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The Road to Reform: A Grounded Theory Study of Parents' and Teachers' Influence on Elementary School Science and Mathematics

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The Road to Reform: A Grounded Theory Study of Parents' and Teachers' Influence on Elementary School Science and Mathematics

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Abstract

Though elementary teacher educators introduce new, reform-based strategies in science and mathematics methods courses, researchers wondered how novices negotiate reform strategies once they enter the elementary school culture. Given that the extent of parents' and veteran teachers' influence on novice teachers is largely unknown, this grounded theory study explored parents' and teachers' expectations of children's optimal science and mathematics learning in the current era of reform. Data consisted of semistructured, open-ended interviews with novice teachers ($n = 20$), veteran teachers ($n = 9$), and parents ($n = 28$). Researchers followed three stages of coding procedures to develop a logic model connecting participants' discrete designations of the landscape, regulating phenomena, contextual orientation, and desired outcomes. This logic model helped researchers develop propositions for future research on the interactive nature of parents' and teachers' influential role in elementary science and mathematics education. Implications encourage science and mathematics teacher educators—as well as school administrators—to explicitly develop and support novice teachers' ability to initiate and sustain parent/family engagement in order to create a school climate in which teachers and parents are synergistically motivated to change.

Continuous improvement of elementary teacher methods courses directs our interest in helping science and mathematics methods students enter the classroom successfully. The recent advent of standards in mathematics education (National Council of Teachers of Mathematics, 1989, 2000; National Governors Association Center for Best Practices, Council of Chief State School Officers (NGA/CCSSO), 2010) and science education (National Re-

search Council, 1996, 2013) gave rise to new curricula guidelines and instructional strategies. These documents guide our methods course design wherein future teachers learn to construct science and mathematics lessons focused on developing children's access skills, process skills, and content knowledge. Although we are introducing new, reform-based strategies in our methods courses, we wonder how our students and future teachers will continue new strategies once they enter the elementary school culture.

The extent of parents' and veteran teachers' influence on novice teachers is largely unknown. We know that veteran teachers have been slow to adopt reform strategies (Berkovich, 2011; Smith & Southerland, 2007); testing mandates have helped to solidify old, traditional strategies (Welner & Carter, 2013); and parents lack knowledge and understanding about how and why schools have changed (Remillard & Jackson, 2006; Saracho & Spodek, 2009; Smith & Southerland, 2007). This research endeavor aimed to fully explore the critical influence of parents' and teachers' expectations of children's science and mathematics learning, particularly those related to optimal school learning for children, in an era of new-reform.

Data Collection and Analysis

This grounded theory study examined how a varied group of parents, novice teachers, and veteran teachers described their knowledge and assessment of elementary science and mathematics learning: What are children doing in science and mathematics classes, what learning is important, and how well are children doing in today's classrooms?

Our data consisted of semistructured, open-ended interviews with novice teachers ($n = 20$), veteran teachers ($n = 9$), and parents ($n = 28$). We expected these records of thoughtful, experiential data would help us derive theoretical propositions about parents' and teachers' managed expectations of students' science and mathematics learning in this reform era, grounded in the views of these study participants.

Method

Participants

Participants ($N = 57$ total) represent a wide range of parents and teachers with vested interests in K–6 grade children's science and mathematics learning and were purposefully selected from convenient samples. Veteran, award-wining teachers represent wide distribution from California to Maine and were selected via personal connections with national, teacher award networks, and professional associations. Novice teachers, though somewhat geographically limited to the southwestern United States, representing traditionally certified teachers from both bachelor's and master's programs, were primarily sampled from recent graduates who were teaching near the local university campus. Parent participants included some referrals from national colleagues (20%), although the majority came from a pool of graduate students' friends and family members who resided in the southwestern United States. This participant pool included a balanced distribution of educational backgrounds, school sites, and socioeconomic status (SES). In sum, we attempted to engage a

broadly representative group of participants, but selections were bounded by factors of convenience and resources.

Materials and Instruments

Two interview protocols (one for teachers and one for parents) asked participants to: provide demographic information about themselves and their child or classroom; remember and describe their own elementary science or mathematics learning and describe their child's or classroom's current science or mathematics learning; and express their hopes and dreams for their child's or classroom's science and mathematics learning. We conducted 75% of the interviews ourselves, and the remaining interviews were conducted by graduate students (who also helped identify participants). Most interviews were held face-to-face, though a few were conducted by telephone or e-mail; recorded interviews were transcribed.

Theoretical Perspective/Procedures

This study employed protocols for a grounded theory study (Glaser & Strauss, 1999; Miles, Huberman, & Saldaña, 2014; Strauss & Corbin, 1990, 2007), wherein a theory might be inductively derived from the research data. We engaged in reciprocal steps of data collection where constant comparison of data, emerging categories and theoretical sampling of different groups helped to maximize determination of the similarities and differences across parent and teacher responses (Strauss & Corbin, 1990, 2007). As we worked to construct our theoretical propositions, we continuously coded the narrative data, categorized it, and integrated the big ideas into a logic diagram or model for testing and verification.

Once we completed interview transcriptions, we followed "open coding" procedures (Strauss & Corbin, 1990, 2007) to analyze, label, and organize discrete ideas into categories of causal conditions and strategies for navigating reform-based teaching and learning practices in K–6 science and mathematics classrooms. Open coding guided organization of these categories into a typology of four strategies. As a second step, we followed "selective coding" procedures (Strauss & Corbin, 2007) to define contextual factors guiding parents' and teachers' influence on K–6 science and mathematics teaching and learning. In this process, we reexamined our notes to review the contexts and intervening conditions that seemed to prompt parents' and teachers' participation in science and mathematics education reform. We ultimately developed four narratives to profile the central phenomena or broader context of parents' and teachers' influential role in children's science and mathematics learning. In our third and final step, we employed "axial coding" to develop a logic model to connect participants' discrete designation of the landscape, regulating phenomena, contextual orientation, and desired outcomes. This logic model gives rise to our propositions or hypotheses for future studies.

