January 2018

DRAFT

Designing Assessments for Multidisciplinary Constructs and Applications: A User-centered Methodology

Chapter 4- Supplements
Tables, Boxes and Figures

(Guilford, in press)

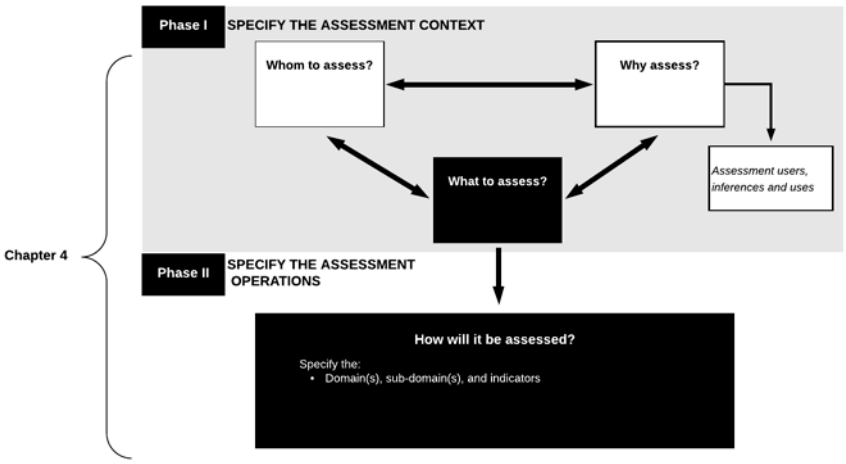


Figure 4.1 Connecting Chapter 4 to the Process Model and the rest of the book.

Note: See Figure 1.6 in Chapter 1 for the complete model

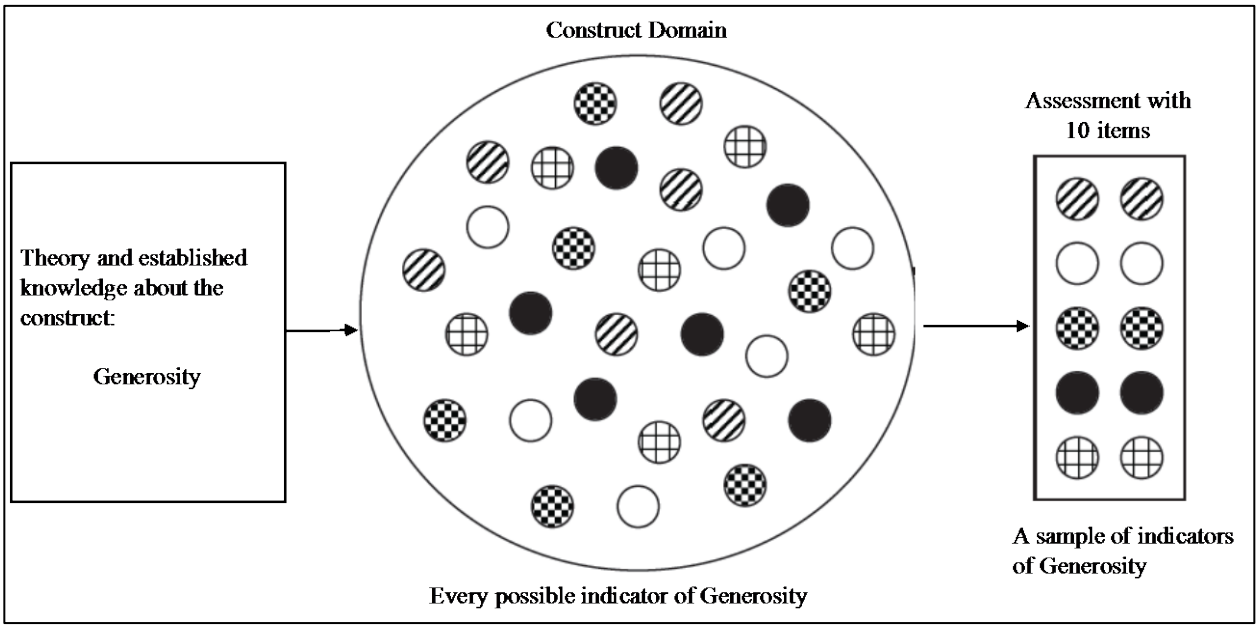


Figure 4.2 Applying Domain Sampling Methods to Ensure Content Relevance and Content Representativeness

