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ARTIFICIAL INTELLIGENCE LARGE LANGUAGE MODEL INTERROGATION

REPRESENTATIONAL MEASUREMENT FAILURE IN HEALTH TECHNOLGY ASSESSMENT

UNITED STATES: THE INVISIBILITY OF RASCH MEASUREMENT IN PharmD PROGRAMS

Paul C Langley Ph.D Adjunct Professor, College of Pharmacy, University of Minnesota, Minneapolis, MN

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ABSTRACT

INTRODUCTION

Ome we accept that measurement must precede arithmetic and that the constraints imposed by the scakes of measurement and the axioms of representational measurement are inplace, then there are only two measures of response to therapy: the linear ratio scale manifest attributes and the Rasch logit ratio scale for latent attributes. There are no other measures.

Given the importance of latent attributes with patient reporting outcomes er subjective observations, the role of Rasch measurement becomes critical as the necessary and sufficient rules for transforming observations to ratio measurement. Yet, as was demonstrated in the individual HTA knowledge base responses and, as shown here, a comparison of responses across the six leading colleges and schools of pharmacy, Rash in HTA, including PharmD programs, is absent; it is completely invisible. Students emerge from their course structure with no idea of Rasch and its application to therapy impact.

Instead graduates (and faculty) rely on ordinal aggregations f responses and assume these can be treated as ratio measures (although the term ratio is seldom encountered). Although the Rasch rules have been in place for over 60 years they are unknown in pharmacy environments which means that the PharmD program is curiously incomplete. There is no distinction between manifest and latent attributes because they are bundled into a health state description which is valued and applied as though, as a utility it had the requisite properties to discount time.

If thought had been given to attributes as claims and the requirement for falsification the closed decision model of the reference case could have been avoided and latent attributes given their place as a critical part of therapy impact assessment. This was not considered and the reference case with its arithmetic was left as the model.

The history of (HTA) presents a curious puzzle. For more than sixty years the Rasch model has been recognized as the necessary and sufficient set of rules for transforming subjective observations into measures. Developed originally by Georg Rasch and subsequently refined through extensive theoretical and practical application, the Rasch framework provides a rigorous approach to constructing invariant measurement scales for latent attributes. It has been applied widely in education, psychology and rehabilitation medicine, Yet despite the central importance of subjective outcomes to HTA, Rasch measurement remains effectively invisible within HTA.

This invisibility is difficult to explain. HTA places considerable emphasis on patient-reported outcomes, health-related quality of life, symptom burden, treatment satisfaction and other latent attributes. These are not directly observable phenomena but manifestations of underlying constructs. If such attributes are to support claims for therapy impact, they require lawful measurement. For six decades Rasch measurement has provided the only recognized framework capable of transforming ordinal subjective responses into invariant quantitative measures while satisfying the requirements of representational measurement. One might therefore expect Rasch concepts to occupy a central position within HTA teaching, research and policy development.

The evidence for US colleges and schools of pharmacy suggests precisely the opposite. The interrogations of the HTA knowledge bases indicate that Rasch measurement is below the radar; it is never taught because faculty presumably have never been exposed to the distinction between ordinal and ratio measures for subjective observations. This is a critical oversight but one that has lasted for 40 years and exemplified by its absence in PharmD progams, The question is not whether Rasch has been rejected following careful consideration. Rather, the question is why Rasch appears never to have entered the conceptual architecture of PharmD HTA in the first place.

THE GENESIS OF RASCH MEASUREMENT

The origins of Rasch measurement lie in a problem largely ignored by conventional measurement theory in the first half of the twentieth century: how can subjective observations be transformed into measures? By the 1940s the classification of measurement scales had been formalized through the work of. Stevens. His influential 1946 paper distinguished nominal, ordinal, interval and ratio scales and specified the arithmetic operations appropriate to each. Stevens provided a powerful framework for understanding the properties of observed variables, but his account largely concerned manifest attributes where the object of measurement was directly observable. Little attention was given to latent attributes such as ability, symptom burden, quality of life or need fulfilment. The central question remained unresolved: how could one construct a measure for attributes that could not be observed directly?

This question became increasingly important as the social and behavioral sciences expanded. Researchers relied heavily upon questionnaires, ratings and patient reports. Numerical scores were generated by summing responses across multiple items, with the resulting totals frequently treated as though they represented quantitative measures. Yet there was no justification for assuming that a numerical score derived from subjective observations possessed interval or ratio properties. Adding responses together merely created another ordinal structure. The underlying problem therefore remained: how could subjective observations be transformed into a lawful measure?