Verification

We followed Miles and Huberman's (1994) multiple procedures to verify our data. Recognizing our likely bias as preservice teacher educators (objectivity), we held frequent meetings to insure high inter-rater consistency among the researchers and graduate research

assistants over time (dependability). We two researchers continued data analysis and discussions to refine the coding (authenticity) and to define the categories of causal conditions and strategies for navigating reform, the broader context and roles of participants' reform management strategies, and the propositions for future testing (applicability).

Typology of Strategies for Navigating Reform

From an early point in this research study, we realized all participants were experiencing science and mathematics education reform in one way or another. Though participants differed in their knowledge and understanding about why science and mathematics teaching and learning had changed, they all knew something about changes in K–6 science and mathematics teaching (if only how things had changed since they were in elementary school themselves). We came to think of these participants as "travelers" on the road to reform wherein their experiences with reform helped to determine their mode of travel. This gave rise to our notion of "vehicles" that support participants' travel modes along the road to reform. Open coding (a) enabled classification of participants according to their knowledge, beliefs, and expectations of K–6 science and mathematics education and (b) guided development of our metaphorical idea of travelers on the same road but in different vehicles. Participants were then sorted as tour bus, school bus, jeep, or classic car travelers on the road to reform (Table 1).

Table 1. Open Coding of Parents and Teachers on the Road to Reform: Dimensionalized Examples

	Novice Teachers	Veteran Teachers	Parents
Tour bus	$n = 13$	$n = 2$	$n = 13$
	Take comfort in scripted mathematics curricula. Need time to research science lessons. Follow an open-door parent policy.	Expect children need a firm, global understanding. Recognize manipulative and pattern blocks provide important experiential learning. Try to find balance between drill and problem solving.	Know the basics are important. Describe teachers as "quite knowledgeable." Find teachers "knowledgeable" and school personnel "approachable."
School bus	$n = 7$	$n = 1$	$n = 10$
	Want students to understand they use math every day. Note short supply of science materials. Expect parents don't want to help or communicate with the teacher.	Worry science isn't valued until it is tested (fifth grade). Fret about the time it takes to prepare science units that cover all the standards. Experience frustration dealing with low SES parents.	Would like to see more hands-on learning but "the program is set." Experience frustration when their child can solve math problems but can't explain the logic. Generally critical of school communications.

Jeep	*n* = 4	*n* = 5	*n* = 4
	Worry that students stress to the point that *the test* is all they think about. Want to help parents understand new mandates. Seek strategies for effective teaching while still going along with the program.	Maintain systematic parent communication and volunteer involvement. Earn credibility with administration to *push the system*. Write grants to get access to extraordinary curricula and materials.	Find school personnel are not approachable. Expect testing mandates encourage teachers to keep all students at the same level.
Classic car	*n* = 0	*n* = 1	*n* = 1
		Conclude that test preparation leads to surface teaching. Note that children need to develop conceptual understanding (beyond drill). Prefer that children (rather than teachers) be held accountable for their own learning.	Consider science fair as the only real science though it is an optional, extracurricular activity. Expect increased school structure reduces the time for learning. Worry new requirements encourage right-answer learning rather than figuring things out (thinking).

***The Tour Bus* (N = *31*)**

Tour bus travelers are comfortable; they appreciate having a driver and well-padded, reclining seats with arm and foot rests. Large viewing windows, well-designed suspension, and air conditioning complete the comfort details. These compliant travelers notice things have changed but they generally appreciate the order and routine of new instructional approaches. So, while they might point to concerns about reformed instruction, they generally give a nod to the driver and note the upside of these changes. In general, tour bus travelers are satisfied with science and mathematics teaching and learning practices just as they are.

Fifty-nine percent of novice teachers (*n* = 16) portrayed themselves as tour bus travelers. These early career teachers (averaging 1.56 years of teaching) recently completed their certification program and were just beginning to understand their role as teacher. Thus, they appreciate scripted curricula (where the teacher's lessons are written out word-for-word) and district-required mathematics trainings. As one novice teacher explained, "They show you how to teach a lesson and tell you these are the important things you need to teach. We do what we are supposed to do every day because we don't know any different." Some novices expressed dismay with the lack of time and resources for science but recognized the mandated focus on reading and mathematics instruction also aligned with the state tests. When asked about parent communications, one novice second grade teacher described monthly parent letters and another explained she invites parents to "come sit in the classroom." These teachers generally extended a global, "open door" invitation to parents.

Twenty percent of veteran teachers (n = 2) portrayed themselves as tour bus travelers who embrace new strategies but comfortably incorporate some old ones as well. One fifth-grade teacher, a 15-year veteran, expressed the importance of homework and test scores as important cues to how well instruction is going. She recognizes she is teaching mathematics differently from the way she learned as a child while expressing the importance of a balanced approach: "We need to keep that balance between constructivist learning and drill and practice." As another veteran of 24 years explained, first-graders need to do lots of hands-on activities but "they still need to know their facts."

