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William R. Penuel, Rachel S. Phillips & Christopher J. Harris
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Analysing teachers' curriculum implementation from integrity and actor-oriented perspectives

WILLIAM R. PENUEL, RACHEL S. PHILLIPS and CHRISTOPHER J. HARRIS

Curriculum materials and knowledge about curricular purposes and structures are valuable tools that teachers often draw upon to organize instruction and facilitate student learning. Careful analysis of teachers' curriculum implementation and the decision-making that undergirds their curriculum use is critical for fully understanding enactment. This paper compares how *integrity analyses* of implementation of curriculum materials and *actor-oriented analysis* of teachers' curriculum use can help researchers, teacher educators, and curriculum designers interpret teachers' decisions about what aspects of new materials to use and how to use such materials. Drawing on evidence from teacher interviews and observations, we compare two teachers' enactments of a new elementary-level environmental biology unit. Our analyses of integrity point to differences in teachers' adaptations with respect to their consistency with the purposes and structures of curriculum materials as construed by designers. By contrast, our actor-oriented analysis explain how the teachers' different approaches to interpreting the goals and structures of the curriculum unit partly account for patterns in their enactment in ways that can inform refinements to materials and the design of professional development supports for teachers. In so doing, we show how implementation integrity and actor-oriented analyses offer complementary perspectives to inform curriculum research and development.

Keywords: implementation; integrity; actor-oriented perspective; science curriculum

> The curriculum and its associated materials are the *materia medica* of pedagogy, the pharmacopeia from which the teacher draws those tools of teaching that present or exemplify particular content and remediate or evaluate the adequacy of student accomplishments. (Shulman, 1986, p. 10)

Where curriculum often defines only the broadest 'plan for learning' (Taba, 1962), curriculum materials and knowledge about curricular purposes and structures are two of the most valuable tools teachers can draw upon to

William R. Penuel is professor of Educational Psychology and Learning Sciences in the School of Education at the University of Colorado Boulder, UCB 249, Boulder, Colorado 80302, USA; e-mail: william.penuel@colorado.edu. His research focuses on the design, implementation and evaluation of reforms in science and mathematics education.

Rachel S. Phillips is a teaching associate and postdoctoral scholar in educational psychology and learning sciences within the College of Education at University of Washington, Box 354941, Seattle, Washington 98105, USA; e-mail: rachelsp@uw.edu. Her research focuses on underserved youth, particularly those who are incarcerated or in alternative school settings.

Christopher J. Harris is a senior researcher in the Center for Technology in Learning at SRI International, 333 Ravenswood Avenue, Menlo Park, California 94025, USA; e-mail: christopher.harris@sri.com. His research focuses on the design, implementation and study of instructional innovations in K-12 classrooms and informal science contexts.

organize instruction and facilitate student learning (Ball & Cohen, 1996; Darling-Hammond et al., 2005; Shulman, 1986). Curriculum materials provide teachers with student activities to help students accomplish particular aims (Krajcik, McNeill, & Reiser, 2008), and knowledge about curricular purposes and structures provides a framework within which teachers can select and adapt materials in ways that are consistent with designers' intentions (Davis & Varma, 2008).

Teachers' use of curriculum has been a focus of research in a wide range of subfields of education, including the learning sciences (Drake & Sherin, 2006; Schneider & Krajcik, 2002), educational policy (Coburn & Russell, 2008; Stein & Kim, 2009) and curriculum studies (Ball & Feiman-Nemser, 1988; Ben-Peretz, 1990; Choppin, 2009). A recurring finding from these studies is that there is inevitably a gap between the intended and enacted curriculum, that is, between how designers intend for teachers to use curriculum materials to plan and lead instruction, and what teachers in fact do (Brown & Campione, 1996; Reiser et al., 2000; Songer, Lee, & Kam, 2002; Spillane, 1999; van den Akker, 1988).

In this paper, we analyse the gap between the intended and enacted curriculum from two contrasting perspectives, an *integrity* perspective and an *actor-oriented* perspective. Integrity of implementation refers to the degree to which teachers' adaptations of materials are congruent with the curricular goals and principles undergirding the structures of curriculum (LeMahieu, 2011; Sechrest, West, Phillips, Redner, & Yeaton, 1979). It is related to fidelity perspectives on implementation, in that researchers who study integrity of implementation focus on the degree to which teachers adhere to guidance embedded in curriculum materials, maintain integrity to the principles of the designs in their delivery and provide students with sufficient exposure to opportunities to learn embedded within student activities (Dane & Schneider, 1998). By contrast, an actor-oriented analysis focuses on how teachers interpret guidance embedded in materials and how these perceptions shape their decisions about how to adapt materials to their local circumstances. Originally conceptualized as a model for understanding transfer in students' subject-matter learning (Lobato, 2003, 2006), an actor-oriented analysis of curriculum enactment seeks to produce an account that links teachers' decisions about implementation to what they interpret to be salient curricular purposes and structures and how these interpretations are shaped by prior experience and their local context. An actor-oriented perspective on teachers' curriculum use begins with a premise that implementing new materials presents a situation that requires teachers to draw connections between previously encountered curricular goals and structures and the goals and structures of new curriculum.

In this study, we ask: *How do integrity and actor-oriented accounts of curriculum use within a single enactment of a newly adopted curriculum compare?* In developing and comparing these accounts, we consider specifically what design teams can learn from adopting both an external benchmark for judging the quality of implementation (the integrity perspective) and a more teacher-centred view that focuses on the how and why of their decision-making.

The claim we develop in this paper is that these two perspectives on the gap between the intended and enacted curriculum offer complementary perspectives to inform research and development. Specifically, we argue that an integrity analysis can point to areas were more specific guidance is needed for teachers and can identify broad areas of teacher need in future professional development. In contrast, actor-oriented analysis provides specific insights that offer clues as to how curriculum materials and associated professional development need to be modified to support teacher learning. To warrant this claim, we present an analysis of two elementary teachers' perspectives on and enactment of an environmental biology unit co-designed by a team of learning scientists and teachers. We examine the teachers' enactments from an integrity perspective. We also analyse these teachers' constructions of the purposes and structures of the curriculum, situate their constructions within their past experiences and show how these constructions relate to patterns of enactment observed in their classrooms. We conclude by considering what these complementary forms of analysis can contribute to curriculum research and development.

Contrasting perspectives on curriculum use

In this section, we describe and then compare two perspectives on curriculum use that we employed in this study: the *integrity* perspective and the *actor-oriented* perspective.