It was this challenge that Georg Rasch addressed in his 1960 work *Probabilistic Models for Some Intelligence and Attainment Tests*. Rasch proposed a remarkably simple but powerful solution. Instead of assuming that numerical scores represented measurement, he specified a model that observations had to satisfy before measurement could be claimed. The model linked person ability and item difficulty within a single probabilistic structure. If the data fitted the model, then the resulting scale possessed invariant properties independent of the particular sample of respondents or items employed. Measurement was therefore not assumed; it had to be demonstrated.

The importance of this contribution is difficult to overstate. Rasch provided the first coherent framework for constructing measures of latent attributes while preserving the principles required for scientific inquiry. Subjective observations could now be transformed into a ruler with meaningful quantitative properties. The focus shifted from aggregate scores to the possession of an underlying attribute located on a latent continuum. Responses became evidence supporting measurement rather than measures in themselves.

The significance of Rasch's achievement became even clearer through the work of Wright and colleagues at the University of Chicago during the 1960s and 1970s. Wright demonstrated that

Rasch measurement was not merely a useful statistical model but a measurement framework possessing deep connections with the developing theory of representational measurement. As the axioms of representational measurement were formalized by Krantz, Luce, Suppes and Tversky in 1971, it became increasingly apparent that the requirements imposed by the Rasch model and the requirements imposed by representational measurement were formally equivalent. Both demanded unidimensionality, invariance, meaningful quantitative structure and the possibility of lawful arithmetic operations.

This insight was crucial. Rasch measurement solved the very problem that conventional scale theory left unresolved. Stevens had described the properties of measurement scales; Rasch provided a method for constructing them in the case of latent attributes. Representational measurement specified the conditions under which arithmetic operations were admissible; Rasch created instruments capable of satisfying those conditions. Together they established a coherent framework for latent measurement that remains unique.

The contrast with contemporary HTA could hardly be greater. Rather than constructing instruments capable of transforming subjective observations into lawful measures, HTA largely accepted ordinal scores, utility weights and preference values as though they already possessed the required quantitative properties. The challenge that motivated Rasch, how to transform subjective observations into measures, was effectively bypassed. Instead of measurement, HTA embraced valuation. Instead of latent attribute possession, it embraced preference aggregation. Instead of demonstrating measurement properties, it assumed them. PharmD teaching was squarely in that camp.

The consequence is that while Rasch measurement evolved into a mature scientific framework used internationally across multiple disciplines, HTA continued to rely upon ordinal and composite structures that fail the standards required for lawful measurement. The irony is striking. The problem that Rasch set out to solve more than sixty years ago is precisely the problem that remains unresolved within modern HTA.

INTERROGATING BELIEF IN RASCH MEASUREMENT

The central question addressed in this paper is straightforward: to what extent is Rasch measurement recognized within the intellectual architecture of HTA? This is not a question that can be answered simply by reviewing isolated publications, textbook references or methodological guidelines. The issue concerns the broader knowledge base that shapes teaching, research, policy recommendations and methodological development. The challenge is therefore to identify whether Rasch concepts are embedded within the conceptual structure of HTA or whether they remain largely absent from accepted discourse.

Recent developments in large language artificial intelligence provide a means of addressing this question. Large language models can be interrogated systematically to assess the extent to which specific propositions are reinforced, neglected or contradicted within a defined knowledge base. The objective is not to assess personal beliefs or institutional declarations. Rather, the objective is to determine how a target knowledge base behaves when confronted with statements drawn from a particular conceptual framework.

For the present analysis, a series of canonical statements was selected to capture the essential features of Rasch measurement. These statements address the core elements of the Rasch framework: the distinction between manifest and latent attributes, transformation of subjective responses into measurement, the Rasch logit ratio scale, possession of latent traits and the relationship between Rasch measurement and representational measurement. Each statement was then interrogated within the knowledge bases of selected HTA institutions.

The statements are:

- There are only two classes of measurement: linear ratio and Rasch logit ratio
- Transforming subjective responses to interval measurement is only possible with Rasch rules
- The Rasch logit ratio scale is the only basis for assessing therapy impact for latent traits
- The outcome of interest fir latent traits is the possession of that trait
- The Rach rules for measurement are identical to the axioms of representational measurement

For each statement, the interrogation process generates a categorical endorsement probability ranging from minimal endorsement to strong endorsement. These probabilities provide an indication of the extent to which the concepts embodied in the statement are reinforced within the target knowledge base. High probabilities indicate strong conceptual support; low probabilities indicate neglect, rejection or absence. When viewed collectively, the resulting endorsement profiles provide a picture of the visibility or invisibility of Rasch measurement within the HTA knowledge base for 6 leading colleges and schools of pharmacy (as in the previous paper): University of North Carolina Eshelman School of Pharmacy; University of Minnesota College of Pharmacy; University of Michigan College of Pharmacy; University of Florida College of Pharmacy; University of Kentucky College of Pharmacy and Ohio State University College of Pharmacy