Forty-six percent of parents (n = 13) portrayed themselves as tour bus travelers. These parents remarked about how school has changed since they were in school. They remember school was "less hands-on and more fundamental" but their child's school "includes more variety—a change for the better." As one mother pointed out, "We were taught through textbooks alone and math was just practice-over-and-over." These parents want their children to experience "whatever will prepare them for the next grade level and [state test]." One father, a scientist himself, is impressed that his first-grade daughter "can actually talk about something like rocks when she comes home from school." Finally, tour bus parents find teachers to be "quite knowledgeable at the parent-teacher meetings" and the staff to be "approachable."

***The School Bus* (N = *19*)**

School bus travelers are not so contented; they ride on bench seats without arm or foot rests. Comfortable temperatures are challenged on these buses (as the doors open frequently) and the suspension leaves much to be desired. These frustrated travelers notice change but they generally criticize both the driver and the ride while they point to the confusion and limitation of reform. In general, school bus travelers are critical of the reform indicators they notice and some are also concerned or distressed about new science and mathematics teaching practices.

Twenty-six percent of novice teachers (n = 7) portrayed themselves as school bus travelers while pointing to confusion and frustration at the school level. One first-year teacher (a master's graduate with a B.A. in geology and anthropology) expressed general disappointment in her school colleagues where teachers lack initiative (as in "teaching a lesson on measurement using only pictures in the book—no measuring cups") and the principal "wasn't in the classroom checking on teachers and making sure they are using the proper methods." School bus novices arrive with "great aspirations" but grow disappointed with the short time allotment and limited resources for science. As one exasperated fourth-grade teacher explained:

> I don't think there is much emphasis on science and math other than to pass the [state test]. Our principal's background is in reading and language so these are the areas she emphasizes. For example, my teaching team has been sent to 12 workshops this year and all of them in the areas of reading and writing—no math or science training involved.

As a group, these novice teachers would prefer to decrease the school focus on memorization and increase learning connections to the real world. Attempts to communicate with parents have met with fair success, but these teachers have learned "some parents are not able to help their kids [and they] expect education is the school and teacher's responsibility."

Only one veteran teacher joined the school bus travelers. This primary science teacher is an "expert" when it comes to the state science standards (which she copiously follows when she plans her lessons). She is, however, vehemently opposed to a "newly adopted reading program that requires 90 minutes of the school day." In her thinking, "science gets shoved out of the way" when her colleagues hold back some students for extra tutoring in (while the others go to the science lab). This frustrated veteran's passion for science engenders criticism of her teaching colleagues and the limited involvement of parents in her low SES school. She has tried to organize Family Science nights but has not yet established the parent-teacher association (PTA) support she needs.

Thirty-six percent of parents ($n = 10$) portrayed themselves as school bus travelers. Most school bus parents do not question learning standards; they wonder how things might be less stressful for teachers, children, and parents alike, and wish student lessons could involve more hands-on, real-world applications. One fairly satisfied mother is concerned about her first-grade daughter's "test-focused school" and the "testing strategies" she is learning. One fourth-grade mother wondered why her daughter is memorizing mathematics procedures. She reasoned, "If children are taught merely to follow protocols rather than to understand the true logic behind math, math will always remain a mystery and a hardship for them."

In general, school bus parents recognize they are "outspoken." Though they look for a "team effort" they tend to be critical of home-school communications. In this, one private school mother concluded, "Some teachers don't want you in their classroom." A single-parent mother, on the other hand, disagrees with some school policies (why are there no textbooks and why do children need calculators?) but praises the teachers, saying: "They are there for the children."

***The Jeep* (N = *13*)**

Metaphorically, jeep travelers are similar to school bus travelers, except jeep travelers drive their own vehicle. As in the case of school bus traveling, the ride may be uncomfortable, but jeep travelers can go off road whenever they choose. These troubled travelers generally criticize reformed teaching and learning (and the accompanying test agenda) and find ways to alter the journey in order to address their concerns.

Fifteen percent of novice teachers ($n = 4$) fit into the group of jeep travelers. One novice in her first year of teaching fondly remembered student teaching with a 30-year veteran teacher "who didn't follow the [required] math program all the time." This jeep novice

> . . . enjoyed teaching math [with my cooperating teacher] because we didn't stick to the assigned program. I guess when you have been teaching for so long [the principal can] let things slide. It wasn't like the students weren't learning. Her kids were learning right along with the other classes and sometimes more.

As a student teacher, this novice learned how to "catch kids' interests" to make learning "meaningful, fun, and relatable." She came to see that new mandatory curricula and worksheets, intended to ensure student achievement on the state tests, actually "pull teachers to teach one way [when they] know in their heart it is the wrong way." As another first-year teacher explained, "Tests play a huge role so teachers have to work overtime to figure out ways to teach meaningful lessons and have their students do well on the tests." She has a solution: "Teachers need strategies in teaching effectively while going along with the [required] program."

Fifty-five percent of veteran teachers portrayed themselves as jeep travelers ($n = 5$). This group of teachers described established systematic parent communication venues such as quarterly newsletters that identify the science and mathematics children will be learning and suggest ways parents can reinforce these at home (such as counting change). They invite parents to volunteer in the classroom—and in some cases feature parents as guest speakers. Teacher-organized family nights offer fun science and mathematics activities for children to do with their parents. These veteran teachers, many of whom are National Board Certified Teachers or Presidential Awardees, have earned "proven record" status that allows them considerable freedom when it comes to instructional decisions. As a group, they do not buy into "test-driven curricula." Rather, they prefer to "focus on problem solving," determine what they need to do for the state test, "and make it relevant so kids are engaged and learning."

Fourteen percent of parents ($n = 4$) joined the jeep travelers. These parents hold high expectations of schools and successfully resort to alternate paths as necessary. As one jeep traveler explained, "In schools, there are pockets of wonderful surrounded by areas of mediocrity." One mother reported visiting the neighborhood school at the beginning of each year; this one visit (classroom observation and teacher interview) determined whether or not her child would continue to be home-schooled or attend public school. At home, the mother can "jump on kids' questions" and direct engaged learning such as helping her daughter plant a square-foot garden or add digital recordings to her science notebook.

