"Choose Your Own Adventure": Responsive Curricular Choices in Elementary Science

Jennifer Richards, University of Washington, jrich14@uw.edu
Jessica Thompson, University of Washington, jjthomps@uw.edu

Abstract: The complexity and dynamism of learning raises important considerations about the role and design of curricula, and how teachers interact with curricula. In this study, we explored elementary teachers' participation with a curricular mini-unit in science that invited them to choose among possible next steps, selecting experiments that would responsively build on student thinking. We coded 41 written segments of teachers' reasoning about their selected next steps to document varied resources that teachers used in making curricular choices. In the vast majority of segments, we found that teachers drew on student ideas and interests as resources for determining next steps. We also identified four clusters of resources that represent different ways of interacting with students' contributions, with implications for responsiveness, learning, and equity.

Keywords: teacher noticing and responsiveness, curriculum, elementary science, resources

Lines of scholarship across fields, including educational philosophy (e.g., Dewey, 1915/1966), psychology (e.g., Vygotsky, 1978), and the learning sciences (e.g., Rosebery, Ogonowski, DiSchino, & Warren, 2010), depict learning as a complex, dynamic process of situated meaning-making. Meanings that emerge through localized interactions of learners and environments may be patterned in some ways but are also often idiosyncratic (Hammer & Sikorski, 2015), as they emerge from the specific experiences, understandings, motivations, and contextual details in play.

Such complexity raises important issues about curricula and how curricula are used in and across classrooms. Curricula in which the content and sequence of lessons is fully prespecified, even in research-grounded ways, may not support the meaning that unfolds in a given classroom and the authentic engagement of learners in meaning-making (Dewey, 1938/1997). However, it would be untenable for teachers to create emergent curricula that are fully responsive to students' contributions, both pragmatically and systemically as educational systems need shared foundations from which to build.

This paper explores teachers' use of a curricular mini-unit that defines content to be learned but is highly adaptable to students' hypotheses. As part of an elementary teacher professional learning experience in science, we designed a mini-unit of instruction with a "choose your own adventure" component, inviting teachers to choose among possible next steps based on what they noticed in student thinking (Sherin, Jacobs, & Philipp, 2011) and what might forward students' meaning-making in relation to a focal scientific phenomenon. This invitation represented a substantial shift for teachers from "following" a scripted, activity-oriented science curriculum to "participation with" the mini-unit (Remillard, 2005). Thus, in this study, we ask the following exploratory question: *How do elementary teachers employ varied resources (personal, social, conventional) in making responsive curricular choices in science?* In particular, we attend to how and to what degree teachers worked with students' ideas and questions *as* resources for curricular choices, given findings from studies of teacher noticing and responsiveness, which we turn to next.

Conceptual framework

Teacher noticing and responsiveness

A growing body of research attends to the ways in which teachers notice and are responsive to student thinking, in support of meaning-making (e.g., Robertson, Scherr, & Hammer, 2016; Sherin, Jacobs, & Philipp, 2011). While studies show that teachers can notice and respond to student thinking in practice from early in their careers, they also highlight substantial variability in teachers' practices of doing so as systems of schooling commonly draw attention elsewhere (Sherin & van Es, 2009; Thompson, Windschitl, & Braaten, 2013). Further, responding in ways that actively build on students' contributions and advance learning can be especially challenging (Harris, Phillips, & Penuel, 2012). These findings suggest that a critical area to both understand and support is teachers' determination of next steps that build on the work students have started within their classrooms.

Resources in and for instruction

To explore how teachers determine next steps in this study, we draw on the construct of *resources* and their situated use in instructional contexts (Cohen, Raudenbush, & Ball, 2002; Stroupe, 2016). Defined as "physical and intellectual commodities that teachers use" (Stroupe, p. 51) to inform and shape their practice, resources may be wide-ranging and include things like teachers' own instructional aims and knowledge (what Cohen et al. refer to as "personal" resources), ideas and expectations from colleagues and broader institutions ("social" resources), and more "conventional" resources like materials or time. Investigating which resources teachers recruit or recognize and how they coordinate such resources enables us to develop multifaceted, situated accounts of teachers' curricular choices, with particular attention to how teachers work with students' contributions as influential social resources in conjunction with other resources.

Study context

Data for the study come from K-2 teachers' participation in a blended (partly in-person, partly online) Learning Lab on scientific modeling with young students. We organized the Lab around a four-lesson mini-unit in which students create and revise scientific models of why a puddle on the grass disappears over time. For Lesson 3 in the mini-unit, we provide multiple options for experiments that teachers may choose among, with tables highlighting how particular experiments may address common questions or support specific conceptual insights; teachers may also devise their own approach to forward students' meaning-making. We collaboratively examine students' models from teachers' classrooms as part of the Lab as well and consider implications for Lesson 3.