Integrity perspective

For many years, a dominant perspective for analysing how teachers make use of the material resources given to them to help them plan and organize learning activities for students has been the *integrity perspective.* Analysis of implementation integrity seeks to quantify—often through a range of objective measures—the extent to which teachers' uses of curriculum adhere to a model specified ahead of time by actors outside the classroom. Integrity analysis also considers whether teachers provide exposure to curriculum materials designers consider adequate to impact learning, and they characterize the quality of implementation (Dane & Schneider, 1998). This analysis is closely related to analysis of fidelity of implementation (e.g. O'Donnell, 2008) in their emphases on adherence to the principles of designers, but the term 'integrity' signals a stance regarding adaptation that differs from the stance taken in analysis of fidelity. Researchers who prefer the term 'integrity' presume teacher adaptation of materials always takes place when teachers implement curriculum and that the primary focus of analysis should be on whether those adaptations are congruent with the goals and principles designers had in mind (Borko & Klingner, 2013; Debarger, Choppin, Beauvineau, & Moorthy, 2013; LeMahieu, 2011).

From an integrity perspective, the purposes of curriculum materials should be designed to be transparent, and the structures should allow

teachers to realize those purposes by following the curriculum. A key assumption is that clear guidance can enable teachers to follow the curriculum and reduce the gap between the intended curriculum and the enacted curriculum (Remillard, 2005). Guidance regarding implementation of key curriculum structures, including the amount of time to allocate to particular topics and the ways to group students, is hypothesized to lead to better integrity and, consequently, to better student learning outcomes (Freeman & Porter, 1989). Such guidance may even include detailed scripts for teachers about what they should do and say in the classroom to ensure that their students learn (Sawyer, 2004).

An integrity perspective is an outsider's perspective of curriculum enactment. Sometimes, analysis of integrity focuses on the extent to which teachers' constructions of curricular purposes and structures and their enactment of materials in classrooms align with the intentions and plans of expert curriculum designers (e.g. Brown & Campione, 1996). In other integrity analyses, outside evaluators define a model of treatment integrity and then develop and use quantitative measures of adherence and quality of delivery in relation to their model (e.g. Cordray & Pion, 2006). In large school systems, curriculum leaders develop pacing guides for curriculum materials that they intend teachers to follow, based on their perceptions of how much time should be allocated for each content standard (Cobb, McClain, Lamberg, & Dean, 2003). Curriculum designers, evaluators and district leaders all have a stake in curriculum enactment, but they are not the people who must implement curriculum materials with students (Rowan & Miller, 2007). Promoting integrity is for, many of these stakeholders, a primary means by which they seek to influence enactment from outside the classroom.

From an integrity perspective, a key goal of professional development is to provide teachers with the guidance they need to discern the purposes and structures of curriculum materials and to employ instructional techniques that support, rather than subvert, the aims defined by stakeholders outside the classroom. This professional development may entail opportunities for teachers to engage with the materials as students might (e.g. Penuel et al., 2009). In such instances, professional development leaders model instructional strategies that they expect teachers to use in their classrooms to implement curriculum materials effectively. Accordingly, teachers' primary task is to 'translate' their professional learning experience into the classroom in ways that are faithful to the meanings and structures of the curriculum.

Curriculum researchers do not always conduct analysis of integrity of implementation, but when they do, they often rely on quantitative measures (Cordray & Pion, 2006). Some of these measures are based on curriculum-independent theories of implementation so as to permit cross-curriculum comparisons (e.g. Hord & Huling-Austin, 1986). Other analyses of integrity are based on curriculum-specific theories of change; they can be used to test how implementation of particular components mediates outcomes targeted in the curriculum (e.g. Clements & Sarama, 2008). Researchers also use curriculum-specific measures of integrity to analyse factors and processes that support implementation (e.g. Penuel &

Means, 2004). The value of quantitative measures of integrity is that they permit researchers to construct and test models to explain implementation and its effects. In this study, we explore a use of integrity analysis that is focused on a curriculum-specific theory of change and that relies on a combination of simple counts of activities implemented and interview data, with the purpose of helping curriculum designers identify areas where materials and associated professional development can be strengthened.

Actor-oriented perspective

An *actor-oriented* perspective offers a contrasting approach to conceptualizing and analysing implementation. Originally, mathematics education researchers developed actor-oriented perspectives as a lens for identifying instances of learning transfer by students (Lobato, 2003). Lobato (2012) argues that an actor-oriented perspective is particularly useful for developing understanding of how learners interpret transfer situations and how learners' contexts shape transfer. As an example, Lobato, Ellis, and Muñoz (2003) describe a teaching experiment in which students had difficulty with coordinating the quantities that define the slope. From a traditional perspective on transfer, students failed to accomplish the goals set out in the experiment. But Lobato (2003) and colleagues' analysis shows how students' responses actually do draw upon their experience in the classroom, in which certain teaching practices had directed students' attention to differences in a single quantity, rather than to the coordination of quantities.

This particular analysis foregrounds another important aspect of an actor-oriented perspective: An emphasis on interpreting the significance of activities and events within the flow of ongoing classroom activity. An actor-oriented analysis presumes that learners in a given situation make use of beliefs, experience and knowledge to make sense of a given task or activity (Lobato, 2012). Such an analysis looks specifically, too, for evidence from the classroom context itself for clues as to where students' attention or focus has been directed (Lobato, Rhodehamel, & Hohensee, 2012). An actor-oriented perspective presumes that situational cues and attempts to direct learners' attention to phenomena are often ambiguous, especially when the content of learning is rich and complex (Lobato, 2012).

With respect to curriculum materials, an actor-oriented perspective presumes that guidance embedded in materials as to curricular purposes and structures requires teachers' active sensemaking. Teachers can be expected, moreover, to draw on prior beliefs and experiences with other reforms and make use of cues from their social environment in interpreting the purposes for curriculum materials and thinking about their structure (Coburn, 2004; Stein & Coburn, 2008). Especially, early on in the development of materials, the curriculum materials may not be well specified (Cohen & Ball, 1999), in that the designers have left many decisions up to teachers to make about how to orchestrate classroom activities.

Even when designers provide teachers with varied tools for supporting instruction, teachers may need to pose questions about curriculum tools, seek out resources, ask for help from colleagues and solicit feedback on their practice as they go about learning about curriculum (Sinha et al., 2010).

An actor-oriented analysis of curriculum implementation takes the teacher's point of view, that is, an insider's view. Such an analysis focuses on teachers' formulations of goals, their decisions about what to implement or adapt and the reasons they give for implementing materials the way that they do. It situates those decisions within teachers' own goals for student learning, as well as in light of the sense they make of curricular purposes and structures. An actor-oriented perspective presumes, moreover, that teachers make a large number of decisions both before and during instruction, only some of which pertain specifically to the purposes that designers have for curriculum materials. Rather than interpret teachers' decisions with reference to an external standard, an actor-oriented analysis uses frames of reference and meanings that teachers use when characterizing their instructional decision-making. At the same time, an actor-oriented perspective also acknowledges the ways these frames of reference are always partly 'borrowed' from past experience and from other social contexts, including professional development.

