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REPRESENTATIONAL MEASUREMENT FAILURE IN HEALTH TECHNOLGY ASSESSMENT

TEXAS: REQUIRED PROGRAM CONTENT FOR A GRADUATE COURSE IN HTA

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ABSTRACT

Graduate education in health technology assessment (HTA) should provide students with the scientific foundations required to construct defensible quantitative claims of therapy impact. Previous assessment of the publicly available program-content knowledge base associated with major Texas university affiliated HTA, health-economics, pharmacoeconomics and outcomes-research environments identified a marked separation between representational measurement and contemporary HTA. None of 17 topics defining representational measurement was identified as an explicit scientific foundation, while all 20 topics characterizing contemporary HTA and health economics were represented: 0/17 versus 20/20.

This paper asks what an informed prospective student should therefore expect from graduate education in quantitative HTA. Twenty essential topics are proposed as a coherent curriculum rather than optional additions to established teaching. They begin with the principle that measurement precedes arithmetic and encompass attribute definition, numerical assignment versus measurement, scales of measurement, admissible transformations, representational-measurement axioms, ratio measurement and dimensional homogeneity. The framework then distinguishes manifest from latent attributes and establishes their respective measurement pathways. Quantitative therapy-impact claims require linear ratio measurement for manifest attributes or Rasch logit ratio measurement for latent attributes. The resulting claims should be empirically evaluable, replicable and capable of falsification, thereby satisfying the requirements of normal science.

Implementation requires more than adding a measurement module to an existing syllabus. Faculty may themselves need to acquire measurement knowledge absent from their original training and integrate it throughout teaching, research projects and assessment. Students should correspondingly expect to question the measurement status of numerical claims rather than simply master inherited analytical procedures. Integration rather than acknowledgement is the required standard.

A nine-unit transformation program provides one pathway for developing this replacement curriculum, supported by continuing question-and-answer assistance, seminars, workshops, curriculum development, teaching resources and lectures. The challenge for Texas universities is therefore one of transition rather than curriculum expansion. Graduate HTA education should be judged not by its conformity with established professional practice but by whether it equips students to construct defensible quantitative claims and contribute to objective knowledge. For prospective students investing substantial time, money and career opportunity, the question is straightforward: does the program provide that scientific education?

INTRODUCTION

Graduate education in the United States is expensive. A prospective student considering advanced study in health technology assessment (HTA), health economics or quantitative therapy evaluation is being asked to commit tuition fees, considerable time and an important part of his or her future career to the program selected. The student is therefore entitled to ask a straightforward question before enrolling: what scientific capabilities will this program actually give me? If the objective is to acquire expertise in quantitative therapy evaluation, the answer should extend beyond proficiency in established analytical techniques. The student should expect to be taught the scientific requirements that determine whether a numerical claim concerning therapy impact is a measure, whether the arithmetic performed upon it is admissible and whether the resulting claim can contribute to the growth of objective knowledge.

This question has particular relevance in Texas. Previous assessment of the publicly available program-content knowledge base associated with major Texas university affiliated HTA, health-economics, pharmacoeconomics, outcomes-research and health-policy environments identified a striking separation between representational measurement and the established quantitative framework of HTA and health economics [1]. The knowledge base included major activities associated with the University of Texas System, the Texas Center for Health Outcomes Research and Education (TxCORE), MD Anderson Cancer Center, Baylor College of Medicine, the University of Houston, Texas A&M University, UT Southwestern Medical Center and other identifiable university-affiliated programs. Using the fixed program-content framework, none of the 17 topics defining representational measurement was identified as an explicit scientific foundation, while all 20 topics characterizing the established HTA and health-economics framework were represented. The result was 0/17 versus 20/20.

An informed prospective student should be aware of this finding. It means that the decision to enroll should not rest simply upon the existence of courses or research programs in health economics, pharmacoeconomics, outcomes research, economic evaluation, comparative effectiveness research or related quantitative methods. Nor should the reputation of the university, the publication records of faculty or the technical sophistication of the methods being taught be taken as evidence that the scientific foundations of measurement are necessarily addressed. The **0/17** result raises a prior question: does the proposed graduate education provide the body of measurement knowledge required to determine whether the quantitative operations encountered in therapy evaluation are scientifically meaningful?