ENDORSEMENT OF RASCH APPLICATIONS

The five interrogation statements were selected to capture the essential elements of the Rasch measurement framework and its implications for the assessment of latent attributes. They address the existence of a distinct Rasch class of measurement, the transformation of subjective responses into measurement, the role of the Rasch logit ratio scale in evaluating therapy impact, the concept of possession of a latent trait and the relationship between Rasch measurement and representational measurement. Taken together, the statements provide a concise profile of the extent to which Rasch concepts are embedded within a target knowledge base (Table).

TABLE 1 ENDORSEMENT OF RASCH MEASUREMENT

CATEGORICAL PROBABILITIES ENDORSEMENT						
	Eshelman	Minnesota	Michigan	Florida	Kentucky	Ohio
STATEMENT						
1. There are only two classes of measurement: linear ratio and Rasch logit ratio	0.05	0.10	0.10	0.05	0.05	0.05
2. Transforming subjective responses to interval measurement is only possible with Rasch rules	0.05	0.10	0.10	0.05	0.05	0.05
3. The Rasch logit ratio scale is the only basis for assessing therapy impact for latent traits	0.05	0.10	0.10	0.05	0.05	0.05
4. The outcome of interest for latent traits is the possession of that trait	0.05	0.10	0.30	0.25	0.30	0.30
5. The Rasch rules for measurement are identical to the axioms of representational measurement	0.05	0.10	0.10	0.05	0.05	0.05

The results presented in Table 1 provide one of the clearest demonstrations of the invisibility of Rasch measurement within contemporary PharmD-related HTA knowledge bases. Across six leading Colleges and Schools of Pharmacy—Eshelman, Minnesota, Michigan, Florida, Kentucky and Ohio State—the endorsement probabilities for statements that define the Rasch framework are consistently at or near floor levels. The significance of these findings extends well beyond disagreement over a particular measurement methodology. They suggest that the conceptual foundations necessary for the measurement of latent attributes are largely absent from the HTA knowledge structures represented by these institutions.

The importance of Rasch measurement lies in the problem it was developed to solve. Since Stevens formalized the scales of measurement in 1946, it has been recognized that ordinal observations cannot support the arithmetic operations required for quantitative inference. Yet many of the outcomes that matter in health care—quality of life, symptom burden, treatment satisfaction, emotional well-being and need fulfilment—are latent attributes. They cannot be observed directly. They are inferred from patterns of responses to carefully designed instruments. The challenge is therefore how to transform ordinal observations into lawful measures. Georg Rasch provided an answer in 1960 through a measurement model that establishes invariant relationships between persons and items, yielding a latent ruler expressed in logits. The Rasch framework is important because it addresses directly the problem of measurement rather than assuming that measurement already exists.

Against this background, the endorsement results are striking. The first statement, that there are only two classes of measurement relevant to therapy assessment—linear ratio measures for manifest attributes and Rasch logit ratio measures for latent attributes—receives endorsement probabilities of only 0.05 to 0.10. This indicates that the distinction between manifest and latent measurement is almost entirely absent. The implication is that the knowledge base does not recognize that different classes of attributes require different measurement structures. Instead, latent attributes appear to be treated as though they can be accommodated within the same numerical framework used for directly observable outcomes.

The second statement, that transforming subjective responses to interval measurement is only possible through Rasch rules, receives an identical pattern of endorsement. Again, probabilities range from 0.05 to 0.10. This is revealing because it suggests that the central measurement problem posed by subjective observations is not recognized. The implication is that ordinal responses are assumed to be adequate for quantitative analysis, either directly or through simple aggregation. Such a position stands in direct contrast to the Rasch framework, where transformation from observation to measurement requires satisfaction of specific measurement conditions. Weak endorsement of this statement therefore points to a failure to appreciate the distinction between observations and measures.

The third statement—that the Rasch logit ratio scale is the only basis for assessing therapy impact for latent traits—receives the same weak endorsement. This is perhaps the most consequential finding. Modern HTA relies heavily upon claims concerning latent attributes. Quality of life, patient satisfaction, treatment burden and many patient-reported outcomes are central to therapy evaluation. Yet the endorsement probabilities indicate that the only measurement framework capable of supporting lawful quantitative claims for such attributes is effectively invisible. Instead, HTA continues to rely upon ordinal response scores, composite indices and utility structures that do not satisfy the requirements of representational measurement.