Developing an actor-oriented analysis requires qualitative research methods, including interviews and observations. Frequently, researchers use inductive coding methods to identify meanings of activities and events and patterns of engagement (e.g. Lobato et al., 2003). Inductive coding methods help identify learners' interpretations that neither curriculum designers nor researchers had anticipated, but that proved consequential for their participation in activity (Lobato, 2012). Surprising or unanticipated interpretations can in turn help designers to revise or refine curriculum materials to link more productively to address needs of learners. For our purposes in the present paper, teachers' unanticipated interpretations of curriculum purposes and structures are potentially useful for redesigning embedded supports for teacher learning (educative curriculum materials; Davis & Krajcik, 2005) and professional development.

Comparing the two perspectives on curriculum implementation

Our comparative analysis of two teachers' implementation of the same new curriculum explores the complementarity of integrity and actor-oriented perspectives on implementation. The integrity perspective provides a benchmark for judging the quality of implementation against an external standard set by the design team. In this respect, it provides direct feedback to the team about the feasibility of implementing particular curriculum structures in classrooms. By contrast, an actor-oriented perspective keeps teachers' beliefs, prior experiences and classroom realities at the fore, and it provides a means for identifying the how and why of implementation challenges that design teams must address. An actor-oriented analysis provides more indirect feedback to a design team than does an analysis of

fidelity of implementation, because the feedback takes the form of illuminating the multiple and sometimes contradictory perspectives of teachers on curricular purposes and structures.

Methods

We employed a multiple-case study approach (Stake, 2005) to address these questions, analysing data from interviews and observations from two different teachers who participated in a larger study of the curriculum undertaken by two teams of researchers investigating the curriculum's effects on teaching and learning.

Study setting

The project, that is the focus of this study, was a research–practice partnership (Coburn, Penuel, & Geil, 2013; Radinsky, Bouillion, Lento, & Gomez, 2001) between the X School District and researchers at Y University in the USA. The school district's superintendent initiated the effort with a request for a 'curriculum audit' from a senior faculty member and colleagues of the College of Education at the University. He invited the faculty member's team to analyse the district's adopted science curriculum using the framework for the design of research-based learning environments outlined in the US National Research Council's (NRC, 1999), *How People Learn*. For the district's superintendent, curriculum was an important tool for promoting the improvement of teaching and learning: he had established a common curriculum in science and created an online 'curriculum web' where teachers could access all materials needed for the curriculum.

The University team's initial audit, conducted in collaboration with district teachers and science coaches, revealed that the adopted curriculum for the elementary grades, the Full Option Science System (FOSS) published by the Lawrence Hall of Science, was one that was potentially engaging to students but was not fully 'student- and classroom-centered' as conceptualized in the *How People Learn* framework. Specifically, students had few opportunities to revise and rethink ideas and to get feedback about their thinking.[1] In addition, students were given few opportunities in the FOSS curriculum to devise their own questions or plan investigations to carry out in class. Instead, the curriculum provided teachers with explicit guidance about the questions students should pursue and the steps they should take in conducting investigations in science. The research team concluded that a possible consequence of limiting students' opportunities to pose their own questions and plan investigations was that they would not likely develop these particular skills through encounters with the curriculum.

The collaborative design team decided that the district should not start anew with an entirely new curriculum but, instead, came to a joint decision to work toward repurposing a FOSS unit, *Environments*, as a first

step to improving the science curriculum. To do so, the team engaged teachers in a process of *co-design* (Penuel, Roschelle, & Shechtman, 2007). As part of the co-design process, both the University team and a team comprised of district leaders and teachers first came up with two separate designs, followed by a third one that blended the first two designs. A small team of teachers implemented the first 'blended' design, and then one teacher worked closely with the team over the following summer to revise the unit. In the following school year, both the initial design teachers and a group of new teachers implemented the revised unit. During that field test, researchers conducted research on implementation and student learning (Harris, Phillips, & Penuel, 2010, 2012).

Focal curriculum materials: the designers' perspective

The overall purpose of the new unit, like that of the FOSS *Environments* unit, is to help students learn about factors that are important for the survival of living organisms. In contrast to the FOSS unit, which specifies a series of experiments for students to follow about a range of organisms, the *Isopod Habitat Challenge* unit provides students with significant levels of agency to formulate questions and plan investigations related to the preferences of a single organism, the isopod. In addition, the repurposed unit adhered to three key principles, outlined in *How People Learn* (NRC, 1999), that robust learning environments should be *knowledge-centred, assessment-centred and community-centred*. These principles were specified in the design process, in ways that we elaborate below. We emphasize that these are principles that were initially articulated from the researchers' perspective, but they formed the basis for identifying points of convergence and divergence with teachers' perspectives on the curriculum.

Research-based learning environments are *knowledge-centred*, in that they are focused on developing students' understanding of discipline-based forms of knowing, seeing and valuing (NRC, 1999). The *Isopod Habitat Challenge* aims to accomplish this goal by organizing students' opportunities to learn about the habitats isopods prefer according to a 'challenge-based learning cycle' (Schwartz, Lin, Brophy, & Bransford, 1999). The cycle is organized around a single challenge: to create an optimum habitat for isopods, a small crustacean also called 'pill bugs' and known to many American children as 'roly polys'. In the unit, students first share their initial ideas and questions about isopods, then they take part in a teacher-guided investigation and finally participate in student-generated investigations to answer their questions. The curriculum calls on students to undertake multiple cycles of investigations designed to give them increasing fluency with the practice of posing a question, designing and implementing an investigation, and drawing conclusions from what they observe to be the results of their investigations. As students move through each phase, they revisit and revise their initial ideas and questions, conduct new research, revise their ideas and reformulate their questions again, and then present their final habitat plan in a public forum,

providing multiple opportunities for sense making as part of individual writing, small group and whole class discussion and group presentations.