The starting point should be elementary but non-negotiable: measurement precedes arithmetic. Before numbers are added, subtracted, multiplied, divided or incorporated into any further quantitative analysis, the attribute represented by those numbers must be defined and their measurement properties established. Students should understand the distinction between assigning numbers and creating measures; nominal, ordinal, interval and ratio scales; admissible transformations; the axioms of representational measurement; the requirements for ratio measurement; and dimensional homogeneity. These are not specialist topics to be appended to an otherwise complete quantitative curriculum. They determine what arithmetic is permissible in the first place.

The curriculum must then address the measurement of therapy impact itself. This requires an explicit distinction between manifest and latent attributes. Manifest attributes are directly observable and, where the necessary measurement conditions are satisfied, can support linear ratio measurement. Latent attributes such as pain, fatigue, anxiety or physical functioning cannot be directly observed and require construction of a measurement continuum. For these attributes, students should understand Rasch person-item conjoint measurement, construction of the logit ruler, unidimensionality, fit, local independence, ordered thresholds, differential item functioning, invariance, specific objectivity and attribute possession. These concepts provide a measurement pathway from observed responses to defensible quantitative claims concerning changes in a latent attribute.

The destination of graduate education in quantitative therapy evaluation should therefore be clear. Students should understand that there are two allowable measurement forms for therapy-impact claims: linear ratio measurement for manifest attributes and Rasch logit ratio measurement for latent attributes. They should be able to identify the target attribute, determine whether it is manifest or latent, establish the appropriate measurement pathway and formulate a quantitative therapy-impact claim whose measurement status can be defended. A collection of statistical and analytical techniques is not a substitute for this capability.

There is an equally important scientific destination. Therapy-impact claims should meet the requirements of normal science. They should be stated prospectively, expressed using defensible measures, empirically evaluable, open to replication and capable of falsification. A graduate should understand that the purpose of quantitative analysis is not simply to generate numerical results but to formulate claims that can be confronted by evidence and can succeed or fail. Measurement provides the necessary bridge between observation and the creation of objective knowledge.

Against this standard, the Texas 0/17 versus 20/20 finding assumes particular importance. It does not demonstrate an absence of quantitative teaching or expertise. Quite the reverse: the 20/20 result demonstrates the breadth and sophistication of the existing Texas quantitative program-content knowledge base. The concern is that this extensive analytical structure is not accompanied, as far as can be ascertained from publicly available program content, by the representational-measurement framework required to establish the status of the quantities being analyzed. Texas therefore presents the same fundamental problem identified elsewhere: extensive instruction in quantitative analysis without an identifiable prior foundation in the science of quantitative measurement.

For the prospective student, therefore, the issue is practical rather than abstract. Graduate education represents a purchase of knowledge and capability. Before committing money, time and career opportunity, an informed student should establish whether the proposed program provides the scientific foundations necessary for quantitative therapy evaluation. The purpose of this paper is to identify 20 topics that such a student should expect to be addressed in a graduate program and to explain why each is essential. Together they provide a straightforward standard against which the student can ask: if I enroll in this program, will I be educated in the measurement and evaluation of therapy impact according to the requirements of normal science, and if not, what exactly am I paying to learn?

PROGRAM CONTENT RESULTS

The earlier assessment of the Texas university affiliated HTA and health-economics research-center knowledge base provides the immediate background to the present paper. The result followed the now familiar pattern: representational measurement was effectively absent from publicly identifiable program content, while the established methods of contemporary HTA and health economics were comprehensively represented. There is no need to reproduce those results here. The importance of the Texas finding lies not in its uniqueness but in its consistency with the evidence accumulated elsewhere.

The same pattern has emerged from investigations of measurement inversion, curriculum inversion and program-content inversion in the United States and internationally. Across agencies, research centers, university programs and the wider HTA knowledge base, the principles of representational measurement receive little or no identifiable recognition [2 3]. Measurement preceding arithmetic, admissible transformations, ratio measurement, dimensional homogeneity, the distinction between manifest and latent attributes, and the requirements for constructing measures of latent attributes are largely absent. At the same time, extensive quantitative structures have developed that presume that the numerical values upon which they operate possess the properties required to support the arithmetic being performed.

