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**REPRESENTATIONAL MEASUREMENT FAILURE IN  
HEALTH TECHNOLOGY ASSESSMENT**

**CANADA: HTAi AND THE INSTITUTIONALIZATION  
OF CURRICULUM INVERSION**

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## **ABSTRACT**

*Health Technology Assessment International (HTAi) occupies a central position in the global health technology assessment (HTA) community through its educational activities, professional development programs, conferences, workshops, and methodological leadership. Given this influence, the educational content promoted by HTAi plays an important role in shaping the concepts and analytical frameworks adopted by successive generations of HTA practitioners. This assessment examines whether the HTAi educational framework provides the measurement foundations required for valid quantitative claims or whether it contributes to the perpetuation of curriculum inversion.*

*Curriculum inversion occurs when students are taught quantitative methods and analytical techniques before they are introduced to the measurement principles necessary to determine whether those methods are scientifically legitimate. Using a large language model interrogation based on ten canonical statements, the assessment evaluated the extent to which HTAi educational materials recognize attributes, scales of measurement, representational measurement, unidimensionality, manifest and latent attributes, ratio measurement, Rasch measurement, and falsifiable claims. The results indicate consistently low levels of endorsement for these foundational concepts. In particular, there is little evidence that HTAi recognizes the distinction between manifest and latent attributes, the need for different forms of ratio measurement, or the central role of Rasch measurement in constructing quantitative measures of latent attribute possession. At the same time, utilities, quality-adjusted life years (QALYs), patient-reported outcome measures, and simulation-based evaluation frameworks remain prominent components of HTA education.*

*The findings suggest that HTAi reproduces the same pattern of curriculum inversion observed elsewhere in the HTA community. Students are introduced to accepted HTA methodologies before they are exposed to the concepts required to evaluate their measurement status. As a consequence, measurement inversion becomes institutionalized through education and professional training. The assessment concludes that the future relevance of HTAi depends upon its willingness to engage with the implications of representational measurement and to participate in the reconstruction of HTA around lawful measurement, evaluable claims, and the standards of quantitative science.*

## **INTRODUCTION**

Health Technology Assessment International (HTAi) occupies a unique place in Canadian and global health technology assessment (HTA). Founded in Canada and headquartered in Edmonton, Alberta, HTAi serves as the principal international professional organization for HTA researchers, practitioners, policy-makers, patient representatives, and industry participants. Through its annual meetings, educational workshops, professional development activities, special interest groups, policy discussions, and international collaborations, HTAi plays a significant role in shaping how HTA is understood, taught, and applied across multiple jurisdictions.

This influence extends well beyond methodological guidance. HTAi functions as an important educational institution, helping to define the concepts, analytical frameworks, and assumptions that are introduced to successive generations of HTA practitioners. The organization therefore occupies a critical position in the transmission and reinforcement of HTA knowledge. An assessment of HTAi is consequently not merely an assessment of one professional association. It is an examination of the educational and conceptual foundations that support contemporary HTA practice. If curriculum inversion is present within HTAi, it is likely to influence the wider HTA community through the continuing reproduction of the same methodological assumptions and educational priorities.

In a previous assessment of the HTAi knowledge base it was clear that there was strong endorsement of measurement inversion<sup>i</sup>. In this previous assessment of the HTAi knowledge base it was clear that there was strong endorsement of measurement inversion. The interrogation demonstrated that propositions inconsistent with the principles of representational measurement received high levels of endorsement, while propositions necessary for quantitative science received consistently low levels of support. Utilities were treated as though they possessed the properties required for arithmetic operations, QALYs were accepted as valid quantitative representations of therapeutic value, and simulation models were regarded as capable of generating meaningful evidence despite relying upon measures whose status had not been established. At the same time, there was little recognition of the requirements of ratio measurement, dimensional homogeneity, unidimensionality, or the distinction between manifest and latent attributes.

The obvious question that follows is how such a pattern can be sustained and reproduced. Measurement inversion does not arise spontaneously. It must be transmitted through educational programs, professional training, workshops, methodological guidance, and continuing professional development. This raises a second and equally important question: does the HTAi educational framework provide participants with the conceptual tools necessary to recognize measurement inversion, or does it inadvertently contribute to its perpetuation through curriculum inversion?

## **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<sup>ii iii</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.

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 Canada 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.

## **INTERROGATING THE CURRICULUM**

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.