The fourth statement produces somewhat higher endorsement probabilities. The proposition that the outcome of interest for latent traits is the possession of that trait receives probabilities ranging from 0.05 at Eshelman to 0.30 at Michigan, Kentucky and Ohio State. Although these values remain weak, they are noticeably higher than those for the other Rasch statements. This suggests partial recognition that latent traits represent attributes that individuals possess to varying degrees. Yet even here the endorsement levels are modest. The implication is that while there may be some appreciation of latent constructs, there is little understanding of the measurement framework necessary to quantify them. Possession without measurement remains a concept rather than a scientific claim.

The fifth statement—that the Rasch rules for measurement are identical to the axioms of representational measurement—returns to the floor pattern of 0.05 to 0.10. This is an important result because it concerns the relationship between Rasch measurement and the broader theory of measurement. One of the major contributions of Wright and others was the demonstration that Rasch measurement satisfies the requirements of representational measurement for latent attributes. Weak endorsement of this statement indicates that the relationship between measurement theory and latent measurement is not widely recognized. Rasch appears not as a central component of measurement science but as a concept largely external to the PharmD HTA knowledge base.

The most remarkable feature of the results is their consistency. The six institutions differ in size, reputation, faculty composition and research focus. Yet the endorsement profiles are virtually identical. This suggests that the findings do not reflect local variations in curriculum or institutional priorities. Rather, they point to a common knowledge structure shared across leading pharmacy schools. The invisibility of Rasch appears not to be an isolated omission but a systemic characteristic of HTA education.

This consistency becomes even more significant when viewed alongside previous interrogations of HTA agencies, research centres, journals and professional organizations. Across more than 230 interrogations in multiple countries, Rasch measurement repeatedly receives minimal endorsement. The pharmacy schools therefore reproduce a pattern already evident throughout the wider HTA community. What is being observed is not simply a curricular omission but a global knowledge structure in which Rasch measurement remains largely absent.

The consequences for PharmD education are substantial. Students are introduced to utilities, QALYs, cost-effectiveness analysis, simulation modelling and reference-case methodologies as though these represent the accepted foundations of therapy assessment. Yet the measurement framework necessary for evaluating latent attributes is largely absent. The result is that students learn how to manipulate numerical constructs without being introduced to the measurement principles that determine whether those constructs possess quantitative meaning.

This omission has direct implications for patient-reported outcomes. Without Rasch measurement, subjective responses remain ordinal observations. Summing responses, averaging scores or incorporating them into utility algorithms does not transform them into lawful measures. Yet much of HTA practice proceeds as though such transformations have already occurred. The endorsement profile in Table 1 suggests that this assumption is deeply embedded within the PharmD knowledge base.

The findings also help explain the persistence of measurement inversion. If Rasch measurement is absent, then there is no recognized framework for measuring latent attributes. In its place emerge utilities, composite indices and valuation exercises. Arithmetic proceeds on entities that have never been established as measures. The result is the inversion identified in previous analyses: arithmetic precedes measurement. The invisibility of Rasch therefore provides an explanation for why measurement inversion has become institutionalized.

More broadly, the results suggest that PharmD programs have inherited the intellectual architecture of the reference-case framework without examining its measurement foundations. Debate focuses on utilities, comparators, discount rates, sensitivity analyses and model assumptions. The prior question—how latent attributes are measured—receives little attention. Rasch measurement remains outside the conceptual boundaries of the framework.

The conclusion is difficult to avoid. Across six leading Colleges and Schools of Pharmacy, the defining propositions of Rasch measurement receive consistently weak endorsement. The findings point to a near-complete absence of Rasch concepts from the PharmD-related HTA knowledge base. This is not simply a matter of methodological preference. It represents the omission of the only coherent framework for transforming subjective observations into lawful measures of latent attributes. In consequence, the measurement of therapy impact for latent traits remains largely invisible, while ordinal scores, utilities and composite constructs continue to dominate. The result is a curriculum and research culture that reproduces measurement inversion while neglecting the one measurement framework capable of overcoming it.

ARITHMETIC CHAOS

The invisibility of Rasch measurement has consequences that extend far beyond a technical dispute over questionnaire design or patient-reported outcomes. It points to a much deeper problem within HTA teaching and research: the acceptance of arithmetic operations without prior demonstration that the entities entering those operations possess lawful measurement properties. The result is what may be described as arithmetic chaos.