The cumulative evidence suggests something more serious than the omission of a few topics from graduate curricula. There appears to be little evidence within the HTA discipline of a systematic understanding, or even awareness, of representational measurement as the scientific foundation for quantitative claims. This conclusion is supported not by a single interrogation or jurisdiction but by the remarkable consistency of findings across different forms of assessment and different institutional settings. Texas should therefore be viewed as one expression of a much wider epistemic failure rather than an isolated educational problem.

Indeed, the Texas result is particularly important because of the size and sophistication of its academic health-research environment. The state contains major university systems, medical schools, pharmacy programs, cancer centers and research groups engaged in health economics, pharmacoeconomics, outcomes research, comparative effectiveness research, health-services research and healthcare policy. The absence of representational measurement cannot therefore readily be attributed to a limited academic infrastructure or lack of quantitative expertise. The contrast is the opposite: extensive analytical sophistication exists alongside an apparent absence of the measurement framework required to establish the quantitative status of the numbers being analyzed.

The historical implication is substantial. Graduate programs in HTA, health economics, pharmacoeconomics and outcomes research have been educating successive generations of practitioners for approximately three decades without, as far as can be established from the accumulated evidence, placing representational measurement at the foundation of quantitative therapy evaluation. Students have been trained in increasingly sophisticated analytical methods without first being required to establish the measurement status of the numbers entering those analyses. The result has been the institutional reproduction of measurement failure: faculty teach the framework in which they themselves were trained, graduates become practitioners and future faculty, and the same assumptions are transmitted to the next generation.

This history gives particular importance to the question of required graduate program content. The objective is not to add another specialist topic called “measurement” to an already crowded curriculum. Nor is it sufficient to devote a lecture to scales of measurement while leaving the remainder of the quantitative program unchanged. If representational measurement establishes the conditions under which quantitative claims and mathematical operations are meaningful, it must provide the organizing scientific framework for the course.

The 20 topics that follow are proposed on that basis. Together they describe the minimum body of knowledge that an informed student should expect a graduate program in quantitative HTA to address. They begin with measurement preceding arithmetic and proceed through attribute definition, scale properties, admissible transformations, ratio measurement and dimensional homogeneity to the separate requirements for measuring manifest and latent attributes. They culminate in the two allowable measurement forms for therapy-impact claims—linear ratio measurement for manifest attributes and Rasch logit ratio measurement for latent attributes—and the requirement that such claims meet the standards of normal science through empirical evaluation, replication and potential falsification.

The question for Texas graduate programs is therefore not whether these topics would provide useful additions to existing teaching. It is whether a course claiming to educate students in quantitative HTA can reasonably omit them. The accumulated evidence of measurement, curriculum and program-content inversion suggests that this question has not previously been asked. After three decades of graduate education built without this measurement foundation, it needs to be asked now.

TWENTY ESSENTIAL TOPICS FOR A GRADUATE PROGRAM IN QUANTITATIVE THERAPY EVALUATION

The following 20 topics represent a coherent body of knowledge rather than a menu from which individual subjects might be selected. Each contributes to the progression from defining an attribute, through establishing a measure, to constructing an empirically evaluable therapy-impact claim. An informed prospective student should therefore establish whether these topics are addressed in the graduate program being considered.

1. Measurement must precede arithmetic

Why this is essential. Measurement establishes the properties of the numerical representation before arithmetic is undertaken. Those properties determine which mathematical operations are admissible. Arithmetic cannot retrospectively transform numbers into measures or supply measurement properties that were never demonstrated. A graduate student in quantitative therapy evaluation should therefore understand from the outset that the scientific sequence is attribute definition, measurement and only then arithmetic. Reversing this sequence substitutes numerical manipulation for measurement and undermines the quantitative status of subsequent claims.