Source: Adapted from Author, 2003

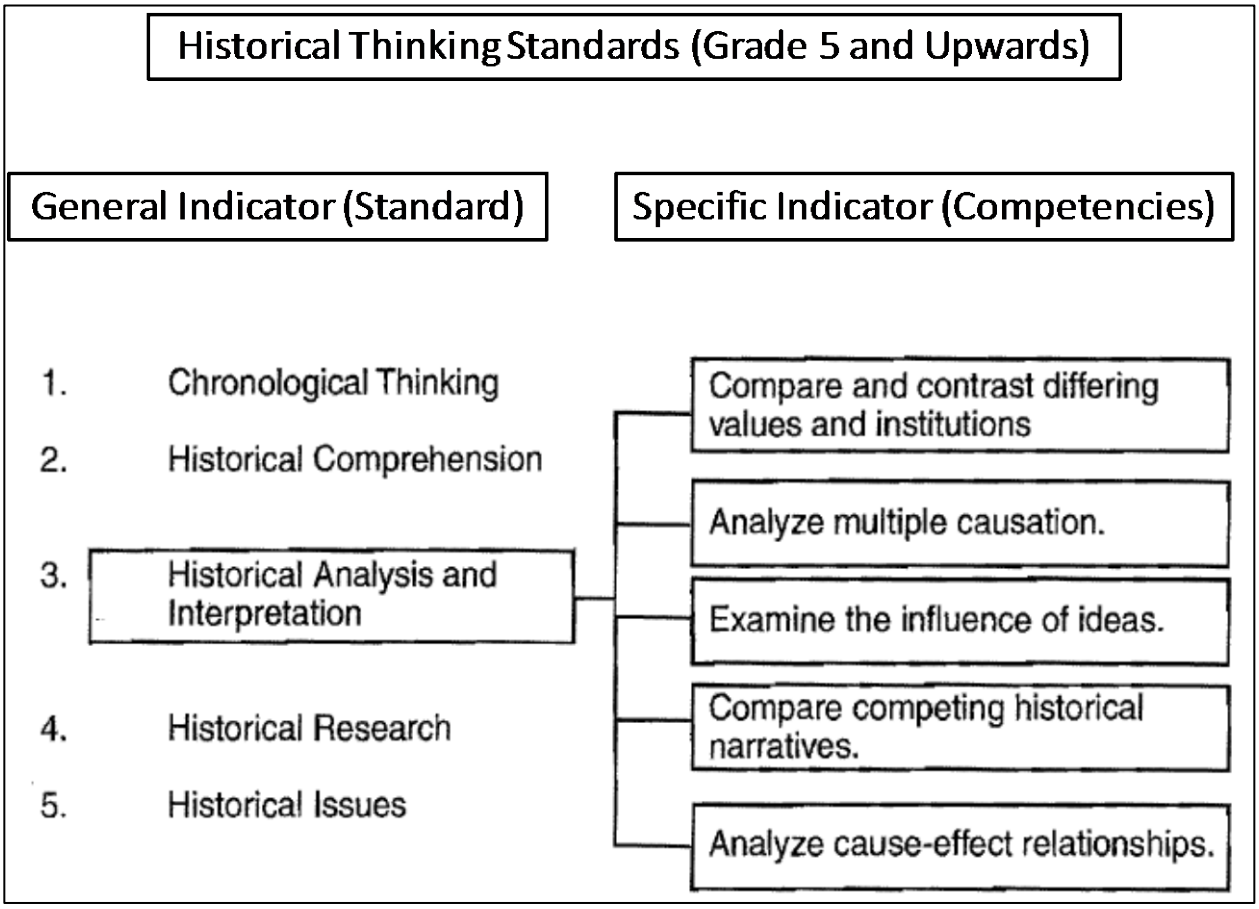


Figure 4.3. An achievement domain in History clarified in the form of a tree-diagram
Source: Adapted from the *National Standards for United States History: Exploring the American Experience* (1994) and the National Council for the Social Studies (2010). *National Curriculum Standards for Social Studies: A Framework for Teaching, Learning, and Assessment*.