Data and methodology

We focused on online reflective posts as our primary data source, in which teachers were asked to share artifacts, insights about student thinking, and instructional considerations that arose as they taught the mini-unit. Specifically, we examined K-2 teachers' posts about Lessons 2 and 3 in the mini-unit for explicit reasoning related to next steps and selected segments in which such reasoning was evident (e.g., "I chose to do the How Does Water Soak Into The Ground experiment because…"). This selection process garnered 41 selected segments across 28 teachers.

To characterize the resources teachers employed in making curricular choices, we engaged in multiple rounds of inductive coding and refinement (Corbin & Strauss, 2008), guided conceptually by Cohen et al.'s (2002) broad categories of personal, social, and conventional resources. This iterative process resulted in the preliminary scheme depicted in Table 1, which we used to code all selected segments. Segments were given multiple codes (e.g., "Deepening understanding" and "Adding ideas") if evident in the teacher's reasoning.

Table 1: Preliminary coding scheme for resources employed in curricular choices

Category	Code	Description
Personal	Deepening understanding	Describes aim of extending student understanding of processes, how and why things occur
	Clarifying concepts	Describes aim of clarifying student understanding of particular concepts
	Testing ideas	Describes aim of testing or "proving" student ideas
	Exploring ideas	Describes aim of exploring or investigating student ideas
	Adding ideas	Describes aim of adding ideas that students have not considered
	Inclusiveness	Describes aim of addressing multiple ideas or contributions
	Expansive content knowledge[1]	Uses content understanding beyond that built into unit
Social	Student ideas	Cites specific ideas students raise (Subcodes include common, less common, and individual)
	Student interests	Cites what students are focused on or want to pursue
	Missing components	Notes what is missing from students (e.g., particular ideas, deeper understandings of how or why things occur)
	Colleagues' contributions	Cites discussions with or feedback from colleagues
Conventional	Classroom artifacts	Cites artifacts like class model
	"Zoom-in"	Mentions "zoom-in" (a way to show unobservables on models)
	External materials	Describes use of materials or supplies beyond that built into unit
	Logistics	Discusses feasibility or time

Findings

Overall trends in resource use across segments

In terms of our focus on working with student contributions as resources for curricular choices, a notable trend is that 27 (of 41) segments explicitly referred to student ideas in discussing next steps (e.g., "[student] posed the idea that heat causes evaporation, after disagreeing with the picture of a magnet next to the sun, saying it can't pull the water… we developed ideas about how to investigate the claim"). Seven additional segments referred to student interests, including directions students wanted to pursue or questions they had. Taken together, this means that 83% of segments cited students' contributions as social resources in play.

Other overall trends included infrequent citing of colleagues' contributions (5 segments, 12%) and logistics considerations (4 segments, 10%).

Clusters represent different ways of interacting with students' contributions

Additionally, we saw that some resources tended to cluster together. Looking across our coding, we identified four patterns that seemed to represent different ways of working with students' contributions, with different implications for curricular choices.

Cluster 1: Exploring what students are interested in (10 segments)

Segments in this cluster described exploring or investigating student interests or ideas, including questions that students raised. Frequent codes included *exploring ideas* (personal), *student ideas* and *student interests* (social), and *classroom artifacts* (conventional). The example below shows what the reasoning in this cluster sounded like, as a teacher considered how to move forward in relation to the class's model (which had multiple numbered ideas):

> In terms of what kids would like to do, the most popular ideas are number 4, looking at how does the sun dry the puddle or what happens there. The other one is how the roots drink the water… And so I'm just going to think a little bit about which one seems to make the most sense to be able to do in class.

In this segment, the teacher cited specific ideas students would like to pursue from the model and indicated that she planned to explore one of the proposed ideas. A common consideration was which ideas were most "popular" or "interesting" among students.

Cluster 2: Deepening students' understanding of ideas (7 segments)

A different cluster emphasized deepening students' understanding of the processes and causes underlying the ideas they raised, combining codes for *deepening understanding* and *expansive content knowledge* (personal), *student ideas* and *missing components* (social), and several conventional resources, including *zoom-ins*. In such segments, teachers tended to identify both an idea students raised (e.g., "my group talked about the water could have 'went underground' and 'soaked into the grass') and a way the idea could be pressed deeper (e.g., "they weren't quite sure why or how"), describing their selected next step as a way to deepen understanding. Teachers exhibiting this reasoning often selected experiments that provided observable evidence of how processes occurred.