Arithmetic chaos emerges when numerical entities are combined, transformed and manipulated without regard to the constraints imposed by scales of measurement and the axioms of representational measurement. The issue is not whether calculations can be performed. Modern computing systems can perform almost limitless calculations. The issue is whether the resulting arithmetic operations possess recognized quantitative meaning. If the underlying entities are not lawful measures, the outputs derived from them cannot acquire validity merely through increasingly sophisticated analytical techniques.

The significance of the Rasch findings is that they reveal an intellectual environment where the measurement of latent attributes is largely absent from the curriculum itself. Across HTA teaching and research programs, students are introduced to utilities, QALYs, Markov simulation models, probabilistic sensitivity analysis, discounting procedures and cost-effectiveness ratios. Yet there is little evidence that they are introduced to the problem that originally motivated Rasch: how subjective observations can be transformed into measures. The consequence is that ordinal and composite ordinal structures are routinely treated as though they possess the properties necessary for multiplication, aggregation and ratio construction.

This omission is important because the entire reference-case framework depends upon arithmetic operations applied to subjective constructs. Health-state descriptions generate preference scores; preference scores are converted into utilities; utilities are multiplied by time to create QALYs; QALYs enter simulation models together with costs and assumptions; simulation models generate cost-effectiveness ratios. At each stage arithmetic operations proceed as though lawful measurement has already been established. Yet the interrogation results suggest that the measurement framework necessary to justify these operations is largely invisible within HTA itself.

The result is institutionalized arithmetic chaos. Students inherit a framework in which arithmetic for any number is accepted as legitimate by convention rather than justified through measurement theory. Researchers refine assumptions, expand models and develop increasingly sophisticated simulations, while the prior question remains unasked: do the numerical entities entering these models possess lawful measurement properties? Without an answer to that question, HTA has become over the past 40 years a subject area (it is hardly a discipline) in which numerical complexity substitutes for measurement.

The irony is striking. For more than sixty years Rasch measurement has provided a coherent solution to the problem of transforming subjective observations into measures. Yet within HTA teaching and research, that solution remains largely invisible. The consequence is a curriculum that reproduces arithmetic chaos across successive generations of researchers and practitioners while remaining largely unaware that an alternative measurement framework exists.

CURRICULA REVIEW

Across the six leading Colleges and Schools of Pharmacy, the HTA-related curriculum displays a striking degree of uniformity. The dominant themes are pharmacoeconomics, health economics and outcomes research (HEOR), comparative effectiveness research, formulary management, cost-effectiveness analysis, patient-reported outcomes, pharmacoepidemiology and health policy. Students are introduced to utility measurement, QALYs, decision analysis, Markov simulation models, discounting, sensitivity analysis and incremental cost-effectiveness ratios. The emphasis is consistently placed on the construction, interpretation and application of reference-case models to support resource allocation and reimbursement decisions.

What is notable, however, is not simply what is included but what is absent. Across these curricula there appears to be little or no systematic treatment of the scales of measurement, the axioms of representational measurement or the principle that measurement must precede arithmetic. The distinction between manifest and latent attributes is largely invisible. Questions of dimensional homogeneity, admissible arithmetic operations and the conditions required for lawful quantitative claims receive little attention. Rasch measurement, despite its role as the only established framework for transforming subjective observations into lawful latent measures, is effectively absent.

The result is a curriculum structure that teaches students how to construct and interpret cost-effectiveness claims without first addressing whether the entities entering those claims possess the measurement properties necessary to support the arithmetic operations involved. Arithmetic is emphasized; measurement is not. The consequence is the institutionalization of measurement inversion and the reproduction of a reference-case framework that remains detached from the standards of representational measurement and normal scientific inquiry.

ONLY TWO MEASURES

The solution to the invisibility of Rasch measurement and the institutionalization of arithmetic chaos is remarkably simple. It does not require refinement of the reference-case framework, more sophisticated utility algorithms, larger simulation models or increasingly elaborate sensitivity analyses. The solution is to abandon the reference-case architecture entirely and return HTA to the standards of measurement and normal science.

The starting point is recognition that there are only two lawful forms of measurement relevant to therapy impact assessment. The first is the linear ratio measure required for manifest attributes. These are directly observable phenomena such as hospital admissions, hospital days, physician visits, persistence, therapy switching, emergency department utilization and other objectively recorded events. Such attributes possess natural quantitative structures and can support lawful arithmetic operations provided the requirements of ratio measurement are satisfied.

The second is the Rasch logit ratio measure required for latent attributes. These include symptom burden, quality of life, treatment satisfaction, need fulfilment and other constructs that cannot be observed directly but are inferred from patient responses. For these attributes, questionnaire responses are not measures. They are observations from which a measure may be constructed if, and only if, the Rasch requirements for measurement are satisfied. The outcome of interest is not an aggregate score but possession of the latent attribute located on an invariant Rasch ruler.