## **HTAi AND CURRICULUM INVERSION**

The curriculum interrogation of HTAi reveals a pattern that is now familiar across the health technology assessment landscape (Table 1). Students and practitioners are introduced to utilities, QALYs, simulation models, and other accepted components of the HTA reference case before they are introduced to the concepts required to evaluate whether these constructs satisfy the standards of measurement. The curriculum teaches the products of the framework before teaching the criteria by which the framework itself should be judged. As a result, accepted methodologies are presented as established analytical tools rather than as propositions whose measurement status must first be demonstrated.

**TABLE 1: CURRICULUM CONTENT ENDORSEMENT: HTAi**

CANONICAL STATEMENT	CATEGORICAL PROBABILITY
An attribute is the specific outcome of interest in a therapy assessment	0.30
Every therapy assessment begins with specification of the target attribute	0.25
The principal scales of measurement (nominal, ordinal, interval and ratio) have different properties and support different forms of analysis	0.20
The measurement status of a target attribute must be established before quantitative claims can be advanced	0.15

The axioms of representational measurement underpin quantitative claims	0.10
Attributes must be demonstrated to be unidimensional before measurement is possible	0.10
A manifest attribute is directly observable and capable of supporting empirical observation	0.35
A latent attribute is not directly observable and requires a measurement model to estimate possession of the attribute	0.25
Manifest and latent attributes require different forms of ratio measurement	0.10
Therapy impact claims must be falsifiable	0.30

The consequence is a self-reinforcing educational system. Because the principles of representational measurement, scale theory, dimensional homogeneity, unidimensionality, ratio measurement, and falsifiability are largely absent, students are not equipped to recognize the limitations of the methods they are taught. Numerical constructions are therefore accepted as measures, not because their measurement properties have been established, but because the intellectual framework required to challenge them is itself missing from the curriculum.

This distinction is important. Measurement inversion concerns the misuse or absence of measurement principles in analytical practice. Curriculum inversion concerns the educational process through which those practices are transmitted and reproduced. If students are never taught the conditions required for measurement, then they have no basis upon which to question the legitimacy of utilities, QALYs, simulation models, composite indices, or preference-weighted scores. The result is a self-reinforcing intellectual system in which numerical constructs are accepted as measures simply because they are widely used.

The ten canonical statements employed in this assessment were selected because they represent the minimum conceptual foundation required for any discipline that wishes to make quantitative claims. They begin with the concept of an attribute and proceed through scale theory, representational measurement, unidimensionality, manifest and latent variables, ratio measurement, and falsifiability. None of these concepts is controversial. They are accepted throughout the physical sciences and wherever measurement is taken seriously. Yet the interrogation indicates that these concepts occupy a peripheral position within the HTAi educational framework.

The significance of the first two statements cannot be overstated. An attribute is the object of measurement. Every scientific claim begins with specification of the attribute to be measured. Before a researcher can claim improvement, deterioration, benefit, harm, value, or effectiveness, it must be clear what attribute is under investigation. Without a clearly defined attribute, measurement is impossible because there is nothing to measure.

Yet contemporary HTA rarely begins with the attribute. It begins with interventions, comparators, costs, utilities, models, evidence synthesis, reimbursement pathways, and policy decisions. Students are taught how to evaluate technologies before they are taught how to define the object

of measurement. This reversal of sequence is the first manifestation of curriculum inversion. The curriculum assumes measurement rather than explaining it.

The same problem appears with the principal scales of measurement. The distinction between nominal, ordinal, interval, and ratio scales is not a historical curiosity. It determines the operations that can be performed on numerical observations. If a variable is ordinal, then only ranking is supported. If a variable is ratio, then multiplication and division become admissible. These distinctions are foundational because quantitative claims depend entirely upon them.

Yet HTA curricula generally treat scale properties as peripheral issues. Students encounter utility scores, preference weights, quality-of-life instruments, and QALYs without first understanding what forms of arithmetic are supported by the underlying scales. Consequently, arithmetic becomes detached from measurement. Numbers are manipulated because they exist, not because their measurement properties justify the operations performed upon them.

This leads directly to the fourth canonical statement: the measurement status of an attribute must be established before quantitative claims can be advanced. This proposition should be self-evident. If one does not know whether an attribute possesses ratio properties, then one cannot legitimately multiply it. If one does not know whether an attribute is unidimensional, then one cannot assume that a composite score measures a single construct. If one does not know whether a variable is ordinal or interval, then one cannot assume that differences between scores have quantitative meaning.