2. Definition of the target attribute before measurement

Why this is essential. Every therapy-impact claim concerns an attribute. Before selecting an instrument, assigning numbers or performing arithmetic, the student must be able to state precisely what is to be measured. Survival, hospital utilization, pain, fatigue and physical functioning represent different attributes and may require different measurement approaches. Failure to define the attribute creates ambiguity about what the resulting numbers represent. Attribute definition is therefore the necessary starting point for selecting a measure and constructing a defensible therapy-impact claim.

3. The distinction between numerical assignment and measurement

Why this is essential. Numbers may be assigned to observations for identification, ordering, classification or convenience without creating a quantitative measure. The fact that responses are represented by integers does not establish equal units, a meaningful zero or permissible arithmetic. Graduate students must therefore understand the difference between producing a numerical score and measuring an attribute. Without this distinction, numerical representations can acquire an appearance of quantitative precision while lacking the properties required to support the mathematical operations subsequently performed upon them.

4. Nominal, ordinal, interval and ratio scales

Why this is essential. The traditional hierarchy of measurement scales identifies fundamentally different numerical structures. Nominal values classify, ordinal values establish order, interval scales support meaningful differences, and ratio scales additionally support meaningful ratios where their defining requirements are satisfied. These distinctions are not introductory terminology to be mentioned and forgotten. They determine what can legitimately be done with numerical values. A graduate should be able to identify the scale properties of a proposed measure before deciding which arithmetic operations are meaningful.

5. Admissible transformations and permissible arithmetic

Why this is essential. A measurement scale is characterized by transformations that preserve the empirical relationships represented by its numerical assignments. These admissible transformations determine which mathematical statements remain invariant and therefore meaningful. Understanding this relationship prevents students from assuming that every mathematical operation available in software is scientifically permissible. Graduate education in quantitative therapy evaluation should establish the connection between scale structure, admissible transformation and arithmetic so that students can justify the operations applied to measures rather than simply calculate numerical results.

6. The axioms and requirements of representational measurement

Why this is essential. Representational measurement requires numerical relationships to represent corresponding empirical relationships in the attribute being measured. This depends upon conditions such as ordering, additivity, solvability, cancellation and related requirements appropriate to the measurement structure. These principles distinguish measurement from arbitrary numerical assignment. A graduate should understand why measurement requires evidence that the numerical system faithfully represents an empirical relational system. Without this foundation, there is no scientific basis for claiming that assigned numbers possess the quantitative properties attributed to them.

7. The requirements for ratio measurement

Why this is essential. Ratio measurement permits the widest range of arithmetic operations required for quantitative therapy-impact claims, but those operations are justified only when the defining properties of the scale have been established. Students should understand the requirements for invariant units, an appropriate non-arbitrary zero and meaningful ratio comparisons. Statements involving multiplication, division, proportions or claims that one quantity is twice another depend upon these properties. Ratio measurement should therefore be understood as a scientific requirement, not simply another label in a hierarchy of scales.

8. Dimensional homogeneity

Why this is essential. Quantities cannot be combined meaningfully merely because they are represented numerically. The dimensions represented by those quantities must be identified and the proposed arithmetic must preserve dimensional coherence. Dimensional homogeneity provides an elementary safeguard against constructing numerical expressions whose components have incompatible quantitative meanings. Graduate students should be able to examine every proposed therapy-impact calculation and ask what dimensions are being combined, what the resulting quantity represents and whether the operation produces a scientifically interpretable measure rather than an arbitrary numerical construction.

9. The distinction between manifest and latent attributes

Why this is essential. Therapy evaluation involves both directly observable and latent attributes. Hospital days, treatment administrations and survival time are manifest; pain, fatigue, anxiety and physical functioning are latent and cannot be directly observed. This distinction determines the appropriate measurement pathway. A graduate should not approach both categories with the same measurement strategy. Recognizing whether an attribute is manifest or latent is therefore a pivotal decision: it determines how a ruler can be constructed and how a quantitative therapy-impact claim can subsequently be expressed.

10. Linear ratio measurement for manifest attributes

Why this is essential. Manifest attributes capable of direct quantitative representation can be measured using linear ratio scales when the necessary properties of unit and zero are satisfied. Examples may include days hospitalized, treatment administrations or units of resource utilization. Students should understand how such measures are defined, why their units remain invariant and what arithmetic they support. This provides the first of the two measurement pathways required for therapy evaluation and establishes how changes in directly observable attributes can support meaningful quantitative therapy-impact claims.