Box 4.1

Ordered domain specifications: Designing mathematics assessment tasks linked to indicators at three levels of difficulty

Assessment Context Specifications

What? Mathematics proficiency levels
Whom? 3rd-5th grade students in primary schools
Why? Classroom assessment purposes

Domain Specifications

General Indicator (*Culminating learning outcome*):

- Identify, generalize, and explain mathematical patterns and relationships, showing understandings of number sense, arithmetic operations, and geometric principles at intermediate levels of difficulty.

Specific Indicators (*Embedded skills and knowledge)* :

- **Level 1:** Identify, continue and explain simple repeating patterns involving shapes, numerals, or letters.
  Task Example: Identify the pattern and fill in the last two blanks in the series. Explain your answers.
  ABC, **ABC**, **ABC, ___, ___.**

- **Level 2:** Identify, continue and explain mathematically increasing (growing) patterns involving a basic grasp of number sense, arithmetic or geometric concepts.
  Task Examples: Continue this pattern, and explain the mathematical rule that helped you predict the last number.
  1, 10, 100, 1000, ___?
  Rule: 1 (x10), **10** (x10), **100** (x10), **1000, 10,000** or another reasonable answer
  3,5,7,9, 11, __, __?
  Rule: 3 (+2), **5** (+2), **7, 9, 11, 13, 15,** or another reasonable answer

- **Level 3:** Identify, continue and explain mathematically increasing (growing) patterns, involving a grasp of arithmetic or geometric concepts at intermediate level, such as, multiplication, division, fractions, prime numbers, squares, etc..
  Task Example: Continue this pattern, and explain that mathematical rule that helped you predict the last number.
  3, 9, __, __?
  Rule: 3, (3^2=) **9**, (9^2=) **81,** and so on or another reasonable answer

Box 4.2 *Stratified domain specifications for a teacher assessment of social-psychological attributes*

Assessment Context Specifications:
What? Social-psychological attributes of effective teachers
Whom? Grade K-12 teachers
Why? Coaching and professional development

Construct Domain Specifications:

Sub-domain 1.

- **General Indicators**. In professional contexts, teachers exhibit/display *personality* attributes of:
  - Conscientiousness
  - Extraversion
  - Emotional stability
  - Openness to experience
  - Agreeableness

Sub-domain 2.

- **General Indicators.** In professional roles, teachers endorse/demonstrate high *motivation* levels with respect to their:
  - Beliefs about classrooms, students, and subject matter they teach
  - Beliefs about the nature of human intelligence
  - Beliefs about their teaching efficacy and self-beliefs in their own capacities to achieve student outcomes
  - Academic expectations of students
  - Attributions of student success or failure
  - Goal orientation

*Sub-domain 3***.**

- **General Indicators.** In professional roles and during teaching, teachers value or practice/demonstrate certain *intra-personal skills*, including:
  - (Managing) emotions appropriately
  - (Applying) metacognition and self-regulation skills to improve practices

Sub-domain 4.

- **General Indicators.** Teachers communicate a value for, and practice certain *inter-personal and social skills* during teaching, such as:
  - Collaboration and teamwork with faculty and colleagues
  - Collective efficacy or beliefs in their school's or team's ability to succeed
  - Collaboration with students
  - Collaboration with guardians/parents of students
  - Acceptance of diversity and individual differences

Note: Indicators are adapted for illustration purposes.