Opportunities for reflection and feedback are integral components of *assessment-centred* learning environments (NRC, 1999). Assessments are embedded throughout the *Isopod Habitat Challenge* unit. In presenting the challenge to students, the unit calls for teachers to pose questions to students about their understanding of 'habitats' and what they think might happen to an isopod put into an empty terrarium. Students are asked to write down their initial ideas about the kinds of habitats they think isopods prefer, share ideas with members of their small group and develop questions they want to investigate. During the student-led investigations, students review together their questions and refine one to investigate as a team; the teacher also asks students during this phase to complete an embedded assessment of students' skill in formulating questions and planning investigations. Upon completion of their investigations, students are expected to revise their initial ideas about the kind of habitat isopods prefer. In the final phase of the project, students work in groups to develop a final optimum habitat and presentation of this to the class, a presentation, named a 'Go-Public' in the curriculum, which serves as a culminating assessment for the teacher. Students work in the same groups throughout the unit.

Participants in effective *community-centred* learning environments assign value to collective knowledge building, making mistakes and being willing to revise one's thinking, building on others' contributions and ideas, and recognizing that solving complex problems often requires unexpected and diverse forms of expertise (NRC, 1999). The *Isopod Habitat Challenge* unit provides multiple occasions for building a community-centred learning environment. Much of students' independent work takes place in autonomous small groups to build knowledge across multiple investigations about the kind of habitat that isopods prefer. In both writing and classroom discussion, students respond to prompts to revise and rethink their initial ideas about isopods. The unit calls for students to use research to answer 'why' questions that link findings from their investigations to explanations based on scientists' investigations of isopod behaviour and habitats.

Study participants

A total of eight teachers across five elementary schools in one mid-size suburban school district in the US Pacific Northwest enacted the *Isopod Habitat Challenge* over 12 weeks in their fifth-grade classrooms. We present case studies of two teachers from one of the schools in the larger project. The school's student population was primarily European American (60%) and Asian American (19%), with a small percentage of students receiving free or reduced price lunch (13%).

The two teachers, Ms Atwell and Ms Jones, have somewhat different backgrounds and were engaged to different degrees in helping to design the focal curriculum unit. Ms Atwell has a BA in English and a Master of

Arts in Teaching degree. At the time of the study, she was in her fourth year of teaching, and had taught fifth grade for all four years. She used the FOSS curriculum during those years of teaching. She was on the team of teachers who first piloted the unit, and then worked closely with one of the University researchers on the redesign over the summer following the first pilot. The second teacher, Ms Jones, has a BA in Geography and a Master of Arts in Teaching degree. During the time of the study, she was in her third year of teaching and had also taught FOSS during those years. She was also on the team of teachers who piloted the first unit. While she did help in some of the redesign, particularly related to the creation of assessments, she was not as involved in this process as Ms Atwell. Additionally, Ms Atwell and Ms Jones taught in classrooms that were adjacent to one another and always planned their science lessons as a team. Neither, despite having taught the FOSS unit before, had participated in professional development related to the original FOSS unit.

Both teachers participated in three hour-long professional development sessions focused on the use of the curriculum. The sessions included short presentations from the research team followed by longer question and answer sessions with the teachers. In the first session, which occurred before the start of the unit, teachers were introduced to the curriculum's purpose and its structure. The researchers provided an explanation of structure using the challenge cycle and the research base for the cycle reflected in *How People Learn* (NRC, 1999). Teachers also watched videotapes of the initial sessions of the unit taught by Ms Atwell from the previous year. Next, teachers reviewed the sequence of the unit, and researchers answered their questions about its structure. Videos were shown of the unit kick-off and teachers were asked to review the unit and respond with any questions. The second professional development session served as a check-in with teachers, and was also an opportunity for teachers to share resources with one another. The final session addressed the course assessments and final student presentations, known as 'Go-Publics'. The information presented in these sessions was not new to the teachers in the study since they were part of the first-year pilot. In addition to participating in the professional development, they also served as mentors to the teachers who were teaching the unit for the first time and were able to offer insight and advice related to their previous experiences with the unit.

Data sources and procedures

Data sources were semi-structured teacher interviews conducted by researchers during and after teachers' enactment of the unit, in addition to narrative documents of lesson enactments produced by integrating field notes and observation protocols completed by classroom observers.

Classroom observations. The classroom observations were spread across the 12-week unit, enabling observers to visit classrooms and record

lessons at the beginning, middle and end of the unit. For each observation, the observer submitted two kinds of data to the study leaders. One was a narrative account from ethnographic field notes taken in class of the key classroom events, including teacher and student actions, interactions and conversations. A second kind of data was a structured observation protocol to record whether or not teachers followed the curriculum guidance provided in the materials for the particular phase of the unit they were enacting. If teachers adapted the unit, this second observer also recorded the nature of the adaptation. Some adaptations had been anticipated by the researchers and were reflected in a structured protocol; and some others the teachers made that were unanticipated were also recorded and subsequently coded. We used as the basis for analysis for this paper the structured protocol data from 12 classroom observations of Ms Atwell's class and from 11 classroom observations of Ms Jones' class. It is an important limitation of the study that we did not observe every class period when both teachers taught. It was not feasible to do so, even though that was our original intention. We know, based on the evidence we do have, that some lessons were skipped or shortened, and so missing evidence in this case might have provided more complete evidence regarding implementation integrity. In addition, from an actor-oriented perspective, a skipped activity might have occasioned a follow-up interview as to why a teacher made that decision.

Interviews. Researchers conducted two interviews with each teacher, one at the middle of their enactments of the unit and a second after the teachers had completed their enactments. Researchers followed a semi-structured protocol; we used our actor-oriented framework to devise questions about teachers' efforts to learn about the curriculum, their perceptions of the purposes of the curriculum and their perceptions of its important features or structures.

Our coding scheme reflects both our conceptual framework and the structure of the data. The high levels for codes (e.g. curricular purposes) are derived from the framework, but specific codes come from the data (e.g. 'purposes of particular activities' or 'purposes as design principles'). We added codes for teachers' use of analogies to other curriculum materials, because such analyses were prevalent across the data for all eight teachers. Independent coding of narratives was conducted with two coders (the second and third authors) who met regularly to compare evidence for codes and calibrate their approaches for identifying evidence. After intercoder agreement of 80% or higher was achieved for all codes, the first coder (the second author) completed coding of the interview data independently.

Constructing the cases

We sought to select cases that, through analysis, could provide insight into the difference between viewing curriculum use from an integrity perspective and from an actor-oriented perspective. To this end, we took an explanatory, multiple-case study approach (Yin, 2003) that focused on how each type of analysis might help to explain variation in curriculum use. In this approach, researchers' aim is not simply to describe the phenomena under study, but to seek explanations for why cases unfold the way they do. Yin's (2003) recommendation is that researchers develop a set of initial possible 'rival explanations' for patterns in the data that they expect to find, both as a guide to instrument design and as a method for guarding against confirmation bias. In both types of analyses, we draw on teachers' use and perceptions of the curriculum.