The interrogation indicates that this principle is largely absent from the educational framework. Instead, HTA students are introduced directly to accepted methodologies. Utility instruments are taught. Cost-effectiveness models are taught. QALYs are taught. Simulation models are taught. Yet the prior question, whether the inputs to these methodologies satisfy the requirements for measurement is seldom asked. The result is an educational system that teaches arithmetic before measurement.

The absence of representational measurement is perhaps the most striking finding. Representational measurement is the discipline that explains how empirical observations can be represented numerically. It establishes the conditions under which numbers can meaningfully correspond to attributes in the real world. Without representational measurement there is no basis for distinguishing a measure from a score, an index, a ranking, or a preference weight.

The interrogation suggests that representational measurement is almost entirely absent from the HTAi curriculum. This omission is not trivial. It removes the intellectual framework required to evaluate whether accepted HTA constructs are measures at all. Students are therefore denied access to the conceptual tools that would allow them to assess the scientific legitimacy of the methods they are being taught.

The same observation applies to unidimensionality. Measurement requires a single attribute. If a construct combines multiple attributes, then it cannot automatically be assumed to represent a single quantitative dimension. Yet many HTA instruments aggregate diverse domains into a single index. Mobility, pain, emotional wellbeing, self-care, cognition, social participation, and other

dimensions are combined into composite scores that are subsequently treated as though they represent a single measurable quantity.

The curriculum typically presents these instruments as established tools. What is missing is any systematic discussion of whether the underlying construct is unidimensional. The result is that students learn to accept multidimensional indices without understanding the conditions under which a single quantitative measure can legitimately be claimed.

The distinction between manifest and latent attributes represents another major omission. Manifest attributes are directly observable. They can be counted, timed, or recorded through empirical observation. Examples include hospital admissions, mortality, medication possession, emergency visits, and treatment discontinuation. These attributes can potentially support linear ratio measures because they possess observable units and meaningful zeros.

Latent attributes are fundamentally different. Pain, fatigue, depression, quality of life, and need fulfillment cannot be observed directly. They must be inferred through a measurement model. Their existence is not in doubt, but their measurement requires a different methodological approach. The curriculum interrogation indicates only limited recognition of this distinction.

This is a profound deficiency because latent attributes dominate many patient-centered claims in HTA. If these attributes are not measured appropriately, then the resulting claims lack quantitative legitimacy. The issue is not whether patients experience pain or improved quality of life. The issue is whether these experiences have been measured according to accepted scientific standards.

This leads inevitably to Rasch measurement<sup>iv</sup>. The Rasch model is unique because it provides a framework for transforming ordinal observations into measures of latent attribute possession while simultaneously testing the conditions required for measurement. Unidimensionality, invariance, item functioning, category performance, and person-item relationships are all evaluated explicitly.

Yet Rasch measurement occupies virtually no role within the educational structure reflected in the interrogation. This absence is revealing. The curriculum teaches latent outcomes, patient-reported outcomes, quality-of-life assessment, and utility instruments, but it does not teach the one measurement framework capable of supporting lawful latent measurement. Students therefore encounter latent variables without encountering the measurement model required to justify claims about them.

The ninth statement addresses perhaps the most important distinction of all: manifest and latent attributes require different forms of ratio measurement. This proposition sits at the heart of the alternative framework proposed throughout these assessments. Manifest attributes support linear ratio scales. Latent attributes require Rasch logit ratio scales. Together these two forms of measurement provide a complete framework for evaluating therapy impact.

The interrogation suggests that this distinction is effectively absent. Consequently, students are never exposed to the possibility that HTA could be reconstructed on measurement foundations. Instead, they are taught to regard utilities, QALYs, and simulation models as the natural language of value assessment. Alternative approaches based on measurement science are rarely considered.

The final statement concerns falsifiability. This is significant because quantitative claims must be capable of empirical evaluation. A therapy impact claim that cannot be tested is not scientific. Yet much of HTA revolves around long-term simulation exercises whose outputs are inherently insulated from direct empirical evaluation. Students learn to interpret these outputs without being encouraged to ask whether the underlying claims are falsifiable.

Taken together, these findings reveal a coherent pattern. HTAi does not merely omit certain measurement concepts. It reproduces a curriculum structure in which measurement theory is subordinate to established HTA methodology. The sequence is reversed. Students first encounter accepted practices and only later, if at all, encounter the concepts that would allow them to evaluate those practices critically.