Source: Madni, A., Baker, E.L., Chow, K.A,, Delacruz, G.C., & Griffin, N. C. (2015). Assessment of teachers from a social-psychological perspective. *Review of Research in Education*, 59, 54-86.

Box 4.3 *Stratified domain specifications for a cognitive competency assessment for doctors*

Assessment Context Specifications:

What? Cognitive competence in a domain called "Practice Based Learning and Improvement" and "Evidence Based Medicine" (PBLI-EBM), as defined by the medical profession. A tree diagram showing four cognitive levels and "action" sub-domains where the indicators would be demonstrated is presented below.

Whom? Resident physicians undergoing training at university hospitals

Why? Program and resident outcome assessments for accreditation purposes

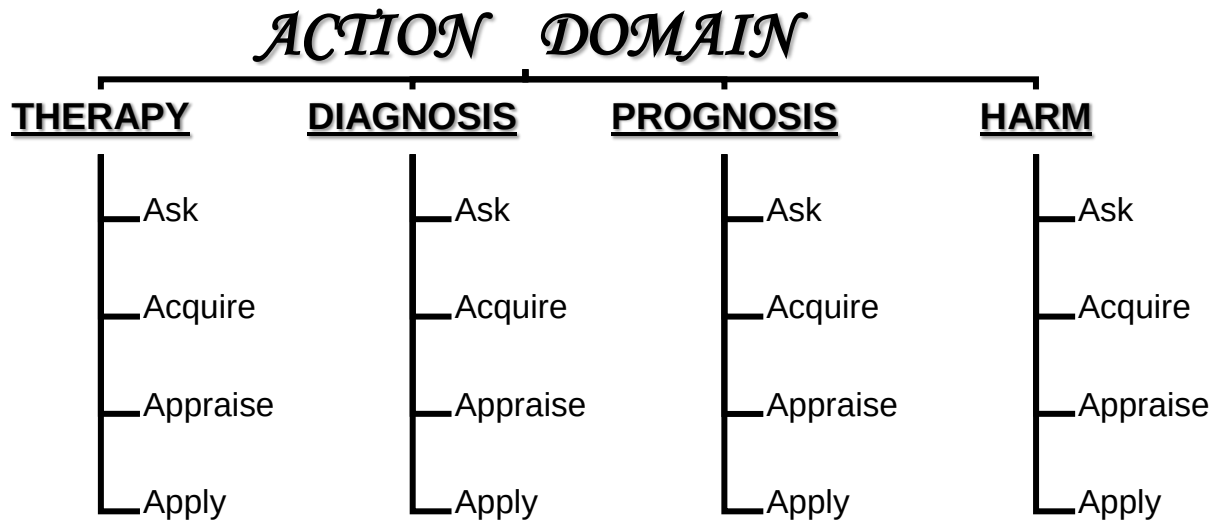
Construct Domain Specifications:

General Indicator.

Competent physicians will be able to locate, appraise, assimilate and apply evidence from scientific studies to address patients' health problems.

Specific Indicators.

- Formulate clinical questions to guide information searches relevant to patient needs, with a clear definition of the patient population, proposed therapy/intervention, suitable control/comparison condition, and patient outcome criteria *(Sub-domain: Ask).*
- Search for, and select, the best evidence from clinical research studies to choose actions *(Sub-domain: Acquire).*
- Critically appraise the evidence for validity, generalizability and applicability to patient cases *(Sub-domain. Appraise).*
- Evaluate evidence from studies by applying knowledge of study designs, statistical methods, and other criteria of research quality *(Sub-domain: Appraise).*
- Integrate the evidence, once appraised, into clinical decisions while taking patient values and circumstances into account *(Sub-domain: Apply).*



Excerpted and adapted for illustration purposes from:

Authors (2009).