All parents of special needs children ($n = 4$) identified themselves as jeep travelers. One father reported that he and his wife had "resorted to outside tutors in order to overcome school deficiencies," while another mother reported her child's school would not accept any medical tests done outside of school; thus her daughter did not receive special help until fourth grade when school tests verified the need. In some cases, jeep-traveling parents engender conflict with classroom teachers that cause parents to feel unwelcome in the classroom.

***The Classic Car* (N = 2)**

Classic car travelers are similar to jeep drivers. These travelers are also drivers who do not expect a comfortable ride and are likely to choose alternate routes. Classic car travelers, however, are nostalgic about the highly positive science and mathematics learning experiences they experienced in the "good old days" and criticize the ways in which reform curricula and strategies have altered the school environs overall. None of the novice teachers described themselves as a classic car traveler. One veteran teacher ($n = 1$) travels the road

to reform in a classic car. This 14-year veteran is very unhappy with new "surface teaching" practices in her school where "children are just going through the motions rather than thinking." Children are presented basic learning opportunities, but there is no probing for deep understanding. She fondly recalls the structured classrooms of the 1970s where students knew what was expected of them, and students were held accountable for their own learning.

One parent ($n = 1$) is highly critical of the school science curriculum. As a scientist himself, this father recognizes the school science fair as the only real science his daughter encountered in grade school (though this was an optional, extracurricular activity). He is troubled about the way in which teacher-directed, test-focused lessons focus on limited content and add structure to the school day. He remembers a more flexible school day where he had opportunity to study and explore. He reasons, "Kids are missing out on the excitement of figuring something out or solving a problem on their own. This is what drives me still today."

Summary

This analysis of teachers' and parents' knowledge, beliefs, and expectations of reform in K–6 grade science and mathematics education helped us classify participants according to four metaphorical modes of transportation. While we recognized most novice teachers chose the tour bus and most veteran teachers chose the jeep, we identified four contextual dimensions (participants' educational background, school-learning experience, socioeconomic status, and children's skill level) helped to influence parents' and teachers' vehicle designations.

Respect for the mandated school curricula, administrative support, and classroom access was central to these stories. As Hobbs (2008) explained, teachers move through a decision-making process wherein their initial, limited confidence is shorn up by experience with student success (within 4–8 years). Certainly, administrative support in the allocation of academic time and provision of instructional materials significantly impacts teachers' reform-oriented teaching practices (Johnson, 2013; Raizen & Michelsohn, 1994). Parent communications is likely a considerable challenge for novice teachers as they have had little experience to observe how these partnerships are initiated and sustained (Sumison, 1999). Two recent reports point to the importance of parents' attitudes and beliefs related to children's participation and achievement. In a study of the interdependence of home and school cultures on children's attitudes and beliefs, Thomas (2013) found parents' confidence in their child's mathematics ability predicted third- through fifth-grade achievement scores; similarly, parents' science beliefs and attitudes paralleled their children's beliefs and attitudes. In a related study, Orona (2013) determined the mother's value of "mathematics as useful" positively predicted children's fifth-grade mathematics achievement scores. Certainly, as Jeynes (2005) argued, family involvement remains an untapped resource for equalizing academic achievement of all students.

Roles and Contextual Factors

In our next analysis of these data, we employed selective coding procedures (Creswell & Brown, 1992; Miles et al., 2014) to organize stories about the contextual factors defining parents' and teachers' influence on children's science and mathematics learning. The resulting narratives profile the broader context and illuminate participants' discrete designations of power and influence on K–6 science and mathematics teaching and learning as determined by educational experiences, school-learning experiences, SES, and children's grade/skill levels. Details of these features are outlined in Table 2.

Table 2. Selective Coding: Contextual Roles of Parents and Teachers' Influence on Children's Science and Mathematics

	Educational Attainment	Personal School Learning Experience	Socioeconomic Status (SES)	Children's Grade/Skill Level
Novice teachers	Average experience = 1.65 years Bachelor's degree in education or master's degree in education. Master's level teachers (recent graduates) come from broad backgrounds (i.e., child development, geology, and business).	Remember doing science (hands-on experiments) in elementary school. Closely follow mandated curricula "because we don't know any different." Refer to reform ideas and strategies (methods course learning) and note mentor teachers as role models.	Expect teachers can get students excited but parents are responsible for nourishing their children's interests. Believe low SES parents have little time and don't show up for open house.	K–3 teachers are especially concerned about reading and math skills. Fourth- to sixth-grade teachers worry students are too stressed about "the test."
Veteran teachers	Average years of teaching = 21 Advanced certifications and leadership trainings. Recognized board-certified, award-winning teachers.	Remember rote, textbook learning, desks in rows, and not much science. Easily able to find a balance between test preparation curricula and constructivist, problem-solving instruction.	Recognize low SES parents could exert more influence than they realize: "these kids need more than tested skills." Established parent communications; easier when one is older than the children's parents. Note high SES parents often visit the classroom.	Determine what needs to be done for the state test. Make it relevant so kids are engaged and learning. Focus more on problem solving and less time reteaching tested skills.

Parents	Advanced degrees (n = 6) Bachelor degrees (n = 6) High school/ Some college (n = 16)	Remember they sat and listened to the teacher. Note today's students learn in more ways. Parents of special education students particularly worry that achievement is measured by state tests.	Less-educated parents observe the school program is set: "not much parents can do." More educated parents bemoan the schools' focus on state test scores. Note high SES parents expect homework.	Parents of special-needs students are frustrated by testing, limited school services. Overall, parents express the importance of real-world learning connections.