11. Construction of therapy-impact claims for manifest attributes

Why this is essential. Measurement becomes scientifically useful when it supports an evaluable claim. Students should learn how a manifest attribute is translated into a protocol-defined therapy-impact claim specifying the target population, comparator, timeframe, unit of measurement and expected outcome. The claim should state in advance what observation would support or fail to support it. This moves graduate education beyond descriptive numerical analysis to hypothesisdriven therapy evaluation in which a measured impact is capable of being independently assessed, replicated and potentially rejected by empirical evidence.

12. Why ordinal observations and summed scores do not constitute latent measures

Why this is essential. Questionnaire response categories commonly represent ordered observations, but assigning integers to those categories does not establish equal intervals between them. Adding such integers together does not, by itself, create a measure with invariant units. Graduate students working with patient-reported outcomes must understand this distinction. Otherwise, arithmetic performed on summed scores may be interpreted as measurement without the necessary quantitative structure having been demonstrated. Recognizing the limitations of ordinal observations is the starting point for legitimate measurement of latent attributes.

13. Rasch person–item conjoint measurement

Why this is essential. Latent attributes cannot be directly observed and require a measurement framework capable of constructing a quantitative continuum. Rasch measurement locates persons and items conjointly on the same latent-attribute scale, providing a basis for transforming ordered observations into measures. Graduate students should understand the logic of this relationship rather than treating Rasch as merely another statistical technique. Its importance lies in constructing a ruler for an otherwise unobservable attribute so that differences in attribute possession can support quantitative therapy-impact claims.

14. Construction of a Rasch logit measurement continuum

Why this is essential. Understanding Rasch measurement requires more than knowing its name or operating software. Students should learn how response data are used to estimate person and item locations, how the provisional continuum is constructed and how logits provide the common metric upon which persons and items are located. This establishes the practical bridge between ordinal observations and latent measurement. A graduate should understand where the resulting measures come from, what they represent and why construction of the ruler precedes its use in evaluating therapy impact.

15. Requirements for a defensible Rasch ruler

Why this is essential. A fitted Rasch model does not automatically establish a defensible measurement instrument. Students should understand the empirical requirements that the ruler must satisfy, including unidimensionality, item fit, local independence, ordered response thresholds, differential item functioning, targeting and stability. These requirements test whether the proposed instrument behaves as a measurement system rather than merely providing a statistical description of response data. A graduate should therefore be capable of evaluating whether a proposed latent ruler meets the conditions necessary for quantitative interpretation.

16. Invariance and specific objectivity

Why this is essential. A fundamental objective of measurement is that comparisons should not depend arbitrarily upon the particular measuring instrument or sample used. Rasch specific objectivity requires person comparisons to remain invariant across appropriate items and item comparisons across appropriate persons, subject to the requirements of the measurement model. Students should understand why this property is central to constructing a defensible latent measure. Without appropriate invariance, observed differences may reflect characteristics of the instrument or sample rather than differences in possession of the target attribute.

17. Attribute possession on a Rasch logit scale

Why this is essential. The purpose of latent measurement is to determine the extent to which a person possesses the specified attribute. Once a defensible Rasch ruler has been constructed, the person's response pattern locates that individual on the latent continuum. Graduate students should understand this concept of attribute possession because it changes the focus from questionnaire scores to measures of the attribute itself. Therapy impact can then be expressed as a change in possession rather than simply as a numerical change in an aggregated response score.

18. Therapy-impact claims for changes in latent-attribute possession

Why this is essential. A latent measure should ultimately support an empirically evaluable claim about therapy impact. Students should learn how changes in attribute possession are specified prospectively for a defined population, comparator and timeframe using the Rasch logit measure. The claim must identify the expected change and the evidence that would count against it. This connects latent measurement directly to hypothesis testing and replication. Rasch measurement thereby becomes part of a scientific protocol for evaluating therapy impact rather than an isolated psychometric exercise.

