



# Coordinated, Innovative Designs for International Information Communication Technology Assessment in Science and Mathematics Education

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## Problem

The tremendous increase in the educational use of ICT around the world has been driven and supported by evidence that new technologies can change schools and improve education. Both the investment in educational ICT and the unique learning opportunities it presents argue for the assessment of the skills that students acquire with its use. This project will work with an international group of scholars to identify innovative ways of assessing student ICT competencies—especially those competencies related to use of ICT strategies in science and math problem contexts—while at the same time using technology as the delivery mechanism. The results of this study will inform and coordinate with other assessments, both international and national.

## Goals

- Review current assessment frameworks and performance assessment practices in various countries, particularly those related to ICT assessment, and develop a coordinated assessment framework. Within this framework, address issues regarding variations in the challenge levels of ICT strategies and math and science content appropriate for performance assessments employed in a range of national and international assessments.
- Identify and address technological and practical issues related to large-scale implementation of ICT performance assessment.
- Develop ICT performance assessment prototypes, scenarios, and specifications shells.
- Pilot test prototype ICT performance assessment tasks and conduct cognitive analyses of these tasks.
- Develop a scoring rubrics for the performance assessments.

## Research Questions

- What are the problem solving, knowledge management, and ICT strategies that are valued by national reform efforts?
- What are the ICT applications and tools that promote the development of these strategies?
- What are the design features of performance assessments that could test these ICT strategies and math and science reasoning?
- What are the rubrics that would be used to score these assessments?
- What hardware and software technology issues must be resolved to deliver this assessment online in a variety of international situations?

## Integrated Performance Assessment Modular Design

		DOMAIN COMPLEXITY	
		High	Low
ICT STRATEGY	High		
	Low		

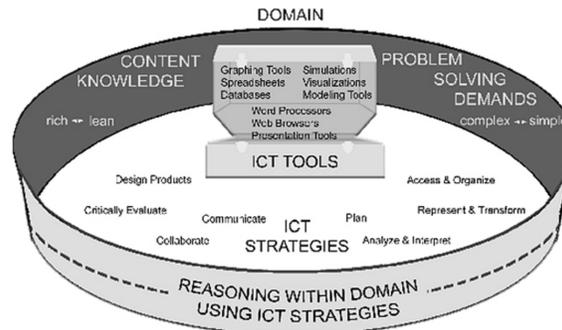
Assessment Design Options for Emphases on Domain and ICT Competencies

Sample Performance Assessment Tasks

MODULE	SAMPLE QUESTIONS	TOOLS
Module 1: Understand the Problem: Plan data gathering; Access & organize information	Identify the environmental conditions that affect the size of the hare and lynx populations	Web Browser
Module 2: Represent & transform	Organize 30 years of population data in a spreadsheet. Graph the data.	Spreadsheet Graphing
Module 3: Analyze & interpret patterns	Predict what happens to the hare population in 10 years. Use evidence to support your prediction.	Modeling Tool

## Coordinated ICT Assessment Framework

Students apply ICT strategies to solve complex problems and manage information. They demonstrate their knowledge and ability to operate technologies as they choose and demonstrate use of appropriate tools.