Educational Attainment

Varied education experiences provided some impetus for the ways teachers and parents came to think about children's science and mathematics learning. Novice teachers had recently completed a bachelor's degree (B.A.) in elementary education (n = 14) or a master's degree (M.A.) in elementary education (n = 13) and averaged 1.65 years of teaching experience in an elementary classroom. Novices differed by age (M.A. programs added two to three years to the certification process) and by backgrounds (most M.A.s earned prior degrees in early childhood though some described degrees and work experience in business and science). Novices with M.A.s (n = 3 out of 4) were likely jeep travelers who searched to find ways around limitations they identified in their schools. However, one divergent novice teaching in a high SES school chose not to teach test skills via the same workbooks used by the veteran teachers in her building. She reasoned, "My education is more current than a teacher who has been teaching for 20 years."

While veterans' teaching experience (averaging 21.4 years) defines them as older than novices, two veterans also described themselves as "older than a lot of my parents." Most veterans held advanced degrees (M.A. = 6; Ph.D. = 1), though a few had not continued formal education (B.A. = 2). As a group, these veterans had received significant awards identifying them as continuous learners and leaders. Advanced studies were evidenced by gifted education and English-language learner certifications and Activities for Integrating Math and Science Leadership Training. Multiple veterans had also been granted National Board Certification (n = 2), the Presidential Award for Science and Mathematics Teaching (n = 2), state Teacher of the Year award (n = 3), and the Milken Foundation Teacher of the Year award (n = 1).

Limited by the nature of our interview protocols, we found few details regarding parents' educational backgrounds. We did determine that the majority of parents completed high school and/or some college (n = 16) and similar numbers of parents held bachelor degrees (n = 6) or advanced degrees at the master's or Ph.D. level (n = 6).

School Learning Experience

Participants' personal school-learning experiences provided some understanding about the concerns they developed about children's science and mathematics learning. Novice

teachers do not remember so many tests when they were in elementary school and worry the current focus on testing causes unnecessary stress for kids and teachers alike. One novice remembered "doing science experiments and [taking] field trips to the island to collect things during low tide." Her memory of long, boring mathematics classes without manipulatives guides her expectation that today's kids will "really benefit from the manipulatives." Another novice teacher detailed a particularly "horrible experience" with an eighth-grade mathematics teacher: "From then on I hated math because I totally shut myself down after she did that to me."

Novices also referenced recent school learning events: (a) new-reform ideas about science and mathematics instruction gleaned from their preservice education programs and (b) impressive role-model encounters while student teaching. Regardless of the grade level or SES of their school, novices realized the importance of conceptual learning, manipulatives, and inquiry methods. For example, one novice described a successful primary lesson on buoyancy wherein students worked in groups to build boats that would float. She noted the importance of the "hands-on" and "problem-solving, creative thinking" features of this lesson. Two novices referenced influential mentor teachers with whom they had student-taught; both mentors modeled ways to modify mandated curricula to meet the needs of student learners. A third-grade novice teacher appreciated learning how to implement the mandated group work but also conduct "class discussions about concepts that really helped students understand." Another second-grade novice teacher learned how to differentiate instruction: "When I was student teaching, the teacher went ahead and taught [the kids] some material that they would be doing [next year]. When there is an opportunity for kids to learn new stuff, I think they should." Novices also referenced parent-engagement models they observed during their student teaching semester. As one novice learned, "parent volunteers can help do the detail work of getting a lesson together—like cutting paper or preparing other things as needed." A second novice described the open-door parent policy she observed during student teaching. Her mentor teacher sent "parent letters, notes, phone calls, and monthly newsletters to keep the communication open" and "invited parents to stop by to talk or observe their child in the learning environment."

Veteran teachers remember rote-school, textbook learning, "reading groups and math facts" "with desks in rows and not much science." As one teacher remembered, "We didn't do hands-on math or science. [In fact], I don't even remember doing much science [but] I do remember going to the observatory." Another veteran recalled learning "the exact steps" to solve a mathematics problem. She did not understand "why" or ask any questions: "I just remember knowing this is what you do [or you would] get the whole problem wrong." Now, as classroom teachers, these veterans are easily able to balance constructivist learning strategies and problem-solving instruction with the demands of test preparation curricula. They understand the principal is "interested in test scores" but they also know students need manipulatives like Cheerios and graph paper so they can draw arrays to "gain conceptual understanding of multiplication and division." One veteran told of a new assistant principal who directed the staff to "teach to the test." When the principal found this veteran's resignation letter on his desk the next morning, he changed the direction: "Do not teach to the test. Just do whatever you have been doing." What troubled this

veteran was "The other teachers didn't say a word. They didn't want to teach [to the test] either, but they [feared they would] lose their job."

Parents' memories and school-learning experiences resembled those of novice and veteran teachers alike. Parents remember "the lecture method" more than anything: "less hands-on experiments and more fundamental stuff." These parents noticed that "there are more ways of teaching kids nowadays." When parents were young, it seemed like they either "sat and listened to a teacher" or "read a text." These personal school experiences are evident in the ways they levy judgment on their children's school experience. For example, parents noticed the school's emphasis on mathematics and limitation on science whether they pointed to allocation of instructional materials, allotted time, or testing schedules (where mathematics is tested every year and science is only tested in fifth grade). One first-grade mother recommended, "Science should be expanded-on [since] they are already doing extensive math." Parents of special needs students exerted particular criticism of test-focused schools. One fourth-grade father judged the school leaders to be more concerned about "their own personal agendas relative to recognition." Another special education parent (technically, a foster parent) identified the school event that prompted her level of involvement: "My cousins didn't know how to educate their daughter and they were treated like dumb farmers that didn't know the law."

