurement or whether it instead reproduces methodological convention without first establishing the conditions required for lawful quantitative measurement. The findings provide an objective assessment of whether the Norwegian curriculum prepares future practitioners to undertake measurement-based scientific evaluation or perpetuates the existing framework of measurement inversion that has been identified across numerous HTA knowledge bases internationally.

## **INTERROGATING THE NORWEGIAN 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**

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.

## NORWAY AND CURRICULUM INVERSION

The interrogation of the Norwegian health technology assessment (HTA) curriculum demonstrates a consistent pattern of weak endorsement across the ten canonical statements that define the scientific foundations of representational measurement (Table 1). Endorsement probabilities range from only 0.05 to 0.20, indicating that these concepts occupy at best a peripheral position within the Norwegian curriculum knowledge base. While elementary concepts such as attributes and manifest observation receive modest recognition, there is little evidence that students are systematically introduced to the measurement principles that must precede lawful quantitative analysis.

**TABLE 1: CURRICULUM CONTENT ENDORSEMENT: NORWEGIAN KNOWLEDGE BASE**

CANONICAL STATEMENT	CATEGORICAL PROBABILITY	NORMALIZED LOGIT
An attribute is the specific outcome of interest in a therapy assessment	0.20	-1.40
Every therapy assessment begins with specification of the target attribute	0.15	-1.75
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	-2.20
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	-2,20
A manifest attribute is directly observable and capable of supporting empirical observation	0.20	-1.40
A latent attribute is not directly observable and requires a measurement model to estimate possession of the attribute	0.10	-2.20
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 strongest endorsements are confined to recognition that an attribute represents the outcome of interest in a therapy assessment and that manifest attributes are directly observable, each with a probability of 0.20. Even these probabilities indicate only limited curriculum coverage. More importantly, these concepts are not linked to the broader framework of representational measurement required to establish whether subsequent quantitative claims are scientifically legitimate.

The interrogation identifies particularly weak endorsement for the concepts that distinguish measurement from numerical manipulation. The measurement status of a target attribute, unidimensionality, latent measurement, and the requirement that different forms of ratio measurement are needed for manifest and latent attributes all receive probabilities between 0.05 and 0.10. These findings suggest that Norwegian HTA education provides little opportunity for students to understand the conditions that determine whether numerical outputs constitute lawful measures.

The weakest endorsement is observed for the axioms of representational measurement and the recognition that manifest and latent attributes require different forms of ratio measurement, both with probabilities of only 0.05. These concepts provide the mathematical and scientific foundations upon which quantitative inference depends. Their near absence indicates that the curriculum gives priority to analytical methods while paying little attention to the measurement conditions that justify those methods.

Taken together, these findings indicate that the Norwegian HTA curriculum exhibits the defining characteristics of curriculum inversion. Rather than introducing students first to measurement theory and then to quantitative analysis, the curriculum proceeds directly to utilities, QALYs, economic evaluation, evidence synthesis, and decision modelling. The scientific foundations governing measurement therefore remain largely absent from educational practice. Norway consequently mirrors the broader international pattern in which arithmetic has displaced measurement as the basis of HTA, allowing measurement inversion to be reproduced through successive generations of education, research, and policy development.

## **Statement-by-Statement Review**

### **Statement 1: An attribute is the specific outcome of interest in a therapy assessment (Probability 0.20; Logit -1.40)**

Recognition of the concept of an attribute is limited. Although Norwegian HTA routinely evaluates therapies and health interventions, the curriculum gives relatively little emphasis to identifying precisely what characteristic is to be measured before selecting analytical methods or outcome instruments. Discussion therefore moves rapidly to evidence synthesis, economic evaluation, and modelling without first establishing the attribute that forms the object of scientific measurement.

### **Statement 2: Every therapy assessment begins with specification of the target attribute (Probability 0.15; Logit -1.75)**

Endorsement of this principle is weak. The findings suggest that Norwegian HTA education emphasizes established assessment procedures rather than requiring explicit specification of the target attribute as the first step in scientific inquiry. Measurement consequently becomes secondary to methodological convention, with evaluation framed around accepted analytical techniques rather than clearly defined measurable outcomes.

**Statement 3: The principal scales of measurement (nominal, ordinal, interval and ratio) have different properties and support different forms of analysis (Probability 0.15; Logit – 1.75)**

Recognition of the implications of scale theory is similarly limited. While students may encounter the traditional classification of measurement scales, there is little evidence that the consequences for admissible arithmetic and quantitative inference are systematically incorporated into HTA teaching. The curriculum therefore provides little basis for distinguishing lawful from unlawful numerical operations.