Results

Analysis of Ms Atwell's curriculum use

From an integrity perspective, Ms Atwell's curriculum implementation was largely consistent with the original purposes the design team members had for the unit, which is hardly surprising given her extensive involvement in the co-design process. At the same time, an actor-oriented analysis that drew on evidence from interviews and observations revealed that her curricular purposes were framed in part by broader social goals for elementary school learning, namely the development of responsibility and skills of negotiation.

Integrity analysis. Ms Atwell's constructions of the purpose were strongly aligned with those of the collaborative design team and with discipline-specific goals and assessments for student learning promoted by her district. Throughout a number of her responses to interview questions, Ms Atwell highlighted learning about specific aspects of the inquiry process as key to what students should learn from participating in the activities of the *Isopod Habitat Challenge.* These include asking questions, planning investigations, negotiating with group members about the direction of inquiry, writing conclusions and communicating results.

Throughout all but one phase of research, Ms Atwell followed the guidance provided in the curriculum closely. Of the elements and structures described in the curriculum that we observed, Ms Atwell made use of 27 of them in the classroom and skipped only one activity (table 1). Of the one activity skipped, as observers we were unclear as to whether Ms Atwell implemented the step the day after our observations, when we could not be present.

Ms Atwell did make adaptations to activities, particularly at the beginning of the unit. Some small adaptations were ones that did have the potential to undercut student opportunities to construct knowledge and make discoveries without being guided too soon toward correct answers.

Table 1. Integrity analysis of Ms Atwell's enactment of the curricular activities during each phase of the isopod habitat challenge unit.

Unit phase	Followed guidance	Adapted guidance	Skipped an activity
Challenge	4	4	0
Initial ideas	5	4	0
Teacher-led experimental research	8	0	1
Student-led experimental research	2	0	Missing
First revision of ideas	4	0	0
Web research	2	0	0
Second revision of ideas	2	0	0
Go public	Missing	Missing	0

Note: Each number in tables 1 and 2 refers to instances observed; variation across tables is due to difference in when observers were able to be present.

For instance, instead of simply asking students a question about what is likely to happen if isopods were placed into an empty terrarium during the Challenge phase, after listening to students' responses, Ms Atwell offered her own account of what would happen.

At the same time some adaptations were congruent with the purposes of designers to make the FOSS unit more student-centred. For example, Ms Atwell posed additional questions of students aimed at helping them generate hypotheses about what is needed to help isopods survive, something the curriculum materials did not explicitly call for her to do. Similarly, in the Initial Ideas phase, in addition to asking students about prior experiences with isopods, Ms Atwell invited students to compare their different ideas with one another. Though this guidance does not appear in the unit, she orchestrated the discussion so as to invite students to see differences in initial ideas that could form the basis of later investigations. Thus, in most cases we analysed, Ms Atwell's adaptations provided students with additional opportunities to learn that were consistent with the overall purpose of the unit and that may even have enhanced it.

Actor-oriented analysis. When prompted to describe the purposes for the revised unit, she drew on concerns she had developed after implementing the unit the prior year, concerns we did not hear expressed by other designers or district leaders. For her, a key purpose of the unit was to develop students' understandings of *why* isopods prefer particular kinds of habitat. As she put it, 'it's not just to learn about isopods, but it's to learn about … why the isopods do these things, not just what they need, but why they need them'. Without this emphasis, she argued, the unit would require students to do too little work and 'the learning that results from that would be really minimal'. Pushing students to answer why questions is necessary to 'make it meaningful' and to 'challenge the students on their assumptions'.

Ms Atwell's own constructions of the unit purposes were most evident from analysis of the adaptations she made to the unit as part of enacting

it. For example, Ms Atwell's emphasis on the 'why' aspect of the unit was evident in the way she enacted the unit. After students had come up with a set of initial plans for investigations, she provided groups with feedback that indicated where she placed value and directed them to probe deeper as to the basis for isopods' preferences. The direction given to one group, as recorded by observers, is illustrative:

> So a lot of you guys have told me what you're going to do with those things, but it doesn't tell me why. I've heard students say that isopods need to eat. Why? Why is that? Why wouldn't isopods just eat a sandwich? What is it that they need? I want you to think not just about what they are doing, but why. Why do they need soil? This is what you are going to discuss now in your group.

In her interview, she indicated this was a key criterion she was using to assess students' initial ideas. Of those initial ideas, she commented, 'there was a lacking in specificity but also not really understanding the reasoning why'. By contrast, at the end of the project during the Go Public phase, she noted that, 'they would say something like isopods need moist carrots because they get nutrients and they get their moisture from their food'. She was pleased that the students' revised ideas had more specificity and an answer to her probing of students as to why isopods preferred a particular kind of habitat.

Another purpose Ms Atwell constructed for the unit was to develop a sense of ownership or responsibility for classroom activities, a purpose she believed the enactment of the unit accomplished. She suggested that the unit encouraged teachers to take students 'more seriously' and to treat them in a more 'adult-like' fashion. Both she and the students took up these new positions readily, she said:

> I think that they rose to the occasion and that they knew that they were being charged with this responsibility of not only caring for the isopods but independently or as a team figuring out what they needed. And when they saw that I was taking a step back and not telling them what to investigate, telling them the answers, they knew they had to step up to the plate, and I think that a lot of kids took more ownership as a result.

Ms Atwell drew on her knowledge of other curriculum materials to make sense of the new approaches within the curriculum. She saw the *Isopod Habitat Challenge* as distinctive among the curriculum materials she uses, or as she put it, 'different from most of what else we teach' and 'contradicts the way a lot of people are teaching right now'. Several dimensions made it stand out for her. First, the curriculum is student-centred, which to her means that the focus is 'on where the student's interest lies'. It is in its student-centredness that the unit contradicts what most teachers do and puts the unit 'outside of the comfort zone of a lot of teachers'. In addition, the curriculum supports students reflecting on their thinking, that is, on developing 'metacognition, so the students are developing the skills to know what they know and to know what they don't know'.

She attributes her understanding of what makes the curriculum 'student centered' in part to her participation in the design process. As part of that process, she had read *How People Learn* (NRC, 1999), which she

said summarized 'the Bransford research and the theory behind' the unit design, referring to the Committee's ideas reflected in the volume. She said that what she read resonated with her and fit within the goals she had for her students' learning, which is why she became so deeply involved in the co-design process. At the same time, she said being part of the project changed her teaching:

> I think for me it was really challenging. It was a big shift in thinking for me and it definitely pushed me out of my comfort zone as far as getting away from being up on stage and directing the lesson and stepping back and letting the kids take charge of that.

