Browser-based Resource for Responsive Teaching in Science: A Product of the Learning Progressions in Scientific Inquiry Project

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Responsive Teaching

Responsive teaching involves attending and responding to the substance of student thinking as it unfolds, shifting learning agendas as needed within a particular lesson while still meeting larger learning goals. A responsive approach includes:

- eliciting students' generative engagement around a provocative situation
- listening to students' thinking to form a sense of what they are doing and identifying productive beginnings of scientific thinking
- discovering opportunities for larger learning goals building on what students have begun.

Responsive teaching aligns with the essence of scientific practice. While children learn science concepts they also engage in the kinds of activities that constitute science.

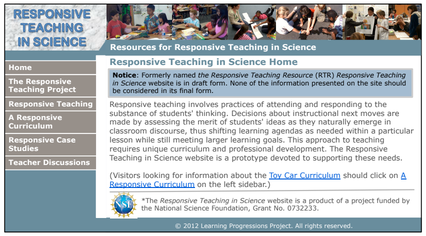
At its core, scientific inquiry is the pursuit of mechanistic, coherent understanding of the natural world - mechanistic in the sense of cause and effect; coherent in the sense that evidence and ideas are mutually consistent (Russ et al. 2008).

The impetus for our involvement with responsive teaching is a desire to study students' engagement in, and teachers' facilitation of, genuine scientific inquiry.

The Resource

The ***Resource for Responsive Teaching in Science*** is a prototype for supporting the study and implementation of responsive teaching. It is based on work with 13 teachers in grades 2 – 6 over a period of 3 years.

This poster highlights three sections of the ***Resource***: an example responsive curriculum, case studies of responsive teaching, and actual teacher discussions that occurred on their journeys to becoming responsive teachers.


RESPONSIVE TEACHING IN SCIENCE

Resources for Responsive Teaching in Science

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Responsive Teaching in Science Home

Notice: Formerly named *the Responsive Teaching Resource* (RTR) *Responsive Teaching in Science* website is in draft form. None of the information presented on the site should be considered in its final form.

Responsive teaching involves practices of attending and responding to the substance of students' thinking. Decisions about instructional next moves are made by assessing the merit of students' ideas as they naturally emerge in classroom discourse, thus shifting learning agendas as needed within a particular lesson while still meeting larger learning goals. This approach to teaching requires unique curriculum and professional development. The Responsive Teaching in Science website is a prototype devoted to supporting these needs.

(Visitors looking for information about the Toy Car Curriculum should click on A Responsive Curriculum on the left sidebar.)

*The *Responsive Teaching in Science* website is a product of a project funded by the National Science Foundation, Grant No. 0732233.

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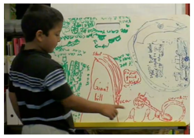
http://plrg.sdsu.edu/responsiveteaching

A Responsive Curriculum



Responsive teaching is guided by students' ideas and reasoning. A responsive curriculum needs to support teachers in this endeavor. We use a ***Launching Activity*** to get things started. Unlike a driving question that is used to organize a unit as a whole, a launching activity incites students' intellectual agency and generates productive possibilities for the class to pursue. We then have a ***Menu of Possible Activities*** to support students' exploration and development of emerging ideas. Finally, to give teachers a sense of what can actually happen in a classroom, we provide examples of ***Teacher Enacted Trajectories*** that are rich with video and commentary.

Toy Cars

Toy Cars provides a context for discussions on the mechanisms of how toy cars work, ideas of forces and energy, or the effects of factors such as weight and friction on a car's motion. Students engage in many practices of science as they pose questions, design and carry out experiments, gather evidence to support ideas, and articulate their arguments in front of their class, within their groups, or in their science notebooks. *Toy Cars* is suitable for many grade levels in elementary school.

Launching Activity

To launch *Toy Cars* the teacher holds up a toy car and asks, "How can I get this toy car moving?" This is a very generative activity for tapping into students' mechanistic reasoning. Students reliably think of a rich variety of mechanisms, from pushing, throwing and kicking the car, to rolling it down a hill, to flinging it with a rubber band, and so on. From those ideas, and the discussion surrounding them, the teacher decides what to do next. We provide detailed information, suggestions, classroom video clips and commentaries about the launching activity.

