

designing curricula supporting the development of statistical literacy

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Summary

- Develop a mastery rubric (MR) for your curriculum
 - Be sure it includes elements of statistical literacy
 - Use MR to develop assessments (formative &/or summative) to reflect your curricular elements
 - Task-specific rubrics permit evaluation of features of assessments reflecting overall curricular goal OR statistical literacy elements - or both.

Outline

- Definition of statistical literacy
- Rubrics: for tasks OR curricula
- Example of a Mastery Rubric - for Clinical Research (CR)

Statistical Literacy: defined

two interrelated abilities¹

- (a) interpret and critically evaluate statistical information, data-related arguments, or stochastic phenomena
- (b) discuss or communicate their reactions to such statistical information, such as their understanding of the meaning of the information, or their concerns regarding the acceptability of given conclusions...

<http://www.stat.auckland.ac.nz/~iase/islp/def>

A rubric...

“...a set of ordered categories to which a given piece of work can be compared. Scoring rubrics specify the qualities or processes that must be exhibited in order for a performance to be assigned a particular evaluative rating.”²

- Identify the key skills in ‘statistical literacy’.
 - a list of what your program’s graduates should be able to do³
- Describe each skill at 3-4 distinct performance levels
 - the manner in which they could do (or, what characterizes the best, next best, not-worst and worst you’ve ever seen) each.

With a rubric in place, you can:

- identify didactic opportunities to develop the target skills
- create assignments requiring demonstration of target skills.

Describe performance of ‘the ideal student’ at the start and end of program.

Towards a rubric for SL: *KSAs*

Messick’s criteria (1994)⁴, part 1 - via statistical literacy definition¹:

- What are the SL-specific knowledge, skills, and abilities (KSAs) to be obtained via the curriculum?
- interpret statistical information
- critically evaluate statistical information
- critically evaluate data-related arguments
- critically evaluate stochastic phenomena
- discuss reactions to statistical information
- communicate your understanding/the meaning of the information
- communicate concerns regarding the acceptability of given conclusions

Additional KSAs for the rubric?

- literacy skills, statistical knowledge, mathematical knowledge, context knowledge, and critical questions
- beliefs, attitudes, and critical stance

-these are fairly diffuse KSAs; not elemental enough to incorporate in teaching and assessments?

Towards a rubric: *revelio!*

Messick part 2: What actions/behaviours by the students will reveal these KSAs⁴?

- not lecture attendance
- not statistics course test score- too diffuse.

- Each KSA requires targeted assessments - the creation & evaluation of these assessments could be *challenging*.
- Formative feedback can help push lower-performers above a criterion level, so that all students can be identified as having achieved the goal.

Towards a rubric: *observables*

Messick, part 3: What tasks will elicit these specific actions or behaviours⁴?

- Test and example questions that involve or generate written or verbal arguments.
- Group work in class for dyads or triads to develop a 3-5 point argument or presentation of a given text sample.
 - group *homework* probably less effective.

Curriculum-level rubrics

- Course and/or assignment should generate evidence of progress through the rubric.
- Explicit goals: specific enough? represent separable skills? -refine as needed.
- 'Messick three': develop activities within which the target skill(s) must be exhibited.
- Curricular goals→ course/assignment goals: ensure adequate opportunities to develop & demonstrate each target skill.
- Students see what constitutes expert-level performance; revise their own work to meet highest expectations.
- Metacognitive skills, required to monitor student performance, are a crucial attribute of a rubric-based approach to curriculum design that is uniquely appropriate for the maintenance, and further development, of their literacy skills.
- An MR supports, and focuses, the design of specific courses and the types of assignments within courses to bolster claims that material has been 'learned', rather than emphasizing what material has been covered⁵.

Ex. MR³ for clinical research curric: levels

LEVEL:	BEGINNING:	NOVICE:	COMPETENT:	PROFICIENT:
Description of performance: <i>General description of work</i>	Complete inconsistency in aims/goals/approach; poor articulation/communication; general unfamiliarity with scientific method and research methods. <i>Unreadable, unratable, very difficult reading/evaluation.</i>	Inconsistency present in several, but not all study elements; developing skills of articulation of argument and flow; communication skills developing; developing familiarity with scientific method and research methods. <i>Readable and ratable; novice standing obvious.</i>	Solid consistency stated aims/goals/approach. Good articulation of aims which are concrete and achievable. Strong communication; skillful description of and compliance with scientific method and research methods. <i>Readable and providing a solid framework for editorial commentary and improvement.</i>	Complete consistency in terms of aims/goals/approach. Excellent articulation of aims which are concrete and achievable. Strong communication; skillful description of and compliance with scientific method and research methods. <i>Excellent work, interesting read, editorial input specific and targeted.</i>
DOMAIN:				
Develop an analysis plan that will enable the study to evaluate the evidence from the data to address each of the study aims and hypotheses.	No specific analyses are planned. Any analyses that are planned are not appropriate for stated aims, as far as can be determined. If included, power calculations are inappropriate given design and stated aims; effect sizes are wildly optimistic.	Planned analyses do not fit study design or specific aims. Specific analyses that are planned are not appropriate for some stated aims. Power calculations are inappropriate given design and stated aims; effect sizes are optimistic and not well justified.	Planned analyses generally fit study design and specific aims. Power calculations are appropriate given design and stated aims; effect sizes are optimistic and not well justified.	Planned analyses are optimal for study design and specific aims. Power calculations are appropriate given design and stated aims; effect sizes are well justified and alternative formulations are conceptualized (ie, effect sizes and power calculations are based on least powerful version of design).

Ex. MR³ for clinical research curric: skills

Critically review the literature and evaluate the quality of evidence relating to an important research question.
Articulate a research objective that follows from a critical review of the literature and develop achievable specific aims and perhaps testable hypotheses that address the objective.
Develop a research design and protocol that provides an efficient and effective framework and data to meet each of the study aims and hypotheses.
Develop an analysis plan and estimate the sample size that will enable the study to evaluate the evidence from the data to address each of the study aims and hypotheses.
Direct the implementation of the study design and protocol assuring the quality and completeness of the data.
Oversee the implementation of the analysis plan, assemble the evidence, and draw inferences from the evidence regarding each study aim and hypothesis.
Assemble the evidence in the form of tables and graphs, and present the results together with the study methods orally and in writing.

Summary

- Develop a mastery rubric (MR) for your curriculum
 - MR highlights opportunities for statistical literacy
 - Assessments (formative &/or summative) developed to reflect SL-related curricular elements within existing classes/tasks
 - Integration of SL into existing curriculum with specific assessments/items is efficient, although complex!
 - An “outcomes-”⁵ or “performance-”⁶ based approach to education. The program can be “...evaluated on the extent to which it had accomplished its explicit goals...”⁷

References

1. Gal, Iddo. (2002). Adults' Statistical Literacy: Meanings, Components, and Responsibilities. *International Statistical Review*, 70 (1): 1-25.
2. Messick S. (1994). The interplay of evidence and consequences in the validation of performance assessments. *Educational Researcher* 23(2): 13-23.
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6. Toohey S. (1999). *Designing Courses for Higher Education*. Philadelphia, PA: The Society for Research into Higher Education & Open University Press.
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