Cluster 3: Clarifying common and/or individual (mis)understandings (6 segments)

The clarifying (mis)understandings cluster focused on specific ideas from students that teachers felt required clarification or rectification. Here, the emphasis was not on *missing components* as above, but rather on *clarifying concepts* (personal) in relation to common and/or individual *student ideas* (social) as seen in the following example: "Many replied that the sun was most like the sponge because it 'sucks the water up.' We need to clarify the evaporation process, so I plan to do the kettle experiment."

Cluster 4: Inclusively pursuing multiple ideas (5 segments)

Finally, several segments depicted teachers planning to do several experiments to address multiple ideas in play in their classrooms, including less common ideas. Codes here included *inclusiveness* (personal), *student ideas* and *student interests* (social), and *external materials* (conventional) as teachers sought to support additional ideas (e.g., "I think I'm going to try to find information about storm water management for 'the water goes into the drain'").

Discussion

While we know that teachers frequently make curricular choices or adaptations in practice, we know less about the varied resources they draw on in doing so and how the dynamics change when they are explicitly *invited* to do so in relation to student meaning-making. This study contributes to our growing understanding of how teachers may "participate with" curricula (Remillard, 2005) and make responsive choices in science teaching.

We found that teachers drew on students' contributions as resources for curricular choices across 83% of coded segments – a high proportion, given the variability seen in teachers' attention in prior studies when they were asked to focus on student thinking (e.g., Sherin & van Es, 2009). This finding sparks questions of why. For instance, one conjecture is that the Lab's focus on scientific modeling, and specifically the notion of students as creators and editors of models over time, provided a cohesive context or frame within which to build on student thinking. Moving forward, we intend to explore this conjecture as well as whether particular curricular supports or Lab activities were especially useful for teachers, which can inform the design of future professional learning opportunities.

Additionally, this study identified four primary ways that teachers worked with students' contributions in determining instructional next steps. While one of the identified clusters (Cluster 3, clarifying (mis)understandings) reflects a more traditional emphasis on correcting students' ideas, the other three clusters represent different approaches to responsively building on students' contributions. However, we believe that the approaches may have diverse affordances for advancing particular forms of learning (Harris, Phillips, & Penuel, 2012) and equity across perspectives and participants in the classroom community. For example, Cluster 2's emphasis on deepening understanding may advance students' learning of the hows and whys of specific processes, but may also limit how many and whose ideas are elevated for consideration. Future studies could explore the prevalence and fluidity of these approaches to being responsive to student thinking and their implications for learning and equity.

Endnotes

(1) We recognize that varied kinds of content knowledge are likely involved in teachers' choices, but such resources are largely tacit or underdetermined in their posts. Here, we highlight use of "expansive" content knowledge that clearly extends beyond content discussed in the curriculum.

References

Cohen, D. K., Raudenbush, S. W., & Ball, D. L. (2003). Resources, instruction, and research. *Educational Evaluation and Policy Analysis*, *25*(2), 119-142.

Corbin, J., & Strauss, A. (2008). *Basics of qualitative research: Techniques and procedures for developing grounded theory* (3rd ed.). Thousand Oaks, CA: Sage Publications, Inc.

Dewey, J. (1966). *Democracy and education*. New York: Free Press. (Original work published 1915)

Dewey, J. (1997). *Experience and education*. New York: Touchstone. (Original work published 1938)

Hammer, D., & Sikorski, T. R. (2015). Implications of complexity for research on learning progressions. *Science Education*, *99*(3), 424-431.

Harris, C. J., Phillips, R. S., & Penuel, W. R. (2012). Examining teachers' instructional moves aimed at developing students' ideas and questions in learner-centered science classrooms. *Journal of Science Teacher Education*, *23*(7), 769-788.

Remillard, J. T. (2005). Examining key concepts in research on teachers' use of mathematics curricula. *Review of Educational Research*, *75*(2), 211-246.

Robertson, A. D., Scherr, R. E., & Hammer, D. (2016). *Responsive teaching in science and mathematics.* New York: Routledge.

Rosebery, A. S., Ogonowski, M., DiSchino, M., & Warren, B. (2010). "The coat traps all your body heat": Heterogeneity as fundamental to learning. *Journal of the Learning Sciences*, *19*(3), 322-357.

Sherin, M. G., Jacobs, V. R., & Philipp, R. A. (2011). *Mathematics teacher noticing: Seeing through teachers' eyes.* New York: Routledge.

Sherin, M. G., & van Es, E. A. (2009). Effects of video club participation on teachers' professional vision. *Journal of Teacher Education, 60*(1), 20-37.

Stroupe, D. (2016). Beginning teachers' use of resources to enact and learn from ambitious instruction. *Cognition and Instruction*, *34*(1), 51-77.

Thompson, J., Windschitl, M., & Braaten, M. (2013). Developing a theory of ambitious early-career teacher practice. *American Educational Research Journal, 50*(3), 574-615.

Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes*. Cambridge, MA: Harvard University Press.