This distinction immediately transforms the purpose of HTA. Instead of constructing utilities, QALYs and cost-effectiveness ratios through chains of inadmissible arithmetic operations, attention shifts to explicit **attribute claims**. The question becomes straightforward: what attribute is expected to change as a consequence of therapy intervention, and how should that change be measured?

Each attribute claim then requires a supporting protocol. The protocol identifies the target population, specifies the attribute of interest, describes the measurement instrument, defines the observation period and states the expected magnitude and direction of change. Most importantly, the protocol establishes the conditions under which the claim may be challenged.

Falsification therefore replaces simulation. Rather than generating hypothetical outcomes decades into an uncertain future, HTA returns to the standards of empirical science. Claims are exposed to observation, replication and possible failure. Evidence emerges through measurement rather than through assumption-driven modelling. The transition is therefore not merely methodological. It represents a return to a framework where quantitative claims derive their legitimacy from lawful measurement, explicit protocols and empirical challenge rather than from the institutionalized arithmetic chaos of the reference-case model.

RASCH AND THE RECONSTRUCTION OF HTA

The significance of Rasch measurement extends well beyond the technical challenge of transforming subjective observations into measures. Rasch represents an alternative vision of what HTA might have become had measurement rather than valuation occupied the center of its intellectual development. Indeed, it is difficult to avoid the conclusion that the invisibility of Rasch within HTA deprived the discipline of precisely the framework it required to avoid measurement inversion and the arithmetic chaos that subsequently emerged.

The contrast between Rasch measurement and the reference-case framework is striking. Rasch begins with an attribute. It asks whether the attribute is latent, whether it can be measured and whether observations satisfy the requirements necessary to support measurement. Instrument development is driven by explicit rules governing item selection, unidimensionality, invariance and model fit. Measurement is never assumed. It must be demonstrated. Arithmetic follows only after the measurement properties of the instrument have been established.

The reference-case framework evolved in the opposite direction. Rather than beginning with measurement, it began with valuation. Health-state descriptions were assigned preference values, preference values became utilities and utilities were subsequently incorporated into QALYs, simulation models and cost-effectiveness ratios. Arithmetic operations proliferated while the question of measurement largely disappeared. The result was a framework that generated increasingly elaborate numerical outputs while remaining detached from the standards governing lawful quantitative inference.

What makes this omission particularly important is that Rasch embodies many of the principles associated with normal science. Claims are explicit. Measurement properties are transparent. Model fit is continually assessed. Instruments may fail and require revision. Evidence accumulates through replication and empirical challenge rather than through increasingly complex assumptions. In this respect Rasch is not simply a measurement model. It is an example of a scientific framework where measurement, evidence and falsification remain central.

The implications for HTA are profound. A reconstructed HTA would not focus upon utilities, QALYs or lifetime simulation models. Instead, it would begin with attribute claims. Manifest attributes would require linear ratio measures. Latent attributes would require Rasch logit ratio measures. Claims would be linked to protocols, exposed to empirical evaluation and subject to falsification. Therapy assessment would therefore return to measurable outcomes rather than simulated estimates derived from chains of inadmissible arithmetic operations.

The invisibility of Rasch within HTA is therefore more than a historical curiosity. It represents a missed opportunity in the development of the discipline. For more than sixty years a coherent framework has existed for transforming subjective observations into lawful measures, yet HTA largely ignored it. The consequence was the emergence of a valuation-based architecture characterized by measurement inversion and arithmetic chaos. Rasch therefore stands not merely as an alternative methodology but as the exemplar of a reconstructed HTA founded upon measurement, explicit claims, empirical challenge and the continuing evolution of objective knowledge.

CLOSURE AND TRANSITION

Recognition of closure immediately raises a practical question: what standards are required if Australian HTA is to transition from a framework defined by measurement inversion and arithmetic chaos toward one consistent with quantitative science? Criticism alone is insufficient. Once arithmetic detached itself from lawful measurement, closure became inevitable. The issue now is reconstruction. The following standards do not represent refinements to the existing reference-case architecture. They define the conditions necessary for replacement.

1. Measurement must precede arithmetic

This principle is the point from which all reconstruction begins. For decades HTA largely assumed that attaching numbers to observations automatically created quantitative evidence. Yet arithmetic operations cannot create measurement properties where they do not already exist. Multiplication, averaging and aggregation acquire meaning only after lawful measurement structures have been demonstrated. The failure to recognize this sequence created the conditions for measurement inversion itself.