General Cognitive Demands	ICT Knowledge & Strategies: Use Technology to Solve Complex Problems	Sample Component Strategies: Use Technology to:
Declarative Knowledge	Identify/list required domain information	<ul style="list-style-type: none"> <li>Identify features</li> </ul>
	Identify features and functions of technology tools	<ul style="list-style-type: none"> <li>Identify functions</li> </ul>
	Identify uses of tools	<ul style="list-style-type: none"> <li>For each tool group and specific tool, identify appropriate uses</li> </ul>
Procedural Knowledge	Perform steps	<ul style="list-style-type: none"> <li>Follow directions</li> </ul>
	Operate tools	<ul style="list-style-type: none"> <li>Use algorithm</li> <li>Produce component and complete operations</li> </ul>
Schematic and Strategic Knowledge	Plan strategies and procedures	<ul style="list-style-type: none"> <li>Analyze problem</li> <li>Identify needed and given information</li> <li>Pose questions</li> <li>Specify design for data/information collection</li> <li>Specify analysis plan</li> <li>Choose appropriate tools</li> <li>Specify product form and content</li> </ul>
	Access and organize information & data	<ul style="list-style-type: none"> <li>Specify search purpose/topic</li> <li>Navigate directories</li> <li>Generate Web searches</li> <li>Search multiple representational formats</li> </ul>
	Represent and transform information & data	<ul style="list-style-type: none"> <li>Generate representations from data or phenomena</li> <li>Transform data from one form to another</li> </ul>
	Analyze and interpret information & data	<ul style="list-style-type: none"> <li>Take and record measurements</li> <li>Identify information/data</li> <li>Apply quantitative and qualitative procedures</li> <li>Understand &amp; compare data and information</li> <li>Infer trends/ patterns</li> <li>Produce solutions/findings</li> <li>Use modeling and visualization tools to investigate, compare, test</li> </ul>
	Critically evaluate	<ul style="list-style-type: none"> <li>Evaluate relevance, credibility of information, data, representations</li> <li>Evaluate quality of plan, conduct, analysis, argument, conclusions</li> </ul>
	Communicate ideas, findings, arguments	<ul style="list-style-type: none"> <li>Express questions, ideas clearly &amp; appropriately</li> <li>Present ideas, findings in alternative formats appropriate for audience</li> <li>Present supported argument/findings</li> </ul>
	Design product	<ul style="list-style-type: none"> <li>Compose product to fit constraints, appropriate for audience, purpose</li> </ul>
	Collaborate to solve complex problems and manage information	<ul style="list-style-type: none"> <li>Plan project work and roles</li> <li>Contribute relevant information</li> <li>Fulfill task assignment</li> <li>Incorporate and integrate others information and views</li> </ul>

## Accomplishments

### Coordinated ICT Framework

### Prototype Performance Assessments

- Predator-Prey: For 13-year olds. Modules assess strategic use of Internet, productivity, communication, and modeling tools in a problem-based scenario drawing on life science concepts associated with population dynamics.
- Car Crash: For secondary students. Modules assess inquiry strategies using the Interactive Physics modeling tool to solve a design problem requiring use of physics and mathematics concepts associated with Newton's Laws of Motion.
- Solar Power: For secondary students. Modules assess strategies used to solve a solar energy problem using the ArcView visualization tool and knowledge of earth science and mathematics concepts associated with solar radiation.

### Scenarios—describing modules for additional performance assessments

### Survey—development and administration of technical infrastructure survey to 19 countries

### Publications and Presentations

- Quellmalz, E.S. (2004). *Assessing student learning in technology-rich environments—an AERA Professional Development Course*. Conducted at the annual meeting of the American Educational Research Association, San Diego, California.
- Quellmalz, E.S., Kreikemeier, P., Zalles, Rosenquist, R., & Hurst, K. (2004). *Designing assessments of learning with technology*. Presented at the annual meeting of the American Educational Research Association, San Diego, California.
- Quellmalz, E.S., & Kozma, R. (2003). Designing assessments of learning with technology. *Assessment in Education*, 10, no. 3, 389-431.
- Quellmalz, E.S., Kozma, R., & Kreikemeier, P. (2003). *Development of ICT performance assessments for the 21st century*. Paper presented at 2003 North American IOSTE Symposium, Williamsburg, VA.
- Quellmalz, E.S., Kreikemeier, P., Zalles, D., & Hurst, K. (2003). *Solar power task: Assessing extended student reasoning with performance assessments*. Presented at the annual meeting of the ESRI User Conference. San Diego, CA.
- Quellmalz, E.S., & Zalles, D. (2002). *Designing technology assessments: Cognitive-based modular design*. Presented at the American Educational Research Association Annual Meeting, New Orleans, LA.
- Quellmalz, E.S. & Hinojosa, T. (2000). *Technology supported assessment of technology proficiency—assessment frameworks*. Presented at the American Educational Research Association Annual Meeting, New Orleans, LA.

## For More Information

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