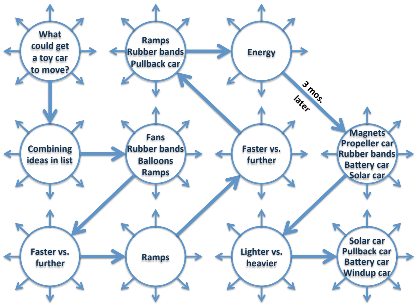
Menu of Possible Activities

Based on teachers' implementations, we have identified a list of activities and issues that generated significant discussion in classrooms. They are presented here as a *menu of follow-up activities.* Links include planning suggestions, and video clips and commentaries describing how this activity played out in teachers' classrooms.

Organizational	Exploring/Discussing	Issues
Making Ideas Clear and Precise (in a list)	Exploring Regular Toy Cars	Faster versus Further (How do you know who wins the race?)
Combining Ideas (into a list)	Ramps	Lighter versus Heavier (Effects of Weight)
	Rubber Bands	Fair Test
	Fans	Surface Effects
	Magnets	Energy
	Pullback Car	Lab & Real World Connections
	Windup Car	
	Propeller Car	
	Balloon Car	
	Battery Car	
	Solar Car	

Teacher Enacted Trajectories

The *Resource* has examples of teachers' actual enactments of *Toy Cars*. This one is from a third grade classroom. Each node represents an activity or significant issue that engaged students. Bold arrows show the sequence of those activities/issues. The first node is the launching activity. Other nodes correspond to choices from the *Menu of Possible Activities*. Shorter, lighter arrows emanating from the nodes suggest that the teacher *could* have made different next move decisions. Each node is linked to video clips and commentaries about what happened in the classroom.



Responsive Case Studies

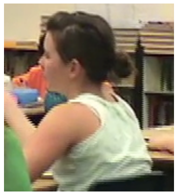
Our case studies in the ***Resource*** serve as examples of responsive teaching and serve as the basis for professional development towards developing a responsive approach to science education. They include video clips of interesting student conversations, example analyses of student thinking, teacher and student artifacts, examples of teacher responsiveness, teachers' rationales for their instructional decisions, and suggestions for professional development study. The case studies are from 4th & 5th grades exploring the water cycle, launched by the following question:

One night it rains. When you go to school the next day, you notice a large puddle of water on the driveway. Later that day, when leaving school, you notice that the puddle is gone. What could have happened to the puddle?

A snippet from one case study is shown in the next column. The teacher, Bonnie, has taught elementary school for 30 years. Previously she closely followed implementation guidelines provided in district-adopted science curricula. Like other project teachers, she found responsive teaching both challenging and exhilarating. Her fifth grade class engaged in a 15-hour exploration of the water cycle.

In the initial puddle discussion, Jacob and Hannah sensed that the size of the puddle affects its evaporation. A casual observer might exclaim, "Of course they would think that! More water means more time to evaporate!" But Hannah and Jacob were more thoughtful. In their reasoning they mention the role of the puddle edges and how bits of water might rise:

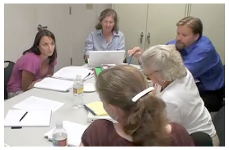
Jacob: If it goes off, if a kid jumped in the puddle, it would go in different sections, and it's easy to evaporate that. Because it's not in a big clump where it could join together, and you get one. If the heat goes around the edges, it can evaporate better. But if it's just one big puddle, you can't get to little stuff that's in the big one, so.



Hannah: I think when someone jumps in it, the little splatters, I think those make it easier for it to evaporate. Because they're so small, that maybe the little drops or sections of the puddle can raise better. So then I think the bigger it is, the more, how it's the big puddle. So I think when there's the little ones, the edges, there's little small edges, so it takes less time to evaporate.

Example PD Questions. The ***Resource*** suggests PD questions such as: How do Hannah and Jacob's ideas seem similar, and how do they seem different? What questions would you like to ask them to help you better understand their ideas?

Teacher Discussions



In our PD, teachers addressed questions about students' thinking, the scientific merits of students' ideas, and possibilities for instructional decisions. Discussions about students' ideas often became discussions about the ideas themselves, furthering teachers' understanding of the science.

The ***Resource*** presents myriad examples of video from PD sessions. These serve as resources for teachers, and as examples of discussions for professional growth towards responsive teaching.

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Russ, R.S., Scherr, R. E., Hammer, D. and Mikeska, J. 2008. Recognizing mechanistic reasoning in scientific inquiry: A framework for discourse analysis developed from philosophy of science. Science Education, 92(3): 499–525.

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