19. The two allowable measurement forms for quantitative therapy-impact claims

Why this is essential. A coherent graduate curriculum should bring the preceding measurement principles together into two pathways for quantitative therapy-impact claims: **linear ratio measurement for manifest attributes and Rasch logit ratio measurement for latent attributes**. The student should understand why the nature of the attribute determines which pathway is appropriate and why other numerical representations cannot simply be assumed to constitute measures. A graduate should leave able to identify the attribute, select the appropriate measurement form and defend the quantitative status of the resulting claim.

20. The requirements of normal science

Why this is essential. Quantitative therapy evaluation should culminate in claims capable of participating in normal scientific inquiry. The attribute must be defined, the measure must satisfy appropriate measurement requirements, and the claim must specify the population, comparator, timeframe and predicted therapy impact. Most importantly, the claim must be empirically evaluable, open to replication and capable of falsification. A graduate program should therefore produce students able not merely to generate numbers, but to construct quantitative claims that can succeed or fail when confronted by evidence.

FACULTY AND STUDENTS

The 20 topics described above imply more than revision of a syllabus. For Texas universities they require a change in the relationship between faculty, students and the quantitative framework that has traditionally defined graduate education in HTA, health economics, pharmacoeconomics and outcomes research. If measurement becomes the organizing principle of therapy evaluation, both faculty and students enter a post-legacy environment in which established methods can no longer be accepted simply because they are familiar, widely used or institutionally supported. Every quantitative claim must instead begin with the attribute, satisfy the requirements of measurement and employ only arithmetic justified by the properties of the measure.

For Texas faculty, this presents an unusual academic challenge. Many current teachers and researchers were themselves educated within programs in which representational measurement was absent. They subsequently developed research careers, publications, teaching materials and professional relationships within the same framework. The evidence from measurement inversion, curriculum inversion and program-content inversion suggests that this omission has been reproduced across successive generations. Faculty cannot therefore be expected to correct the problem merely by being told that measurement should receive greater emphasis. The first requirement is acquisition of a body of knowledge that, for many, was not part of their own graduate education.

This should not be interpreted as a criticism of faculty competence within the framework in which they were trained. Texas has substantial expertise in economic evaluation, statistics, epidemiology, decision analysis, health-services research, outcomes research and related quantitative methods. The problem is more fundamental. Expertise in these areas does not automatically provide expertise in representational measurement. The post-legacy challenge requires faculty themselves to examine attributes, scales, admissible transformations, ratio measurement, dimensional homogeneity, manifest and latent attributes, Rasch measurement, specific objectivity and attribute possession. Only then can these principles be incorporated coherently into graduate teaching.

The responsibility extends well beyond adding a lecture or module entitled *Measurement*. If students are taught that measurement precedes arithmetic, that proposition must have consequences throughout the course. If they are taught that scale properties determine admissible operations, those restrictions must subsequently be respected. If manifest and latent attributes require different measurement pathways, assignments, research projects and assessments must reflect that distinction. Representational measurement cannot occupy one week of a Texas graduate course and then disappear while the remainder of the curriculum proceeds unchanged. Integration rather than acknowledgement is the standard.

Faculty must also be prepared for a different type of classroom. Students who understand representational measurement should be encouraged to ask elementary but potentially disruptive questions: What is the attribute? Is this a measure or merely a score? What is the scale type? Where is the zero? Are the units invariant? What transformations are admissible? Does the proposed arithmetic preserve dimensional homogeneity? Is the attribute manifest or latent? If latent, how was the ruler constructed? These questions should not be regarded as challenges to faculty authority. They are precisely the questions that graduate education in quantitative science should encourage.

The responsibility of the Texas graduate student is correspondingly greater. Students should not approach HTA as a collection of procedures to be mastered, reproduced and subsequently applied in academic, industry or policy settings. They should expect to understand why a quantitative operation is scientifically admissible before performing it. The objective is not proficiency in software or conformity with an established analytical template, but the ability to construct and defend a quantitative claim. Students should therefore be prepared to challenge their own assumptions, identify measurement failures and reject numerical operations that cannot be justified by the properties of the measure.