**Statement 4: The measurement status of a target attribute must be established before quantitative claims can be advanced (Probability 0.10; Logit –2.20)**

This statement receives very weak endorsement. Establishing measurement status is the essential prerequisite for quantitative science because arithmetic cannot legitimately precede measurement. The interrogation suggests that Norwegian HTA education generally assumes that existing clinical outcomes, utility measures, and patient-reported scores possess appropriate measurement properties without requiring independent demonstration.

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

This is one of the weakest endorsed statements within the interrogation. The mathematical principles governing representational measurement receive almost no explicit recognition within the curriculum knowledge base. As a result, students are unlikely to encounter the scientific foundations that determine whether numerical observations constitute lawful measures capable of supporting quantitative claims.

**Statement 6: Attributes must be demonstrated to be unidimensional before measurement is possible (Probability 0.10; Logit –2.20)**

Recognition of unidimensionality is limited. Norwegian HTA education provides little evidence that students are required to establish whether an attribute represents a single measurable construct before undertaking quantitative analysis. Composite measures and multidimensional instruments can therefore be accepted without demonstrating that they satisfy one of the fundamental conditions for scientific measurement.

**Statement 7: A manifest attribute is directly observable and capable of supporting empirical observation (Probability 0.20; Logit –1.40)**

This statement receives the strongest endorsement alongside Statement 1, although the probability remains low. There is some recognition that directly observable clinical outcomes differ from more abstract constructs. However, this distinction is not developed into a comprehensive measurement framework that differentiates the measurement requirements for observable and non-observable attributes.

**Statement 8: A latent attribute is not directly observable and requires a measurement model to estimate possession of the attribute (Probability 0.10; Logit –2.20)**

Recognition of latent measurement is weak. Although Norwegian HTA makes extensive use of patient-reported outcomes and quality-of-life instruments, there is little indication that the curriculum systematically introduces the measurement models required to estimate possession of latent attributes. Instead, aggregated scores and utility values appear to be accepted as though they themselves constitute measures.

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

This statement receives one of the lowest endorsement probabilities in the interrogation. The curriculum demonstrates little appreciation that manifest attributes require linear ratio measurement whereas latent attributes require Rasch logit ratio measurement. The absence of this distinction contributes directly to the routine treatment of utilities, preference scores and composite indices as though they possessed equivalent measurement status.

**Statement 10: Therapy impact claims must be falsifiable (Probability 0.15; Logit –1.75)**

Recognition that therapy impact claims should be capable of empirical falsification is limited. While evidence-based practice is emphasized within Norwegian HTA, comparatively little attention is given to the prospective specification of evaluable, independently replicable and falsifiable claims. Consequently, many quantitative conclusions depend more upon accepted modelling conventions than upon direct empirical testing of scientifically measurable outcomes.

## **MANIFEST AND LATENT ATTRIBUTES: THE MISSING FOUNDATION OF NORWEGIAN HTA**

A central finding of the Norwegian 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 particularly significant because the distinction between manifest and latent attributes is not a methodological refinement but one of the foundational concepts of representational measurement. Without it there is no coherent basis for determining how therapy outcomes should be measured, what constitutes a lawful quantitative claim, or whether the arithmetic applied within HTA is scientifically admissible.

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 adherence,

treatment discontinuation, adverse events, laboratory values, and healthcare resource utilization. These attributes are observable phenomena that can be counted, timed, or otherwise recorded directly. When properly specified, they support linear ratio measures with a meaningful zero and lawful arithmetic operations. The scientific task is straightforward: define the attribute, establish the unit of observation, specify the observation period, and subject the resulting claim to empirical evaluation and independent replication.

Latent attributes present a fundamentally different measurement problem. Pain, fatigue, depression, anxiety, physical functioning, treatment satisfaction, health confidence, and need fulfilment cannot be observed directly. Their existence must be inferred from observable indicators, typically responses to structured questionnaire items. Consequently, latent attributes require a measurement model capable of estimating possession of the attribute while satisfying the axioms of representational measurement. Within HTA this requirement is met through Rasch measurement, which provides a logit ratio measure possessing the properties required for lawful quantitative inference.

The importance of this distinction cannot be overstated. Manifest attributes require linear ratio measures, whereas latent attributes require Rasch logit ratio measures. These are the only two measurement frameworks capable of supporting lawful quantitative claims regarding therapy impact. The distinction therefore determines the entire measurement strategy adopted within HTA.

The interrogation suggests that the Norwegian curriculum knowledge base does not recognize this distinction as an organizing principle for HTA education. Instead, outcomes are grouped within broad categories such as patient-reported outcomes, quality of life, utility measurement, clinical effectiveness, and value assessment. These categories are descriptively useful but scientifically inadequate because they fail to distinguish between directly observable attributes and attributes requiring a measurement model. The measurement requirements governing each type of outcome consequently remain obscured.