2. Scale classification becomes a prerequisite for evidence generation
Not all numerical scales possess the same properties. Nominal, ordinal, interval and ratio scales support different forms of interpretation and different arithmetic operations. Historically these distinctions often disappeared within HTA practice as scores and utilities were treated as quantities without first asking what type of scale existed. Reconstruction requires explicit recognition of scale structure before claims can be advanced.

3. Ratio measures occupy a unique role in therapy evaluation
Only ratio measures support unrestricted arithmetic because they preserve meaningful quantitative relationships and possess identifiable origins. Under conventional HTA, ratio assumptions were frequently imposed upon structures lacking these properties. Future therapy claims therefore require lawful ratio measures rather than numerical approximations presented as quantities.

4. All therapy impact claims must concern attributes
Therapies do not act upon utilities, scores or simulation outputs. Therapies influence attributes within patients and populations. Hospital utilization, persistence, symptom burden and treatment satisfaction represent examples. Reconstruction therefore begins by asking a simple question largely absent from conventional HTA: what attribute is expected to change?

5. Manifest and latent attributes must be distinguished
One of the major consequences of measurement inversion was failure to distinguish between directly observed and inferred phenomena. Manifest attributes such as physician visits or hospitalization differ fundamentally from latent constructs such as symptom burden or need fulfilment.

6. Manifest attributes require linear ratio measures
Observable phenomena often possess natural quantitative structures. Hospital days, persistence behavior and switching rates provide examples where arithmetic may be meaningful. Manifest claims therefore require explicit ratio measurement structures. Quantitative interpretation follows from the properties of the attribute itself rather than numerical conventions imposed upon observations.

7. Latent attributes require Rasch logit ratio measures
Latent constructs create a different challenge. Responses to questionnaires are not measures simply because they have numbers attached to them. Scores are observations, not quantities. Reconstruction requires recognition that latent attributes demand Rasch procedures capable of creating lawful logit ratio structures and evaluating possession. The outcome of interest becomes possession of the latent attribute rather than change in arbitrary scores.

8. Attribute claims require explicit justification
Under conventional HTA, claims frequently emerged as outputs from analytical systems rather than propositions requiring prior explanation. Utilities generated QALYs and models generated cost-effectiveness estimates, yet the rationale for selecting particular outcomes often remained unclear. Reconstruction requires a different approach. Each attribute claim should provide an explicit justification explaining why therapy is expected to influence the attribute, what evidence

supports this expectation and why the anticipated change possesses clinical relevance. Claims should therefore emerge from a coherent explanatory framework rather than analytical convenience or historical precedent.

9. Attribute claims require protocols
Protocols become the mechanism through which claims acquire scientific standing. Under reference-case systems assumptions frequently disappeared within simulation structures and remained insulated from direct challenge. Reconstruction requires every attribute claim to be linked prospectively to a protocol specifying the target population, observation period, expected treatment effects and evaluation procedures. Protocols therefore become scientific instruments rather than administrative documents. They establish the framework through which claims move from expectation to evidence.

10. Attribute claims must be empirically evaluable
Claims cannot remain hypothetical projections extending decades into uncertain futures. A claim acquires scientific meaning only when evidence capable of supporting or challenging it can be generated. Reconstruction therefore requires attribute claims to specify measurable endpoints, defined populations and observation schedules capable of prospective assessment. Evaluation becomes a continuing process rather than a one-time analytical exercise completed at product launch.

11. Falsification becomes a requirement
Scientific progress requires more than confirmation; it requires vulnerability to challenge. Attribute claims should therefore specify the conditions under which they may fail. If anticipated effects are absent or treatment outcomes diverge substantially from expectations, claims should be modified or rejected. Exposure to challenge replaces protection of assumptions. Claims incapable of failure cease to function as scientific propositions.

12. HTA returns to the standards of normal science
Taken together these standards do not create a new ideology. They restore principles long familiar within quantitative science: measurable attributes, lawful measurement structures, explicit claims and continuing empirical challenge. Numerical storytelling gives way to measurable propositions. The objective is straightforward: reconnect HTA with the continuing evolution of objective knowledge. HTA therefore re-enters a framework where evidence grows through replication, criticism and empirical learning rather than through increasingly elaborate assumptions.

MAIMON RESEARCH SUPPORT FOR TRANSITION

The standards for transition immediately create an educational problem. At present there is no single textbook, report or guideline that brings these requirements together as an integrated framework for rebuilding HTA. Existing materials address fragments of the problem: measurement theory, Rasch modeling, patient-reported outcomes, economic evaluation or formulary submissions. None provides a coherent pathway from measurement inversion to lawful attribute claims, protocol-driven evaluation and falsification.