The post-legacy curriculum also provides students with a much clearer destination. Therapy evaluation begins by defining the target attribute and determining whether it is manifest or latent. For manifest attributes, the student should be able to construct or identify an appropriate linear ratio measure. For latent attributes, the student should understand the construction and evaluation of a Rasch logit ratio measure and the assessment of attribute possession. These are not simply two additional analytical techniques. They constitute the two measurement pathways through which quantitative therapy-impact claims can be constructed.

The final obligation shared by faculty and students is to return quantitative therapy evaluation to the requirements of normal science. Claims should be specified prospectively and expressed in terms that permit empirical evaluation. They should be open to replication and, critically, capable of falsification. Failure is therefore not something to be avoided by constructing increasingly elaborate analytical systems. A claim that fails when confronted by evidence contributes to knowledge because it can be rejected, revised or replaced. Faculty should teach this process; students should expect to participate in it.

Transition to a post-legacy environment will inevitably be demanding in Texas precisely because the existing academic infrastructure is so substantial. Established courses, research programs, doctoral supervision, publications and professional networks cannot be reconstructed overnight. Nor should faculty be expected simply to discard decades of accumulated expertise. The immediate requirement is different: established quantitative methods must be reconsidered against the standards of measurement that should have preceded them. Those that satisfy the requirements can be retained; those that do not must either be reconstructed or abandoned.

That is precisely where the responsibility of the university becomes important. Texas universities are not required to accept the conclusions advanced here without criticism. Faculty should be encouraged to challenge representational measurement, the proposed distinction between manifest and latent measurement pathways, and the conclusions drawn for contemporary HTA. Academic disagreement is entirely appropriate. What is increasingly difficult to defend is the continued education of graduate students in quantitative therapy evaluation without exposing them to the body of measurement knowledge necessary to understand that challenge. Academic freedom protects criticism and disagreement; it does not make an established body of scientific knowledge disappear from the curriculum.

The scale of the Texas university system makes the opportunity particularly significant. A transition within major Texas programs would influence not only current graduate students but future faculty, researchers and practitioners entering pharmaceutical research, health systems, academia, government and industry. Conversely, continuing to reproduce a curriculum in which representational measurement remains absent would transmit the same epistemic limitation to another generation. The decision about program content therefore has consequences extending well beyond the individual course.

The 20 topics proposed here consequently represent more than required program content for Texas. They define a different educational relationship. Faculty are responsible for providing the measurement foundations, subjecting them to critical examination and demonstrating their application; students are responsible for understanding, questioning and applying them. The common objective is a graduate capable of moving beyond inherited numerical procedures to the construction of therapy-impact claims grounded in linear ratio measurement for manifest attributes or Rasch logit ratio measurement for latent attributes, and capable of contributing through those claims to the continuing evolution of objective knowledge.

TRANSITION TO LAWFUL MEASUREMENT

The transition to lawful measurement requires more than demonstrating the measurement failures of contemporary HTA. It requires a replacement framework grounded in representational measurement. The Maimon Research nine-unit transformation program provides that framework [4]. The Maimon Research program is designed as more than a sequence of educational materials. It provides a structured template for faculty, researchers and practitioners seeking to understand and implement the transition from legacy HTA to a framework grounded in representational measurement. The program comprises 45,000 words of structured instructional material with the nine units moving progressively from measurement preceding arithmetic through attributes, scales of measurement, admissible arithmetic and dimensional homogeneity to the distinction between manifest and latent attributes, linear ratio measurement, Rasch measurement, attribute possession and the construction of empirically evaluable therapy-impact claims. The program can therefore be used for individual faculty preparation, as a framework for reconsidering existing graduate teaching, or as the foundation for developing a new postgraduate course in HTA organized around the requirements of lawful measurement and normal science.

An important feature of the program is that participants are not left simply to work through the material independently. Those enrolled have access to continuing 24/7 on line Q&A support as they study the units and, importantly, as they begin to apply the framework in teaching, research or therapy evaluation**.** Questions arising from particular attributes, proposed measures, Rasch applications, therapy-impact claims, protocols or curriculum development can be raised as they occur. The purpose is to support the transition from understanding the principles to applying them in practice. This continuing interaction is particularly important for faculty whose previous education did not include representational measurement and who may be reconsidering assumptions embedded in many years of teaching and research. The objective is not simply completion of nine units, but development of the capability to use the measurement framework independently and to introduce it confidently to students and colleagues.