Part of what helped Ms Atwell was enacting the unit once and then reflecting on what worked and what didn't, a process that was facilitated by her involvement in the unit revision the year after the first test of the *Isopod Habitat Challenge.* She says that in the first year, 'I was feeling it out as I went', noting that, 'it's hard to see the big picture until you've taught it'. Afterwards, she reflected on what worked and what did not work, and observed that the big shift required for teachers was from a paced lesson plan to allowing for student direction:

> The way our curriculum is set up now in most subject areas, it's lesson one [on] day one, lesson two, day two, lesson three, day three. And this is not like that at all. You don't really know when you're going to be doing what and the kids dictate the pace, which is part of the beauty of it. But for people who like to plan, that's really difficult.

Another distinctive feature of the curriculum for Ms Atwell was the opportunity afforded students for going through a cycle of inquiry multiple times, which she believed helped students better understand the specific activities of inquiry. At the concluding interview, Ms Atwell said,

> There was a huge difference in their comfort level going through the inquiry process as far as writing a question, making a prediction, collecting data, understanding data, understanding repeated trials, writing a conclusion. They just seem to get it. It clicked in this unit because they had so many opportunities to practice it.

That these multiple opportunities were focused on a single organism in the *Isopod Habitat Challenge* unit was an important feature of the design for Ms Atwell. It allowed students to 'concentrate on the inquiry process'. It also contrasted sharply with what she perceived to be a lack of focus within the FOSS unit, where 'we're going to do an investigation on bean plants today and darkling beetles the next week'.

Ms Atwell's adaptations were also consistent with her idea that promoting student choice and ownership were important curricular purposes of the *Isopod Habitat Challenge.* After a day of student-led investigations, for example, she asked students to vote on whether to conduct another round of trials. She followed the majority vote, which was to conduct another day of student-planned and student-led investigations. When providing assistance to student groups, Ms Atwell redirected questions from students about what they should do back to the groups. 'That's up to

you', she would say, or 'That's something you have to negotiate'. Though we observed her suggesting directions to groups, for the most part, she reinforced students' autonomy in decision-making in ways consistent with her own goals for student learning.

Analysis of Ms Jones' curriculum use

Ms Jones' curriculum use was largely consistent with the purposes the design team members had for the unit, however it was not as consistent as Ms Atwell's. In addition, although Ms Jones' account of the purposes of the curriculum was in alignment with designers' purposes, she elaborated less than did Ms Atwell, such that it was difficult to discern how differentiated her conception of the unit's purposes were. Her implementation was in line with both what she saw as the implementation goals of the unit, namely being student-centred, and her more personal goal of developing analytical thinking in her students.

Integrity analysis. Ms Jones' ideas about the purposes for the unit were partly congruent with those of the researchers on the curriculum design team. In a large number of responses to interview questions, Ms Jones kept returning to the notion that the intention of the unit was to go deeper into the curriculum so that the students could develop their inquiry skills and become analytical thinkers. Her elaboration of inquiry made no reference to science as a discipline, as Ms Atwell's had, but she did assert that inquiry skills were general skills that were important in preparing students for middle and high school. Analytical skills, she said, were general skills that entailed developing an understanding of the 'why' behind whatever they were doing in class.

Ms Jones' also frequently mentioned in interviews that engaging in student-centred teaching was important to the unit. Like Ms Atwell, she reported that this was difficult for her to do but appreciated the opportunity afforded by the student-led investigations. At a broad level, being student-centred meant giving students autonomy (letting students do their own thing) and flexibility in responding to students' bids to take the class in a particular direction. As she put it:

> I love the fact that it is so flexible. I feel like the rest of my day and the rest of the year is so fixed. And I love the fact that particularly last year, I knew that my students were totally invested when I said, 'Okay. The isopods are here. We have to create our habitats'. And they said, 'Ms Jones, we are not ready. We still have to answer this question and this question and this question. We don't want to find out in print research. We want to find it out on our own in the classroom'. And I was like, okay, I can't say No. We have to do another round of investigations. And so they even divided up the questions.

Despite finding student-centred teaching challenging, the last sentence indicates that at times at least, she was able to let students direct the class

Table 2. Integrity analysis of Ms Jones' enactment of the curricular activities during each phase of the isopod habitat challenge unit.

Unit phase	Followed guidance	Adapted guidance	Skipped an activity
Challenge	3	3	1
Initial ideas	3	1	1
Teacher-led experimental research	4	0	0
Student-led experimental research	3	0	0
First revision of ideas	2	0	0
Web research	2	1	0
Second revision of ideas	Missing	Missing	Missing
Go public	2	1	0

and even organize themselves. Autonomy and flexibility appeared to be intertwined for Ms Jones: giving students more autonomy required—and at the same time enabled—flexibility in her teaching.

Ms Jones followed most of the curriculum activities closely, but she followed a lower number of them than did Ms Atwell. Of the curriculum elements and structures described in the curriculum that we observed, Ms Jones enacted 19 of them and skipped two (table 2). As was the case for Ms Atwell, we could not be sure that Ms Jones did not implement activities we coded as 'skipped', but the percentage we recorded was slightly lower for Ms Jones (89%) than for Ms Atwell (96%). From a statistical standpoint, these differences were not significant.

At the same time, the adaptations Ms Jones made to the unit were consistent with what she said in interviews. We observed that orchestrating discussions proved challenging for her, particularly early on in the unit. In the Challenge phase, many students responded to her initial challenge question, but a discussion in which students built upon one another's responses did not ensue. In the Initial Ideas phase, she recorded only some of the students' ideas, and observers judged one student's contributions to dominate discussion. She did not incorporate a class discussion of student groups' plans during the period we observed in this phase, either. From the standpoint of designers, Ms Jones' difficulties with orchestration were adaptations that potentially undermined the aim of creating a 'community-centered' learning environment when implementing the curriculum.

In addition, rather than allowing students to work together in small groups to design their student-led investigations, Ms Jones gave directions not included in the unit and that were inconsistent with the curriculum designers' purpose for the curriculum structure of planning investigations. An observer recorded her saying to students:

> I'm going to add something cause you guys wouldn't have known unless I said so. Make sure the two types of soil do not touch, in other words, there needs to be a little section with no soil. I'm also going to say, make sure soil is smoothed out, so don't make it a mountain make it a prairie, I'll give you just a minute to write that down.