Socioeconomic Status

The SES of the child's school provided defining characteristics to teachers' and parents' ideas about home-school relations. Novice teachers did not understand the limitations of low SES students—how they lacked foundational knowledge and why their parents were not likely to visit school. One novice first-grade teacher in a low SES school reasoned, "Parents in our area are very busy with work and don't have much time to spend with their children learning about science and mathematics." Another novice teacher in a low SES fourth-grade classroom explained, "I thought that students would be coming to me a little more knowledgeable. In some cases, I almost feel I need to start with square one."

For the most part, novices in low SES schools reported relatively "good relationships with parents." Primary-grade novices contact parents about "current events, grades, and classroom behaviors" and purposefully work to "keep friendly relationships" in order to "gain parents' trust and support." These novices expect parent communications are important to "managing student behaviors." One novice in a low SES school effectively communicates with parents via letters and phone calls. She learned "parents written [notes] on homework [papers]" helped focus school lessons the next day. Two primary level novices in low SES schools bemoaned the limited parent involvement in their school. One saw it as her own responsibility to develop since "sometimes these things are pushed aside [by the principal]." In contrast, novices in high SES schools describe a "strong bond between parents and teachers" and recognize they are "lucky [to be] in a school with such high parental involvement." In this, teachers send notes and make phone calls about student behaviors and distribute "newsletters describing what we are doing academically, hosting science fairs, doing experiments and lots of hands-on activities."

Homework was a common expectation in high SES schools, particularly in the primary grades. One reluctant novice teacher in a high SES first grade reluctantly explained, "Parents ask for homework. I do not want the children to be bogged down at home but I do assign math homework a few times a week." A first-grade novice teacher's students in a middle SES school follow a three-days-a-week homework schedule "enjoyed by parents and students alike." This schedule includes two parent components:

> On Monday, a parent letter is sent home explaining the concept that will be covered that week. It includes tips and ideas to help reinforce the concepts. On Fridays, we send home a chapter review, and on the back is either a math game or family activity relating to the concept taught that week.

Veteran teachers have established routine parent communication venues such as involving parents as volunteers, hosting family information nights, and sending home parent letters (as many as eight per year). One veteran, in a high SES primary classroom, sends home frequent newsletters and includes guides such as "Ten Ways to Start a Conversation with Your Child." She is sure to include examples of science in everyday life "because parents seem to think that in order for their children to do science they have to have a chemistry set." She wants parents to realize that "science is [encouraging children to ask] questions without parents trying to answer the questions all the time!" Veteran teachers find parents are comfortable coming to visit them since "as parents ourselves, we are more likely to feel compassion."

Low SES parents observed that the school program is set and, though there is "not much parents can do, it seems to work fine." One low SES third-grade parent expressed concern that "[children] don't bring books home anymore. Everything is on printed out sheets." Though this mother wonders if photocopied worksheets are an economical move on the part of the school, she gets frustrated when her daughter asks for help. As the mother explained, "If I have the book [then] there is a page or two before the homework . . . [so we can] go back and forth and review." The textbook, then, helps the mother help her daughter.

Alternatively, parents of middle or high SES children find the school "staff is supportive and approachable and always willing to help with ideas for how we can help our children learn more at home." These parents are connected to the school, involved in their children's learning, and want to become more involved. One parent in a high SES school noted the principal invites parents to share their concerns and parents are willing to provide assistance (financial resources or field trip transportation). Frustrated by the fact that that teachers do not work more with the principal to find extra time or funding, this father reasons, "The problem is the teachers need to have the initiative and ambition to go above and beyond what is being asked of them."

Child Skill Level

Parents' and teachers' desired outcomes of children's science and mathematics learning pointed to differing expectations according to children's grade levels and designated special needs. Novices in grades K–2 expressed primary concern about children's reading and mathematics skills and student-centered, hands-on approaches. As one first-grade novice

explained, "I try to make it as fun and interesting as possible." In this thinking, "Children should be learning the basics—the concepts will lay the foundation for all other concepts as they grow and learn." These teachers enjoy the use of science kits, "big chests full of lessons, teaching tools, fun things to teach with." By third grade, novices report math is taken seriously—not math in general but math for [state] tests. One worried, "I don't think a love for math is instilled in these children. They tend to dread math because they are pushed so hard to do well on these tests." According to one fourth-grade novice, "We need to fight for science. It seems that as a teacher I can be [somewhat] influential, but it is hard to do when Language Arts and Math are such a priority." As a group, novices in fourth through sixth grades work to "instill confidence" in their students given the considerable stress "the tests" cause their students.

Veteran teachers realize low SES students are the ones who "need more than test skills." These teachers balance the special needs of English language learners, gifted students, and low achievers in their focus on conceptual understanding and a "balance between drill and problem solving." They have earned some credibility status with their administrators enabling them to "push the system" a bit when they teach fewer, deeper topics with "less reteaching," but they fret about the politics of the state standards that include "stuff kids don't need to know [like the periodic table in third grade]." One teacher seemed to sum veterans' position on children's skill levels by explaining, "Kids should be reading to learn—not learning to read."