The program can also provide a starting point for broader institutional engagement. Where universities, research centers, academic departments or professional groups wish to explore the implications of the new HTA in greater depth, additional activities can be developed around their particular requirements, including seminars, faculty discussions, workshops, small-group sessions, curriculum-development support and presentations addressing specific measurement or therapy-evaluation problems. These activities allow institutions to move beyond individual enrollment toward a wider reconsideration of how HTA is taught and applied. A fee is charged for access to the nine-unit program to support the maintenance, administration, updating and continuing availability of the system, including participant support. The larger objective, however, is transformation: to provide faculty and institutions with an accessible, supported pathway for replacing the legacy of measurement failure with graduate education grounded in lawful measurement, admissible arithmetic and empirically evaluable claims.

The nine-unit program is therefore offered as a template for faculty preparation and the development of a post-legacy graduate HTA program. Universities may use the framework to reconsider existing teaching or as the foundation for constructing a new graduate course organized explicitly around representational measurement.

Access to the program involves a fee. The purpose of that charge is to support the continuing maintenance of the system through which the program is provided, including hosting, administration, updating and continued availability of the educational materials. It should not obscure the larger purpose of the initiative. The objective is to make available a structured transition framework that universities and faculty can use to move beyond the measurement failures of contemporary HTA.

The required transformation therefore does not have to begin with each university independently reconstructing the measurement framework from first principles. The framework already exists. The immediate question is whether faculty and graduate programs are prepared to use it as the starting point for a post-legacy HTA curriculum grounded in lawful measurement, admissible arithmetic and the standards of normal science.

. There is no going back.

CONCLUSION

The issue facing graduate HTA education in Texas is no longer whether additional attention might usefully be given to measurement. The accumulated evidence from measurement inversion, curriculum inversion and program-content inversion indicates a more fundamental problem: representational measurement has not provided the scientific foundation for the quantitative methods taught and applied within HTA. The consequence has been the transmission across successive generations of students of an analytical framework in which arithmetic has been allowed to precede measurement.

The 20 topics identified in this paper define what an informed student should now expect from a graduate program concerned with quantitative therapy evaluation. They are not optional additions to an established curriculum. They constitute a coherent body of knowledge beginning with attribute definition and measurement before arithmetic, proceeding through scales of measurement, admissible transformations, ratio measurement and dimensional homogeneity, and culminating in the distinction between manifest and latent attributes. The endpoint is equally clear: quantitative therapy-impact claims require linear ratio measurement for manifest attributes or Rasch logit ratio measurement for latent attributes.

The challenge is therefore one of transition rather than curriculum expansion. Faculty must acquire and integrate a body of measurement knowledge that may have been absent from their own graduate education. Students, in turn, should expect more than technical proficiency in inherited quantitative procedures. They should leave a graduate program capable of identifying an attribute, establishing its measurement requirements, selecting the appropriate measurement pathway and constructing a therapy-impact claim that is empirically evaluable, replicable and capable of falsification.

Texas universities now have an opportunity to define what graduate education in HTA should mean in a post-legacy environment. Given the scale and sophistication of the state's academic infrastructure in health economics, pharmacoeconomics, outcomes research, medicine, pharmacy, public health and health-services research, the opportunity is substantial. Texas could continue to reproduce an established analytical framework in which the requirements of representational measurement remain largely absent, or its universities could begin the transition toward a curriculum in which measurement provides the organizing scientific foundation for quantitative therapy evaluation.

The standard should not be whether a program reproduces established professional practice or prepares students to apply methods that have been accepted for decades. Institutional acceptance and widespread use do not establish scientific validity. The appropriate standard is whether the program equips students to construct defensible quantitative claims and thereby contribute to normal science and the evolution of objective knowledge.

For the prospective student investing substantial time, money and career opportunity, the question is correspondingly simple: does the Texas graduate program being considered provide this scientific education? If it cannot demonstrate a coherent pathway from attribute definition, through lawful measurement, to empirically evaluable and falsifiable therapy-impact claims, why enroll?

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