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Box 4.4 *Deriving indicators for unknown constructs by drawing on case studies and direct observation records*

Assessment Context Specifications:
What? An unknown disease or health condition, such as, Leukemia
Whom? Adults
Why? Diagnosis, tracking and treatment of disease

Case 1. This early case presents observation records dated 1845 of a 28 year old slate-layer, made by John Bennett, as described in Mukherjee (2015, pp, 12-13).
Early stages of disease showed the following external signs:
- "a mysterious swelling in his spleen"…
- "great listlessness on exertion", which had continued over a period of 20 months.
- "tumor in his abdomen which gradually increased in size", becoming stationary four months after.
In the next few weeks:
- rapid disease progression
- "fevers"
- "flashes of bleeding"
- "sudden fits of abdominal pain, gradual at first, then on a tighter, faster arc…".
- "more swollen tumors sprouting in his armpits, his groin, and his neck"…leading eventually to patient's death.
An autopsy revealed that:
    - "blood was chock full white blood cells… (which is) a principal constituent of pus"…. (but) "Bennett could not find a source for the pus".

Case 2. Observations of another concurrent case was of a cook in her mid-fifties and conducted by Rudolf Virchow, and presented in Mukherjee (2015, pp, 13-16).
- The case showed "striking similarities" with the first in that the patient had a "massively enlarged spleen"
- " white blood cells had explosively overgrown her blood"..
- again, a mysterious "absence of any wound" as the source of the excessive white blood cells or "pus".
Then, the recognition that:
- "the blood itself was abnormal" …. the blood cells had overgrown in a distorted, uncontrolled fashion with "millions of white blood cells.. ..seen under his microscope" after the patient's death.
- Virchow named the disease "leukemia".

Implications for assessment:
Once observable indicators of the disease were listed, described objectively, catalogued and confirmed across cases, a suitable measurement method could be devised. Because "leukemia could be counted".. "by drawing a sample of blood or bone marrow and looking at it under a microscope" (p. 19), counts of white blood cells in the blood of normal versus diseased individuals became the assessment technique to tap into the key diagnostic indicator of the condition.

Excerpted and adapted for illustration purposes from:
Mukherjee, S. (2010). The emperor of all maladies: A biography of cancer. New York, NY: Scribner/ Simon & Schuster.

Box 4.5

Checking whether the construct domain is specified in defensible, clear and measurable terms

Seven Criteria:

(1) Did you identify the type of construct(s) that you are trying to assess? For example,
- Cognitive constructs
- Non-cognitive constructs
- Health-related constructs
- Social constructs

(2) Did you use appropriate literature, existing research or knowledge-bases, expert viewpoints, case studies, or documentary sources to define and write clear "indicator" statements to represent your construct universe?

(3) Did you organize the list of indicators from very general to more and more specific statements in the form of a tree-diagram, or other reasonable form, bringing clarity, coherence and focus to the domain?

(4) To help design the best-matched items or tasks, and as applicable, did you clarify each indicator statement further by parsing it into its key parts: process/behavior, content, condition, criterion performance?

(5) Did you apply a suitable cognitive, non-cognitive, health-related, or social taxonomy to classify groups of indicator statements to facilitate better design/selection of items or tasks?

(6) Were you able to design/select items or tasks to match indicators individually or in coherent groups, as specified in the domain?

(7) Was the domain validated by peers or external experts? If under-specified or poorly-specified, were indicators revised based on feedback?

Table 4.1

Steps in specifying construct domains with observable indicators

Step	**Process**
Step 1	Locate appropriate resources and knowledge-bases for deriving indicators • Literature reviews, scientific research and/or documentary sources • Expert knowledge and perspectives • Direct observations, critical incident techniques or case studies
Step 2	Write and organize indicators using established tools, guidelines and conventions. • Use standard guidelines to specify observable behaviors, content, and other dimensions in indicator statements • Organize indicator statements in tree-diagrams, concept maps, or in other useful ways to designate similar, related or dissimilar clusters of indicators
Step 3	Finalize types/levels of indicators that define domain and subdomains • Use appropriate taxonomies for classifying indicators in cognitive, non-cognitive, health-related and social constructs • Develop or select item or task examples to match indicators, either individually or in coherent clusters • Content-validate domains using external reviews