Actor-oriented analysis. The prior experiences Ms Jones used to interpret the purposes and structure of the unit were her previous years' enactments of the original FOSS Environments unit. When asked how she would describe to her colleagues what it was like teaching this unit, Ms Jones drew a contrast between the depth with which the Isopod Habitat Challenge unit allows students to pursue learning to the comparable FOSS unit, which she described as going more broadly rather than deeply into the content. She commented:

> I would have to say that the first thing I say to them is that it's a unit that is more student centered number one and it also takes one topic and goes deeply in that topic instead of perhaps taking a concept and setting, I guess just taking a wider view of that. I think I said this actually in the last interview but FOSS does a great job of covering a lot but not very deeply.

She also draws a contrast between the two units with respect to the relative focus of each on the 'why' vs. 'the how'. The Isopod Habit Challenge allows

> … for them to really dig deep, to take what they've already perhaps know and to dig deeper into, to figure out the why. So, I think that that's really important because I don't think FOSS, I don't think that they go very far in the why, but maybe the how.

Another prior experience that shaped Ms Jones' interpretation of the purpose of the curriculum was her interactions with the lead teacher educator (a former teacher in the district) on the project. When Ms Jones expressed concern about how to orchestrate the student-led investigations to the teacher educator, Ms Jones interpreted messages about letting students take the lead in planning investigations as suggestions to 'ask students' what they should do, an interpretation consistent with the idea that a key purpose of the curriculum was to support teacher autonomy. She interpreted the teacher educator's statement that it was all right for students to make mistakes in investigations as an injunction to 'keep quiet' when student ideas were wrong or where she had knowledge they did not:

> Ms Jones: But I guess another challenge would be the fact that I know information that they don't know and so it's really hard for me to just shut my mouth.
>
> Interviewer: mm.
>
> Ms Jones: It's really difficult for me to just let go and know that that's okay. I mean [the teacher educator] said that great during one of our professional developments 'It's okay to let them make a mistake.' So that was the biggest struggle for me because I love to talk, so yeah just to keep quiet.

On the surface, Ms Atwell and Ms Jones' construction of one of the purposes of the unit as promoting student autonomy was very similar. But the difficulties Ms Jones faced, and her interpretation of the teacher educator's remarks about making mistakes as an injunction to 'keep quiet' suggests a struggle she faced between promoting autonomy, provoking

thinking and reasoning, and maintaining order and control. That struggle helps explain why we observed many occasions in which Ms Jones 'kept quiet' rather than provoking students to deeper thinking and challenging students' ideas and questions as Ms Atwell had. It may also help explain why there were also episodes in which Ms Jones attempted to maintain stronger, teacher-centred control of the discussion. For example, rather than orchestrating full-class discussions of ideas and plans for investigations, Ms Jones preferred to allow for question-and-answer time when students posed questions about their plans and she answered them. In interviews, she said she feared the breadth of topics that students brought up initially, in her very first enactment:

> You know, the first time I taught it, it was really a challenge for me to teach it because I just remember the students bringing up this, that and the other thing and trying to kind of gear the conversation towards what they wanted to talk about, the challenge. And it was hard to bring them back in. 'Okay. Let's focus on this one now'.

In the Print/Web Research phase of the unit, Ms Jones also adapted the unit in a way that reflected her struggle regarding student autonomy. During this phase, the unit calls for teachers to link their explorations to students' own questions, derived from their cycles of experimentation, particularly their conclusions. The aim is to help students be able to link conclusions to scientific explanations for their findings. Ms Jones, however, provided students with a list of questions she suggested they could research, with no reference to students' own ideas. At several points during interviews, she described herself as frustrated by students' limited understanding of the 'why' of what they were doing, which may have led her to provide these questions to students, as part of an effort to guide them toward a scientific understanding of the kinds of habitats isopods prefer.

Discussion

From an implementation integrity perspective, both Ms Atwell and Ms Jones were advocates for the Isopod Habitat Challenge unit and embraced what they saw were its key purposes for promoting a more student-centred learning environment in science. In addition, both enacted all the phases of the unit, and neither skipped many activities at all. At the same time, from an integrity perspective, Ms Atwell did more than Ms Jones to engage students in scientific practices and ways of thinking, including in argumentation in the classroom. Ms Jones often listened to students' ideas, but she did not seek to develop them; other times, however, she provided them with the steps the curriculum designers intended the students to generate themselves.

From an integrity perspective, we could say that one of these teachers has a view of the curricular purposes and structures of the *Isopod Habitat Challenge* that is more congruent with designers' intentions and that is more developed. Ms Atwell's constructions of the curriculum unit's purposes and structures are more detailed than are Ms Jones in numerous

respects. In fact, Ms Atwell had engaged more fully with the unit as a co-designer, having helped redesign the unit after the initial pilot, and Ms Jones had not been part of the redesign, so one might expect that her understanding would be more in alignment with the intentions of the researchers on the design team. This conclusion would be consistent with past research showing that engagement in curricular design activities can be an effective means for promoting teacher learning (Huffman, Thomas, & Lawrenz, 2003; Penuel, Gallagher, & Moorthy, 2011).

From a disciplinary perspective, what is significant about the differences between the two teachers' interpretations of the unit is the degree to which each teacher relates the purposes of the curriculum to practices in science. Ms Atwell's notion of 'student centered' is about—to a certain degree at least—providing students with the opportunity to develop skill in posing questions and planning investigations, to practices that are central to science. By contrast, Ms Jones' struggles and definition of 'student centered' bear little relation to science at all. For her, engaging in inquiry is important for students later, rather than now, and not in any way that connects to discipline-based goals for learning. The image of science learning as requiring engagement with science practices is not only core to the researchers' conception of disciplinary learning, it is reflected in both the *Framework for K-12 Science Education* (NRC, 2012) and the Next Generation Science Standards (NGSS Lead States, 2013) developed from the *Framework*.

For the curriculum designers, the comparison of the two teachers' enactment provides potentially useful information regarding both refinements to the curriculum unit itself and to professional development for the unit. For example, identifying science practices within the structure of the curriculum might provide more guidance to teachers like Ms Jones as to the key features of those practices. In this regard, too, Ms Jones' articulation of a key purpose may be an important resource to the design team. Her emphasis on the 'why' of the phenomenon is closely aligned to the science practice of explanation highlighted in the *Framework* (NRC, 2012, pp. 67–71). In addition, Ms Jones might benefit from professional development focused on orchestrating academically productive classroom discussions. Here, the team might draw on related work on 'talk moves' in science that has proven useful to teachers in supporting their development of a wider repertoire of strategies for orchestrating discussion (see Michaels & O'Connor, 2011).