Similar to novice teachers, parents of young children want their children to "learn the basics" but do not place great expectations on the curricula. As one father remarked about his son's mathematics learning, "I haven't really looked into it as [he] is only in first grade." They reason a "textbook approach such as memorizing all the bones in the body" would be inappropriate and they value the enthusiastic ways their children engage in science and mathematics learning. These parents expect hands-on learning is the best. As one father explained, "I think that this is a great way to get kids to love subjects." One first-grade mother, however, would like her son's mathematics to include more practical applications because the sooner they get "connections to real-life experiences" the better they understand it. When it comes to new math, primary parents are impressed by children's skills. As an example, one mother's first-grade son has learned some mental mathematics techniques to expedite his problem solving. As the mother explained her son's skill with rounding numbers, she realized,

> I am lousy with math in my head. I have actually gotten better by having my child come with homework and he gets it quickly. I'll say "wait a minute" and he explains he rounded this or that and then added three more or something. He gives a wonderful explanation and perfect sequence—and the number is right!

Parents of children with identified special needs expressed particular frustration with mandated, state testing. These parents see that, when schools focus energy on raising students' achievement scores, they reduce their capacity for educating special children. (*Note:* Some special education students are not held to the same testing regime as others, and

their progress does not count toward the school's annual yearly progress [AYP].) According to one father, "It would appear that the focus is on passing state tests for [the school's] own recognition and to teach toward that end at the expense of individual needs."

Similar concerns arose when parents disagreed about the school's decisions concerning achievement-group placement. One mother, who worried that her son would not be adequately challenged in the second-level group, learned these are decisions for the school to make:

> I wanted him in the high math. The teacher said, "Some people don't have the aptitude for math and fifth grade is when you can see it. This is fifth grade and math is difficult." I went to her supervisor and he said the same thing. I said, "I think you are wrong. I think we impose our own thinking on these kids [about not having] a mind for math." I went through the chain of command and voiced my opinion and they said, "Thank you."

On the other hand, extraordinary teacher efforts do not go unnoticed. One mother of a visually impaired child extolled the way one sixth-grade teacher provided access for her son:

> When you have teachers who have love and passion about science, it makes a child turn around their career. [My son] was in Mrs. ___'s class and it is all about science. He did a whole 360! He changed totally because she [encouraged him and made] it so interesting.

A Model, Theoretical Propositions, and Rationales

Lastly, we followed axial coding procedures (Creswell & Brown, 1992) to analyze the features outlined in Table 2 and to define a paradigm model (Figure 1) to map interactions or relationships between categories and subcategories of parents' and teachers' influential role in K–6 science and mathematics education. The central logic of this model suggests when select causal conditions exist (new national standards as they obligate parents, teachers, and teacher educators), and these conditions contribute to particular phenomena (state and local mandates), strategies are employed (whereby K–6 teachers and parents engage in select actions or roles) to ensure desired outcomes or impact (valued student skills or achievement). This logic leads to several propositions and subpropositions for future testing:

1. Road to reform navigation strategies vary by parents' and teachers' contextual experiences.
2. The younger the child and the less experienced the teacher, the more likely the parent or teacher chooses the Tour Bus strategy.
3. The older the child and the less experienced the teacher, the more likely the parent or teacher chooses the School Bus strategy.
4. The more educated the parent or the teacher, the more likely the parent or novice chooses the Classic Car or Jeep strategy.
5. Parents of special needs students, challenged by mandated state tests and the resulting test-focused curricula, are most likely to choose the Jeep strategy.

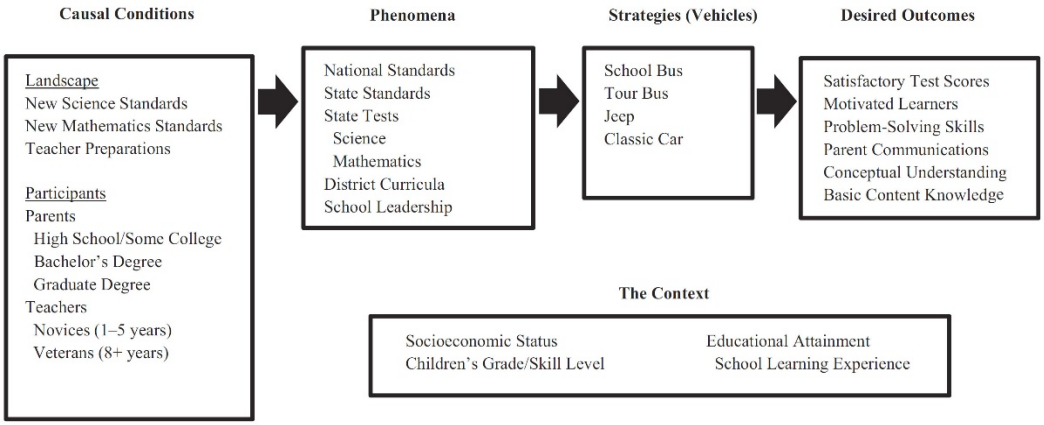

Figure 1. A model of parents' and teachers' influential role in K–6 science and mathematics reform.

This proposition suggests parents' and teachers' frustration about children's learning in science and mathematics is related to children's experience with school testing (which begins in earnest by third grade). Descriptions of participants' navigation strategies help illuminate parents' limited knowledge and understanding of reform initiatives and teachers' limited focus on home-school communications. The literature confirms novices and veterans focus on different measures of instructional effectiveness: early career novices continue concern about the day-to-day logistics of teaching while veterans are able to focus on student achievement (Hobbs, 2008). Novice teachers are also less likely to question or challenge the school leadership (i.e., mandated curricula, established home–school communications systems) (Darvin, 2012). Although parent communication skills are critical to effective teaching (Marko & Martin, 2005), most teachers have little preparation for working with parents or the community (Graue & Brown, 2003; Greenwood & Hickman, 1991; Imig, 1995). The existing literature is less clear about how teacher preparation programs or mentoring programs shortcut novice teachers' developmental process in this regard. One might begin with exploring how methods course experiences and early-career mentoring enhances novices' early-career experiences. Testing these propositions would not only enhance our understanding of how science and mathematics educators might improve teacher preparation programs but provide better clues about how to prepare teachers to build and maintain family relationships (Graue & Brown, 2003). Considering Epstein's (2011) model of the overlapping spheres of family, community, and school, educators might encourage responsive family communications that extend beyond the traditional activities (newsletters, school volunteers) as well as flexibility in responding to parents requests (Coleman, 2013).