Table 4.2

Taxonomies for classifying indicators

Construct Type	Indicator Levels or Types	Definition	Examples
1.0 Cognitive constructs	*1.1 Concept knowledge and understanding*	*Requires concept recall and/or concept comprehension*	• *State a definition, law or principle..* • *Describe in your own words, Paraphrase the meaning of ..* • *Give examples of, Distinguish between ..*
	1.2 Application	*Requires applying concepts, rules, principles*	• *Apply a formula, concept, or rule* • *Solve a problem* • *Use a tool*
	1.3 Complex procedural skills	*Requires the execution of a complex task, involving multi-step and integrative processes, usually following accepted conventions or standards in a discipline or field*	• *Employ a writing process to publish works* • *Write a laboratory record or scientific report* • *Employ scientific methods appropriate to a field to conduct research* • *Develop an architectural blueprint or a model of a building*
	1.4 Higher order thinking and problem-solving skills	*Requires higher level intellectual capacities involving analysis, synthesis, and/or evaluative processes, often in open-ended, problem-solving situations*	*Analyze/Break down, Create, Compose, Compare, Contrast, Critique, Defend, Justify*
2.0 Non-cognitive constructs	*2.1 "Cognitive" and "value-expressive" component of dispositions*	*What a person holds to be true about something; their opinions, beliefs, values, perceived knowledge about some present or past experiences, events, places, persons or objects, as consistent with their sense of identity*	*A belief regarding child bearing and abortions: When it comes to bearing children, women should have the right to choose.*
	2.2 "Emotional" component of dispositions	*What a person feels about some present or past experiences, events, places, persons or objects, Items that tap into "affect" or feelings of joy, calm, fear, happiness, anxiety etc.*	*An emotion related to one's stance on abortions: It saddens me to think of women having abortions.*

(Continued)

Table 4.2 (continued)

Construct Type	Indicator Levels or Types	Definition	Examples
2.0 Non-cognitive constructs	*2.3 "Social-Behavioral" component of dispositions*	*What a person would do, in terms of responses, actions, or practices in relation to given social experiences, events, places, persons or objects*	*An action related to a stance on abortion: I participate in anti-abortion protest marches*
	2.4 "Metacognitive Component" of interpersonal and intra-personal dispositions	*Skills and practices a person would demonstrate to self-evaluate their own behaviors, actions, mind-sets, and self-correct course to reach goals in social, workplace or educational spheres*	*Metacognition on a stance on abortion: I read the latest research on fetal development to see if my postion on abortion makes sense.*
3.0 Health-related constructs	*3.1 Physiological indicators*	*Physiological signs or symptoms of a state of well-being versus an illness/disorder*	• *Heart rate* • *Blood pressure levels* • *Body temperature levels*
	3.2 Behavioral indicators	*Behavioral signs or symptoms of a state of well-being versus an illness/disorder, or what a person will say or do when well versus when ill or suffering*	*Stutter, Forgetfulness, Stumble, Sleep too much, Low energy, Snore loudly.*
	3.3 Physical appearance indicators	*Appearance indicators, or what a person looks like when ill versus when well.*	*Redness of eyes, Paleness of skin, Gaunt.*
4.0 Social or Societally-defined constructs	*4.1 Demographic characteristics*	*Morphological or other grouping factors based on one's roots, as widely used in society*	• *Gender* • *Race* • *Ethnicity*
	4.2 Social class indicators	*Wealth, educational and/occupational characteristics, as accepted/widely used in society*	*Education levels, socio-economic status, annual income.*
	4.3 Geographic, regional or organizational membership indicators	*Grouping characteristics based on membership in a defined region or organization, as accepted/widely used in society*	*Nationality*

Sources: Bloom et al (1956); Author (2003); Eagly & Chaikin, 1998; Katz (1960); Marzano et al (1995), and National Research Council (2012).