Once this distinction disappears, virtually any numerical output can be treated as though it possesses equivalent measurement status. Utility scores, preference weights, composite indices, symptom scales, observational counts, and resource-use measures are brought together within the same analytical framework despite possessing fundamentally different measurement properties. The consequence is a loss of measurement discipline in which numerical construction is mistaken for quantitative measurement.

For Norway this finding has important implications. Norwegian universities, research centers and health authorities have developed a strong international reputation for evidence-based medicine, clinical epidemiology, health services research and health technology assessment. The curriculum interrogation indicates, however, that the educational framework supporting these activities does not begin with the fundamental distinction required by representational measurement. Successive generations of practitioners therefore become proficient in evidence synthesis, economic evaluation, cost-utility analysis and decision modelling without first addressing the elementary scientific question: what type of attribute is being measured, and what form of measurement is required? Until the distinction between manifest and latent attributes becomes the organizing principle of Norwegian HTA education, curriculum inversion will continue to reproduce

measurement inversion, limiting the scientific foundations upon which quantitative claims regarding therapy impact are constructed.

## THE ABSENCE OF RASCH

The absence of the manifest-latent distinction also explains the near absence of Rasch measurement within the Norwegian curriculum knowledge base. If latent attributes are not explicitly recognized as requiring a measurement model, there is no perceived need to introduce the one measurement framework capable of constructing lawful quantitative measures of latent attribute possession. Instead, ordinal questionnaire responses are transformed into utility scores, indices, and QALYs and subsequently treated as though measurement has already been achieved. The measurement problem is therefore bypassed rather than solved.

From the perspective of curriculum design, this represents a classic example of curriculum inversion. Students are introduced to utilities, QALYs, patient-reported outcomes, and reference-case modelling before they are taught to distinguish between manifest and latent attributes. Consequently, they are never encouraged to ask the critical scientific question that should precede every HTA submission: What is the target attribute, is it manifest or latent, and which lawful form of ratio measurement is required?

For Norway this omission is particularly important because HTA occupies an increasingly central role in decisions concerning the adoption, reimbursement, and evaluation of health technologies within a publicly funded healthcare system. The interrogation suggests that the Norwegian curriculum knowledge base has adopted the methodological conventions of contemporary HTA without first establishing the scientific foundations of measurement. Until the distinction between manifest and latent attributes becomes the organizing principle of HTA education, curriculum inversion will continue to reproduce measurement inversion throughout Norwegian teaching, research, and policy evaluation.

One of the most striking findings from the interrogation of the Norwegian HTA curriculum knowledge 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 particularly significant because Norway has established a strong international reputation for evidence-based medicine, clinical epidemiology, health services research, and health technology assessment. Yet the educational framework underpinning these activities gives little recognition to the one measurement framework capable of constructing lawful quantitative measures of latent attributes. The issue is not whether the term *Rasch* occasionally appears in specialist psychometric publications or methodological research. The issue is whether Rasch measurement is recognized as the scientific foundation for measuring latent therapy outcomes. The interrogation indicates that it is not.

This places Rasch in a unique position. Rasch is not simply another psychometric technique competing with item response theory, PROMIS, utility instruments, or preference-based scoring systems. It addresses an entirely different scientific problem. Its purpose is to determine 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 fundamental. Patient-reported outcomes begin with ordinal responses to questionnaire items describing pain, fatigue, anxiety, physical functioning, treatment satisfaction, need fulfilment, or other latent attributes. These responses provide information about order but not quantity. Arithmetic performed directly on ordinal observations cannot create measurement. Summed scores, averages, weighted algorithms, utility values, and preference functions remain numerical constructions unless it has first been demonstrated that the underlying latent attribute has been measured. Numerical manipulation is not measurement.

Rasch measurement was developed precisely to solve this problem. Through the conjoint calibration of persons and items, the Rasch model estimates the location of individuals on a latent continuum while simultaneously testing whether the observations satisfy the conditions required for lawful measurement. Unidimensionality, specific objectivity, invariance, item fit, response-category functioning, local independence, and differential item functioning are not optional methodological refinements. They are the empirical conditions that must be satisfied before a claim regarding possession of a latent attribute can be advanced. Rasch therefore provides both the measurement model and the empirical tests necessary to determine whether measurement has actually been achieved.

The interrogation indicates that this perspective is largely absent from the Norwegian curriculum knowledge base. Students and practitioners are introduced to patient-reported outcomes, utilities, quality-of-life instruments, preference weights, QALYs, and economic evaluation without first confronting the measurement problem these constructs are intended to solve. The educational sequence moves directly from ordinal responses to scoring systems and economic models. The essential intermediate step demonstrating that a latent attribute has been measured is effectively bypassed.

