## **Assessment Task Design Principles and Procedure**

One approach researchers have used to assess content knowledge for teaching is to have prospective and practicing teachers analyze and respond to children's thinking. For example, some assessments present common misconceptions and patterns of thinking from children and ask respondents to comment on children's work and describe ways to help their thinking develop (e.g., Hill, Ball, and Schilling 2008; McCrory et al. 2012; Saderholm et al. 2010). A well-known example of this sort of assessment item comes from the work of Liping Ma (1999). Ma presented a classroom scenario in which a child told a teacher "that she has discovered that as the perimeter of a closed figure increases, the area also increases" (p. 84). The child then presented a  $4 \times 4$  rectangle and a  $8 \times 4$  rectangle as support for the conjecture. Some of the teachers in Ma's study were uncertain how to respond to the child because they did not know for themselves if the conjecture was true or not. Others were able to blend their knowledge of content and pedagogy to ask probing questions to lead the student to discover a counterexample to the claim (e.g., a  $12 \times 1$  rectangle has a greater perimeter, but less area). Hence, this type of item has the potential to reveal qualitative variability in individuals' content knowledge for teaching.

In order to design items that assess statistical knowledge for teaching, it is helpful to have access to children's work samples. One readily accessible source of such work samples is the National Assessment of Educational Progress (NAEP) Questions Tool website (http://nces.ed.gov/nationsreportcard/itmrlsx/search.aspx?subject=mathematics). Figure 1 is a screenshot from the website. It shows a search for constructed response items on NAEP tests taken by eighth-graders. Under the "Select Content Classifications" tab, "Data Analysis and Probability" is checked. Under the "Select Years" tab, the years 2009, 2011, and 2013 are selected. These filters produced a collection of 7 items. Clicking on the "Add All Questions" button on the screen put the items in the "My Workspace" area. From "My Workspace," one can request the questions, answers, student responses, and performance summary data by clicking the appropriate boxes (Figure 2). One can then download all of these materials in HTML or Word by clicking on the desired format.

NAEP Questions Tool

Analyze Data | Sample Questions | State Comparisons | State Profiles | District Profiles

Search for Questions >>> Mathematics Search Results 🛛 💿 🖉

👧 Word

Get Data

MTML

What can I do horo?

what can ruo here: 👳									
		Search Results (7 of 1043)					Workspac	ce (7)	
Refine Search		ŧ	Add All G	uestions	E Rem	ove All	Questions	Print/Sav	ve List 🔽 Show/Hide 🔽
Select Content Classifications	nty		Year 🔻	Grade 🔺	Block 🔺	# 🔺	Туре 🔺	Difficulty 🔺	Description
	115	1	2013	8	M3	2	SCR	Medium	Determine complete sample space
Content Area 🖓	ĥ	$\checkmark$	2013	8	M6	13	SCR	Hard	Identify best method for selecting a sample
<ul> <li>Number properties and operations (0)</li> <li>Measurement (0)</li> <li>Geometry (0)</li> <li>✓ Data analysis and probability (7)</li> <li>Algebra (0)</li> </ul>		$\checkmark$	2013	8	M7	14	SCR	Hard	Evaluate an experimental design
	Ξ	$\checkmark$	2011	8	M8	6	SCR	Hard	Express a numeric quantity as a percent (calculator available)
		$\checkmark$	2011	8	M9	5	SCR	Medium	Label a spinner for a given probability (calculator available)
		1	2011	8	M12	6	SCR	Easy	Explain a probability concept
		~	2009	8	M5	18	ECR	Hard	Solve and explain a problem involving probability
Complexity (2005 and on) 🚯									
Low (3)	-								
Select Yea	irs								
Perform Keyword Sear	ch	*							

Figure 1. NAEP Questions Tool Search Results Screen

NAEP Questions Tool           NAEP           Analyze Data   Sample Questions   State Comparisons   State Profiles   District Profiles													
Search for Questions ≫ Mathematics My Workspace 💿 💿													
What can I do here? 🕘													
	Search	Results (	7 of 1043		My Works	pace (7)							
My Work	1	•	- Rem	ove	Clear	Mv Workspac	e Print/Save List 🔽 Show/Hide 🔽						
Create a Document	Veee	Canda	Disale		- Turne	Differultu	Description						
1 Select Content (Channel and a series )	rear	Grade	BIOCK	#	Type	Difficulty	Description						
1. Select Content. (Choose one or more.)	2013	8	M3	2	SCR	Medium	Determine complete sample space						
Questions	2013	8	M6	13	SCR	Hard	Identify best method for selecting a sample						
Answers (keys/scoring guides)	2013	8	M7	14	SCR	Hard	Evaluate an experimental design						
	2011	8	M8	6	SCR	Hard	Express a numeric quantity as a percent (calculator available)						
Student Responses	2011	8	M9	5	SCR	Medium	Label a spinner for a given probability (calculator available)						
Performance Summary Data	2011	8	M12	6	SCR	Easy	Explain a probability concept						
	2009	8	M5	18	ECR	Hard	Solve and explain a problem involving probability						
2. Select Format. (Choose one.)													

Figure 2. NAEP Questions Tool Workspace Download Screen

After downloading NAEP tasks and accompanying work samples, the process of designing a statistical knowledge for teaching task involves initial considerations such as: (i) Which statistical content tends to be difficult to teach in grades K-12?; and (ii) Which questions have content that matches objectives of the course in which prospective teachers to be assessed are enrolled? Consideration (i) can be addressed by scanning the "Difficulty" column in "My Workspace" (Figure 2). It shows, at a glance, which items were "easy," "medium," and "hard" for a representative sample of U.S. students from the selected grade levels. If one includes

"Performance Summary Data" in the HTML or Word material download, more information about the difficulty of the items is provided. Users are given the percentage of students scoring at the different levels specified in each task rubric. The richest information about statistical knowledge for teaching is likely to be produced in connection with items containing content that is generally difficult for students to learn, since this content is also likely to be challenging to teach. Consideration (ii) must be addressed on a course-by-course basis. However, it is worth noting that looking at the statistical content that is generally difficult to teach may impact the goals one has set for the course. An instructor might decide, for example, to shift course goals so that difficult-to-teach statistics content receives greater emphasis. The opportunity to reflect on course goals in such a manner is a collateral benefit of engaging in this task design process.