



Challenging Inquiry Practices: How Do Teachers Integrate Content and Process in Technology- Rich Science Activities?



Ashima Mathur, University of Michigan School of Education
Nancy Butler Songer, University of Michigan School of Education

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Technology-Rich Science Activities

The teachers in this study implemented an eight-week life sciences curricular unit called BioKIDS. The curricular activities are designed to engage students with content and science processes by using technology during instructional activities.



CyberTracker (CT)

- Icon-based interface on handheld Palm computers
- Students use CT to collect data about the biodiversity in their schoolyard.



Critter Catalog (CC)

- Online database of animals and their characteristics.
- Students use CC to build food chains and food webs and to explore animal habitats.

How Teachers Integrate Content and Process Standards

Teacher A

The GLCEs she selected:

Content GLCEs	Science Process GLCEs
L.LOL.04.15 Determine that plants require air, water, light, and a source of energy and building material for growth and repair.	S.IP.04.11 Make purposeful observation of the natural world using appropriate senses.
	S.IP.05.14 Summarize information from charts and graphs to answer scientific questions.

How she planned to use them:

"...I might do the inquiry process by taking them outside and observe what you see, feel, hear, and we would do that with the plants around us..underneath the inquiry process number eleven, using our senses, the content one, fifteen, talks about plants and what they need--not sure which one would do but that's how I would pull those two again. And eleven, analysis and communication, summarize that which which one is taller than us, which not, graph that. All things I could do" (Transcript A, Lines 76-83).



- Teacher A suggests that students can graph which plants are taller and shorter than the students.
- This pairing of the "graphing" science process with the content theme of "plants" combines the standards superficially.
- A possible way to help students learn deeply about the needs of plants (e.g., light energy) while engaging in science processes would be to have them record plant growth in light and dark conditions and to make and support claims about plants needing light energy to survive.

Teacher C

The GLCEs she selected:

Content GLCEs	Science Process GLCEs
L.LOL Understand that all life forms can be classified as producers, consumers, or decomposers as they are all part of our global food chain where food/energy is supplied by plants which need light to produce food/energy.	S.IP.04.11 Make purposeful observation of the natural world using appropriate senses.
	S.IA.04.14 Develop research strategies and skills for information gathering and problem solving.

How she planned to use them:

"I'm looking at the next page that says understand that that all life forms can be classified as consumers, producers, etc. Ok, and we could take, um, making scientific predictions. That would be one of the processes, the child would probably say that, well, these particular living things would be a producer or a consumer. Then, they would make that prediction, then if we had that particular animal or living thing in a container in the classroom they could make the observations and see and go to the computer to download some information to see if they had some information that they could interpret from that..." (Transcript C, Lines 71-77)



- While the predictions about whether or not something is a producer or consumer engages students' prior knowledge, Teacher C does not specify how students will learn about the energy roles of animals by engaging in these processes.
- For example, it is unclear what information students would need to find on the computer and what they would need to interpret in order to better learn the content.

Elementary science teachers described the importance of emphasizing both content and processes in science class; however, only 20% mentioned that integrating both helps students learn the content more deeply.

Category	Exemplar Quotes	% of teachers
See emphasis on both content and inquiry processes as building blocks for more complex activities and ideas.	"Inquiry processes set up the ability of the child to do higher-order thinking"	15.3%
See emphasis on both content and inquiry processes as important for retaining content.	"Students need to understand the content but inquiry helps them retain the content." "The reason for emphasis on both content and inquiry is that doing so depends understandings and leads to greater remembrance of content."	20%
See emphasis on both content and inquiry processes as promoting/developing thinking skills in their students.	"Begin with good thinking skills for students to be able to explain their answers or opinions with fact and or data." "I believe to develop critical thinking skills—predicting, inquiry, conclusion—using these process for cross-curriculum activities as well."	33.3%

The lack of attention to how engaging students in particular science processes supports their understanding of scientific content concepts was also prevalent in the semi-structured interviews.

Conclusions & Implications

Michigan state standards documents mention the need to work with both content and science process standards: "*The skills and content addressed in these expectations will, in practice, be woven together into a coherent, science curriculum.*" However, this statement does little to support teachers in actually meeting this goal while planning to teach.

Implications for improving standards documents and professional development for practicing teachers:

- State standards documents should provide clear examples of how content and process standards can be integrated.
- Curricular units like BioKIDS, can help teachers identify well-integrated examples of content and process standards by including supports in teacher curriculum materials.
- Professional development workshops can offer opportunities for elementary teachers to evaluate district curricula, textbook activities, and online lessons to recognize and evaluate evidence of strong and weak connections between content and process standards in these documents.

References

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Study Goals

The study examines 1) the ways elementary teachers know and use the Michigan GLCEs and 2) whether elementary teachers plan lessons that integrate content and process standards in ways that align with science education reform.

Study Rationale

The mismatch between elementary teachers' understanding of science teaching and reform-based ideas presents a significant barrier to successful implementation of inquiry-based pedagogy in elementary classrooms. Because "...in learning science one must come to understand both the body of knowledge and the process by which this knowledge is established, extended, and revised" (NRC, 2007), there is a need to study the ways elementary teachers integrate lists of content and process state standards when planning instruction, so that professional development can better target the areas elementary teachers need the most support in using these documents.

Study Methods

- 15 elementary teachers completed a survey about how they use state standards in planning science lessons.
- In semi-structured phone interviews, four teachers were asked to provide examples of how they would use content and process standards, either separately or together, in classroom instruction.
- HyperResearch software was used to transcribe and code the interviews using an open coding methodology (Strauss and Corbin, 1998) at the sentence and paragraph level.

Data Collection

Sample Survey Item:

L.EV.05.11 Explain how behavioral characteristics (adaptation, instinct, learning, habit) of animals help them to survive in the environment.

How would you explain this GLCE to a parent?

Do your students engage in this GLCE in your classroom?

If yes, please describe one example of an activity they do that illustrates this GLCE.

Sample Interview Items:

Since the GLCEs were introduced, have they influenced the way you plan to teach in your classroom?

How would you describe the purpose and importance of the content and science process GLCEs, separately and together?

<http://www.biokids.umich.edu>

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