This omission has profound implications. Without Rasch measurement, latent attributes remain unmeasured. Utility scores, composite indices, and preference algorithms may generate numerical outputs, but they do not establish that the underlying construct has been measured. The existence of a number should never be confused with the existence of a measure. Nevertheless, much of contemporary Norwegian HTA proceeds as though this distinction does not exist. Students consequently learn how utilities are generated, how QALYs are constructed, and how reference-case models are populated, yet they are not taught how latent attributes themselves can be measured. The curriculum therefore introduces numerical representations of patient benefit before introducing the scientific framework required to justify those representations. This is curriculum inversion in its clearest form.

For Norway the implications are direct. A healthcare system that places considerable emphasis on evidence-based decision making should also require that the quantities informing those decisions satisfy the accepted standards of representational measurement. Until Rasch measurement assumes its proper place within Norwegian HTA education, latent attributes will continue to be represented through scores, utilities, and indices rather than lawful measures, and the distinction between scoring and measurement will remain obscured. The consequence is that curriculum inversion will

continue to reinforce the broader pattern of measurement inversion that characterizes contemporary HTA.

## **CONCLUSION: CURRICULUM INVERSION AND THE FUTURE OF HTA IN NORWAY**

The companion interrogation of the Norwegian HTA knowledge base demonstrated that contemporary health technology assessment in Norway 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 treated 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 been created, sustained, and transmitted across successive generations of practitioners. The answer is curriculum inversion.

The interrogation demonstrates that the Norwegian HTA curriculum knowledge base introduces students and 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, economic evaluation, utilities, QALYs, decision modelling, evidence synthesis, and reimbursement methodology rather than upon specification of the target attribute, representational measurement, admissible arithmetic, unidimensionality, manifest and latent attributes, Rasch measurement, dimensional homogeneity, and the requirement that therapy-impact claims be prospectively evaluable, independently replicable, and capable of falsification. Graduates therefore acquire technical competence in constructing the reference-case framework without first acquiring the scientific framework necessary to determine whether that framework supports lawful quantitative claims.

For Norway this conclusion has important implications. Norwegian universities, research institutes, and health authorities have established an international reputation for rigorous clinical research, evidence-based medicine, and health services evaluation. The interrogation indicates, however, that the educational framework supporting contemporary HTA has adopted the analytical conventions of the international reference-case paradigm without first embedding the scientific principles of representational measurement. The consequence is that curriculum inversion has become the mechanism through which measurement inversion is reproduced within Norwegian HTA. Utilities, QALYs, cost-effectiveness ratios, and reference-case simulation models continue to occupy a central position in professional education despite depending upon quantities that fail the accepted requirements for lawful measurement.

This conclusion leaves no room for incremental reform. A framework whose constituent quantities fail the axioms of representational measurement cannot be rescued through improved modelling, better utility instruments, more sophisticated statistical methods, expanded real-world evidence, or increasingly elaborate simulation techniques. None of these developments can create measurement where measurement does not exist. Arithmetic cannot rescue quantities that are not measures. Decades of methodological refinement have failed to resolve this problem because the problem lies beneath the methodology itself, in the absence of lawful measurement.

The implications for Norwegian universities are therefore direct. Continuing to educate students in the construction and application of reference-case models without first teaching the scientific principles governing lawful measurement is incompatible with the central purpose of higher education. Universities exist to advance objective knowledge rather than perpetuate analytical traditions whose measurement foundations cannot support quantitative claims. Students should certainly understand the historical importance of utilities, QALYs, and reference-case modelling, but they should understand them as examples of a paradigm that failed to satisfy the accepted standards governing quantitative science. They should not be taught that these constructs provide valid measures of therapy impact because they do not.

The only scientifically defensible path forward is reconstruction. Every HTA submission should begin with explicit specification of the target attribute. Manifest attributes should be evaluated through lawful linear ratio measures. Latent attributes should be evaluated through Rasch logit ratio measures that satisfy the axioms of representational measurement. Every quantitative claim should be accompanied by a prospective protocol specifying the attribute, measurement method, comparator, evaluation period, replication strategy, and conditions for empirical falsification. Measurement must precede arithmetic in every assessment without exception.

Taken together, the companion interrogations of measurement inversion and curriculum inversion demonstrate that the methodological framework underpinning Norwegian HTA has reached its intellectual limit. It has succeeded in standardizing administrative decision making while failing to establish the scientific legitimacy of the quantities upon which those decisions depend. That framework has no scientific future because it rests upon measurement impossibilities. Its place is no longer at the centre of HTA education but in the history of the discipline as an instructive example of how methodological sophistication can evolve independently of measurement science. The future of Norwegian HTA therefore depends not upon refining the existing paradigm but upon replacing it with one founded on representational measurement, lawful quantitative inference, and empirically evaluable claims regarding therapy impact.

To facilitate this transition, Maimon Research LLC has developed a comprehensive nine-unit HTA Reconstruction Program <sup>5</sup>. 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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