This is the essence of curriculum inversion. The curriculum does not begin with measurement and proceed to application. It begins with application and largely bypasses measurement. The consequence is predictable. Students learn how to use utilities, QALYs, and models without learning how to determine whether these constructs satisfy the requirements for quantitative claims.

The implications extend far beyond HTAi itself. As an international organization, HTAi influences educational standards, professional development, conference programs, workshops, and methodological discourse throughout the global HTA community. If curriculum inversion is present at this level, then it contributes to the continued reproduction of measurement inversion across agencies, journals, research centers, and academic programs.

For this reason, the solution cannot be limited to minor curriculum adjustments. Adding a lecture on measurement theory or inserting a brief discussion of scale types would leave the underlying structure intact. The problem is not lack of supplementary content. The problem is that the curriculum is organized around constructs whose legitimacy depends upon measurement principles that are not taught.

The required response is therefore more fundamental. Measurement must become the organizing principle of HTA education. Students should first encounter attributes, scale theory, representational measurement, dimensional homogeneity, manifest and latent variables, ratio measurement, Rasch measurement, and falsifiability. Only then should they be introduced to utilities, QALYs, preference instruments, and simulation models. The latter should be presented not as accepted truths but as propositions whose measurement status requires critical evaluation.

This does not imply educational disruption. It implies intellectual reconstruction. The objective is not to abolish HTA education but to place it on foundations consistent with quantitative science. The current curriculum teaches students how to operate within the reference-case paradigm. A reconstructed curriculum would teach them how to evaluate whether that paradigm satisfies the requirements for measurement.

The interrogation therefore leads to a clear conclusion. HTAi Canada exhibits the same pattern of curriculum inversion observed throughout the broader HTA community. The concepts required to recognize measurement failure are largely absent, while the methods that depend upon those

concepts are strongly embedded. The result is a curriculum that reproduces measurement inversion from one generation of practitioners to the next. Until measurement becomes the starting point for HTA education, the cycle will continue. The challenge facing HTAi is not curriculum enhancement but curriculum reconstruction grounded in the principles of representational measurement and the standards of normal science.

## **MANIFEST AND LATENT ATTRIBUTES**

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

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

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

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

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

The interrogation suggests that this perspective is absent from the HTAi 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: THE FUTURE OF HTAi**

Given the evidence presented in this assessment, the question of HTAi's future becomes unavoidable. The interrogation indicates not only strong endorsement of measurement inversion but also strong endorsement of curriculum inversion. The concepts required to recognize the limitations of utilities, QALYs, preference-based instruments, and simulation models are largely absent, while the methods that depend upon those omissions remain central to the educational and methodological framework. As a consequence, HTAi finds itself in a uniquely challenging position.

The difficulty is not simply that aspects of HTA methodology have been criticized. Criticism and methodological debate are normal features of scientific inquiry. The challenge confronting HTAi is more fundamental. The conceptual foundations upon which much of contemporary HTA has been constructed have been systematically deconstructed on measurement grounds. The assumptions supporting utility measurement, QALY construction, and reference-case simulation modelling have been shown to conflict with both the conventional scales of measurement and the axioms of representational measurement. If these findings are accepted, then the framework that

has dominated HTA for four decades cannot be regarded as a scientifically secure foundation for quantitative claims.

This places HTAi in a difficult but potentially important position. As the leading international professional organization for HTA, it can continue to defend the existing framework despite the abundant evidence of measurement failure, or it can assume a leadership role in examining the implications of that evidence. The issue is no longer whether utilities, QALYs, and simulation models are familiar, widely used, or institutionally accepted. The issue is whether they satisfy the standards required for quantitative science.

The future relevance of HTAi may therefore depend upon its willingness to engage with this challenge directly. An organization dedicated to advancing HTA cannot remain indifferent to questions concerning the validity of the measurements upon which HTA claims are based. If the findings reported here are ignored, HTAi risks becoming the principal defender of a framework whose scientific foundations have been called into question. If, however, it embraces the challenge, it could become the catalyst for a transition toward measurement-based HTA.

The choice is therefore not between stability and change. The intellectual foundations of the existing framework have already been challenged. The real choice is whether HTAi participates in the reconstruction of HTA around the principles of measurement science or remains committed to defending a paradigm whose measurement foundations have been shown to be absent. In that sense, the future of HTAi is inseparable from the future of HTA itself.

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