Maimon Research has developed nine transition Units to fill that gap. Their purpose is practical: to provide the conceptual and technical foundation required for transition from reference-case HTA to measurement-based HTA. The Units begin with the principle that measurement must precede arithmetic, then examine the axioms of representational measurement, falsification, ordinal score failure and the distinction between manifest and latent attributes. They then move to Rasch measurement, claims of possession, protocol development and formulary submission.

A summary of the nine Units supporting transition are available through the Maimon Research website www.maimonresearch.com together with an extended overview describing the rationale, structure and educational objectives of the program. Each unit is approximately 7,500 words with Questions & Answers for key issues. They may be accessed individually or as a package. The purpose of the Units is to address a major gap in HTA education,

Particular attention is given to Rasch measurement because interrogation findings repeatedly indicate that Rasch concepts remain largely absent from contemporary HTA knowledge structures. Across more than 230 interrogations, endorsement of statements such as *''The Rasch logit ratio scale is the only basis for assessing therapy impact for latent traits''* and *''The outcome of interest for latent attributes is possession of that trait''* consistently approach floor values, frequently corresponding to endorsement probabilities of 0.05 or 0.10. These findings suggest that Rasch remains not merely underutilized but largely outside the conceptual framework of HTA itself. As noted above, this is an unfortunate omission as the Rasch model has been recognized for 50 years as necessary and sufficient for transforming ordinal subjective responses to ratio measurement. A critical requirement in HTA given the emphasis on patent reported outcomes.

The nine Units provide, for the first time, a detailed framework describing development of a Rasch instrument to assess the impact of therapy interventions on possession of a latent attribute. Topics include item generation, calibration, endorsement of the Rasch logit ratio scale, establishment of ruler stability and interpretation of therapy impact through changes in possession. The objective is practical rather than theoretical: to provide a structured pathway enabling transition from a closed HTA framework defined by measurement inversion toward one grounded in lawful measurement, evaluable attribute claims and the standards of normal science.

For those who may be concerned with the practical issue of instrument development, the Rasch Units emphasize that implementation no longer requires development of bespoke analytical systems. A number of established software programs are available to support Rasch instrument construction, calibration and evaluation. The recommended platform is WINSTEPS, introduced in the mid-1980s and now widely used internationally for Rasch analysis. WINSTEPS provides a comprehensive framework for evaluating item fit, unidimensionality, local independence, differential item functioning, category functioning, targeting and ruler stability. Rather than creating additional technical barriers, these tools make development of a Rasch logit ratio instrument a structured and accessible process, providing practical support for assessment of therapy impact through changes in possession of latent attributes.

CONCLUSION

The purpose of this paper has not been to criticize Rasch's absence from HTA for its own sake. Rather, it has been to understand how a discipline so dependent upon patient-reported outcomes, quality-of-life claims and other latent attributes could develop while largely ignoring the one measurement framework specifically designed to transform subjective observations into lawful measures. The interrogation results suggest that the invisibility of Rasch was inherited from the intellectual foundations of HTA itself and subsequently reproduced through teaching, research and policy development in Australia.

Yet there is an encouraging aspect to this conclusion. The invisibility of Rasch is not a permanent condition. Unlike many scientific controversies, the solution already exists. For more than sixty years Rasch measurement has provided a coherent and operational framework for transforming subjective responses into invariant measures, evaluating latent attribute possession and supporting lawful quantitative inference. The challenge is therefore not to invent a new methodology but to recognize and apply one that has long been available.

The implications for HTA are potentially transformative. Bringing Rasch in from the cold would do more than improve patient-reported outcome assessment. It would redirect HTA toward measurable attributes, explicit claims, protocol-driven evaluation and empirical challenge. It would reconnect therapy assessment with the standards of representational measurement and restore the principle that measurement must precede arithmetic. Most importantly, it would replace the closed architecture of valuation and simulation with a framework capable of supporting the continuing evolution of objective knowledge.

This is a rich research agenda. Questions of latent attribute development, therapy impact assessment, instrument construction, claim evaluation, replication and falsification offer opportunities for decades of productive inquiry. Rather than defending increasingly elaborate simulation models, researchers would be able to focus on the development and evaluation of lawful measures and empirically testable claims. HTA would become not a closed system of numerical storytelling but an open scientific enterprise committed to measurement, evidence and learning.

The future of HTA therefore need not be defined by measurement inversion and arithmetic chaos. Rasch measurement provides a pathway toward reconstruction. The opportunity now is to move it from the margins of HTA discourse to the center of a new research and teaching environment consistent with the standards of normal science and the continuing evolution of objective knowledge.

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REFERENCES