1. Teachers' school experiences influence the nature of their acceptance of mandated science and mathematics education methods.
2. The more experienced the teacher, the more hesitant they are to categorically adopt new test-focused teaching methods.

3. The less experienced the teacher, the more likely they are to readily adopt district-mandated science and mathematics curricula and strategies.
4. Novice teachers are powerfully influenced by mentor teachers' negotiations of power with school leaders, parent communications, and instructional decisions.

This proposition and its subpropositions are somewhat surprising. While we learned details about how veterans negotiate reform with their school leaders, we also learned about the considerable influence of school leaders and mentor teachers when it comes to instructional decisions related to mandated curricula and teaching methods. We presume teachers' beliefs lead to changes in classroom behaviors (Guskey, 1986) and administrative support significantly impacts a teacher's ability or inclination to change (Raizen & Michelsohn, 1994). This helps us understand how novice teachers might allude to reform-oriented beliefs and expectations they learned in their methods classes but defer to the direction of school leaders and follow the lead of mentor teachers. Little research explores the models or lasting benefits of preparing novices to communicate with school leaders, but certainly partnerships with school leaders could help position novices in a school climate where teachers and parents are synergistically motivated to change (Wong & Cheung, 2009).

1. Parents' educational attainment and professional status influence their school expectations and involvement.
2. The higher the level of parents' education and professional status, the more parents consider the school and staff as accessible.
3. The less educated the parents, the more likely they are to criticize school policies (i.e., testing procedures, curricula) and defer involvement with the school/staff.

This proposition suggests parents expectations of children's science and mathematics learning are linked to the parents' own educational attainment as well as their relationships with classroom teachers and school staff. The literature confirms that less-educated parents feel uncomfortable approaching teachers (Copple & Bredekamp, 2009) and parents' understanding of school discourse such as teacher language and practice influences their understanding and motivation to adopt school initiatives (Muscott et al., 2008; Souto-Manning & Swick, 2006). To confound this issue, most preservice teachers do not feel prepared to facilitate interactions with parents/families (Foster & Loven, 1992; McBride, 1991; Tichenor, 1997, 1998), and education programs ignore families issues (Graue & Brown, 2003). Many early career teachers express concern that they had little or no opportunity to observe how parent-teacher partnerships are initiated and sustained (Sumison, 1999). One might explore a communication model that encourages novices to understand school as a "caring community that embraces the lives of parents, children, and teachers" (Swick, 1997, p. 154). Such a communication model would enable a realignment of power expectations (Bemak & Cornely, 2002) and encourage teachers to treat families as equal partners (Christensen & Sheridan, 2001). This research might explore the extent of preparation programs in preparing novices to collaborate with parents rather than direct them. We can expect, though, that a parents-as-partners communication model would provide context for validating the expertise parents bring to the relationship (Sheridan, Clarke, Marti, Burt,

& Rohlk, 2005) and codeveloping desired outcomes in children's science and mathematics learning.

Limitations and Implications

We set out to explore the critical experiences influencing parents' and teachers' expectations of children's science and mathematics learning in an era of new reform. We recognize our participant pool was largely limited to a region of the United States where test-focused school strategies have gained particular momentum and our data were limited to transcribed interviews. We recognize, too, as is consistent with the tenets of qualitative research, our model and propositions are left to interpretation. We expect, however, the resulting analyses and propositions delineating the interactive nature of parents' and teachers' influential role in K–6 grade science and mathematics education hold important implications for school administrators and science and mathematics teacher educators—and all others supporting reformed teaching. While teachers and administrators have had considerable access to resources to help them understand new-reform teaching pedagogy and practice, parents have been left out of the loop. Given that this may not have been an intentional decision, it is representative of the discrete designations of power and influence on K–6 science and mathematics teaching.

School administrators and school culture in general can influence families' motivation to work with teachers. Given that principals expect effective teachers are knowledgeable about parent engagement (Marko & Martin, 2005), they can play a critical role in helping novice teachers assume a proactive stance with parents and families (Copple & Bredekamp, 2009). Principals might begin to focus on helping novice teachers balance the pressures of standards-based testing (Darvin, 2012) with the importance of family engagement (Baum & Swick, 2008) as two critical components of the educational process. Principals, too, can help novice teachers connect academic standards with the community health care supports children need to meet them (Berry, 2013).

Teacher educators might embrace new opportunities to help novice teachers recognize and manage principals' and parents' concerns. Parent communication is a relatively unexplored aspect of science and mathematics methods courses, but productive communication skills, focused on real-life application (Baum & Swick, 2008), would particularly augment preservice science and mathematics teachers' skill set. Strategies might involve a prolonged study of one parent/family (Souto-Manning & Swick, 2006), substantial internships in community-based organizations (Berry, 2013), or clinical field experiences that model the ways parent-teacher partnerships are initiated and sustained (Sumison, 1999). Given the empowering effect of veteran mentors, teacher educators might pay special attention to clinical field placements in programs that will allow preservice teachers opportunity for meaningful involvement with families (Chavkin, 2005).

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