From an actor-oriented perspective, we see a different pattern of similarities and differences that help to explain what we observed in their classrooms and that provide different insights that could be useful to the curriculum design team. In Ms Atwell's case, 'student centered' and 'inquiry' were closely tied to particular curricular goals and structures, and they included both a focus on supporting students' engagement in specific steps of inquiry and on developing their ideas. By contrast, these two terms presented Ms Jones with a dilemma she found difficult to navigate. For her, it was as though she either had to tell students what to do, or let them tell her what they would do. Her interpretation of what it

meant to be 'student centered' in her teaching did not present to her a set of roles or moves with which she was familiar.

When we analysed the relationship between these constructions of the purposes and structures of the curriculum with actual patterns of enactment, we were able to discern how particular adaptations might be interpreted in ways that rendered them more comprehensible to us. From the outside looking in, Ms Jones' adaptations in particular were puzzling. She implemented most activities, but went back and forth between the poles of letting students pursue their own direction to giving students clear direction. When we analysed how she interpreted 'student centered' to mean 'letting students do what they want' and teaching by 'keeping quiet', we can understand this pattern in terms of a struggle she was experiencing between past roles she had played in her science instruction and what the curriculum demanded of her. Research in mathematics education suggests this teacher's experience and the particular dilemma may not be unique to science, but is characteristic of reforms that de-emphasize learning content by telling alone: such reforms may create anxiety because they pose threats to teachers' sense of what makes them effective in the classroom (Smith, 1996).

Ms Jones' challenges have different implications for design, from an actor-oriented perspective. They suggest to us that the team might consider specifically when and how teachers can productively guide student thinking, and also when and how they should promote autonomy. At some phases, such as when teachers are eliciting initial ideas and when students are planning investigations, student autonomy is important to cultivate. But even within these phases and especially as students construct questions for investigations, teachers may need to provide more guidance to students. Teachers might benefit from hearing about research that documents the value of *guided*—as opposed to open-ended—inquiry in science (e.g. Furtak, Seidel, Iverson, & Briggs, 2012), as part of supports built into curriculum materials. They may also benefit in professional development from hearing how other teachers like Ms Atwell navigate the tensions related to promoting student autonomy and guiding inquiry.

Conclusion

The findings from this study suggest ways that integrity and actor-oriented analyses of teachers' curriculum implementation can complement one another. Where an integrity analysis helps to identify specific areas where teachers encounter difficulties implementing materials in ways congruent with their intentions, an actor-oriented analysis can help explain why those difficulties come about. Second, where an integrity analysis provides documentation about the specific adaptations teachers make and whether or not those adaptations are potentially productive, an actor-oriented analysis helps explain why teachers make the particular adaptations to curriculum materials that they do. Moreover, it can identify sources of prior knowledge that teachers bring to the situation of implementing new

curriculum materials. Each of these kinds of insights has important implications for design, but for different reasons.

Developing an understanding of why teachers make the adaptations they do helps build empathy for the problems particular teachers are facing. Sometimes, the problems teachers face are similar to ones teacher educators have faced in their own classrooms in the past, but not always. It may be important to be able to bridge a divide in experience and understanding, and an actor-oriented analysis invites outsiders to the situation to take an interpretive, rather than judgmental stance, toward classroom implementation. By doing so, and showing interest in teachers' perspectives, curriculum developers may be able to build trust that facilitates improvement over time.

Knowing something about teachers' sources for making sense of curricular purposes and structures can help curriculum designers as well, to the extent that designers can themselves interpret where those sources may help, or hinder, interpretations of materials consistent with designers' intents. In this study, the gap between what the teacher educator said and what Ms Jones interpreted stood out. In other instances, teachers' comparisons to other curricula and constructions of purpose may be so broad as to hide teachers' differential readiness to enact materials effectively. Both Ms Atwell and Ms Jones could draw a contrast between the FOSS units and the Isopod Habitat Challenge, and their distinctions were similar. Yet their prior experience with FOSS as a contrasting case to the new unit did not prepare both equally well for the challenge of implementing the new unit. The challenge for analysts seeking to take an actor-oriented perspective is to probe deeply enough into teachers' prior experiences to elicit what may be subtle meanings and distinctions that are consequential for implementation.

A third implication of this type of analysis pertains to its value in elucidating the degree to which teachers' constructions reflect a discipline-based conception of teaching and learning. In this respect, the conclusions of this study are similar to those of a number of studies that focus on teachers' and school leaders *sensemaking processes* with respect to mathematics reforms (e.g. Coburn, 2005; Coburn & Russell, 2008; Sherin, 2002). These studies have focused on teachers' understandings of the targeted instructional practices associated with reforms. A common challenge identified in those studies is that teachers' and leaders' conceptions of reforms rarely reflect an appreciation for how particular practices are designed to promote mathematical proficiency, as opposed to learning in general. This presents a problem for the field, because researchers in mathematics and science are today increasingly concerned that students have opportunities to engage in the practices of the discipline, and not simply for the sake of being student-centred but because by participating in these practices, their disciplinary learning is likely to be enhanced (Blumenfeld, Marx, & Harris, 2006). In this context, developing an understanding of disciplinary practices is a critical goal for teacher education.

Our study focused on implementation in the early phases of design. The qualitative approach employed in this study might not scale readily

for use in a large-scale efficacy study, where in-depth qualitative analyses would be cost-prohibitive. Valid and much more 'scaled-down' measures of integrity would be needed for such studies, and they might serve a different purpose from what we have articulated here. For example, in large-scale studies, implementation measures also provide a basis for identifying what aspects of curriculum materials are linked to learning outcomes, that is, for testing theories about what are the 'active ingredients' of curriculum materials (O'Donnell & Lynch, 2008). At the same time, the qualitative approach employed in this study is particularly valuable early on in design, when materials are not fully developed and when the number of teachers implementing the materials is relatively low. It was particularly appropriate to this effort, because designers wished to use implementation evidence not simply to document but also to improve designs.

We have tried to argue that both integrity and actor-oriented analyses can provide value to designers. Ultimately, however, whether in fact, these perspectives *do* provide value depends upon their uptake by design teams and evidence from subsequent enactments. Evidence for the value of each approach should be judged in light of whether implementation improves in subsequent revisions, and in light of whether teachers' constructions of purposes and structures enable productive adaptation of materials. This study did not provide this evidence and as such, that is a key limitation of this study. However, as researchers develop a greater appreciation for different perspectives on implementation, we expect that future research will provide additional evidence to inform our understanding of integrity and actor-oriented perspectives on implementation.

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Note

1. The version of the FOSS curriculum used in the district did not include a set of embedded assessments that are now part of the curriculum. The Assessing Science Knowledge (ASK) assessments do provide students with opportunities to make visible their thinking throughout the unit. Teachers can provide feedback to students on the basis of their interpretations of student responses, interpretations that are supported by rubrics associated with each ASK item.

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