What, How, and Why Do Elementary Teachers Think About Using Representations in Their Science Teaching?

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Abstract: Representations and representational practices are central to science education. Most research into the role of representations in supporting learning has focused on with less attention to how teachers understand representations and their use in classroom instruction. To better understand how teachers use representations, we developed a new framework called Representations for Teachers as Learners (RepTaL). This study leverages the RepTaL framework to explore the multiple dimensions of teachers' representational understanding including their understanding of representational forms, ways of including representations within science, and ideas about what aspects of phenomena students should represent. We have used this framework to analyze interviews with 6 teachers in rural schools in the midwestern United States. We present an analysis of these interviews as an illustration of both the breadth of teacher ideas about representations including some of the limitations and as an illustration of how the RepTaL framework helps to make these ideas visible.

Introduction

Representations and representational practices are central to science education (NRC, 2007, 2013). Although a great deal of literature has focused on how representations influence student learning, less is known about how teachers understand representations in science, and how this, in turn, influences their teaching practices. This study contributes to the literature by beginning to document teacher understanding about representations and representational practices—ways of engaging in the creation, use, and discussion of representations within the classroom (Danish & Enyedy, 2007; Hall, 1996). To analyze teachers' conceptions, we propose a new framework called Representations for Teachers as Learners (RepTaL) for exploring multiple dimensions of teachers' representational understanding including teachers' understanding of representational forms, their ways of including representations within science practices, and their ideas about what aspects of phenomena students should represent. This framework draws upon and revises several previous frameworks in order to depict multiple dimensions of teacher understanding and practice. In the current study, we use this framework to analyze interviews with 6 teachers in rural schools in the midwestern United States who participated in professional development and coaching around the use of representations within their science classrooms. We present preliminary analysis of these interviews below as both an illustration of the breadth of teacher ideas about representations and as an illustration of how our framework makes these ideas visible.

Theoretical framework and literature

Given the importance of representations for science teaching and learning, the goal of the overarching RepTaL project is to better understand how teachers understand and learn about using representations in elementary science classrooms. Our notion of knowledge builds upon sociocultural theories of learning (Danish & Gresalfi, 2018; Greeno & Engeström, 2014) which suggests that knowledge is always situated in sociocultural contexts, and understanding is visible in practice. Therefore, our approach always links any evidence of understanding to a specific context. The present analysis focuses on how teachers' knowledge is made visible when planning and discussing their classroom activities, and future work will further disentangle how their practices differ when working directly with students, and when teachers reflect on their classroom activities.

Our working definition of a representation is anything that stands for something else (Palmer, 1977). However, we recognize that such a definition would likely include too many aspects of teachers' practice for us to reasonably evaluate (all language is a representation, for example). Instead, building on Latour (1988), we are restricting our focus to inscriptions: representations in material form such as drawings and embodiments. To unpack the process through which representations are used by teachers and students in practice (Danish & Enyedy, 2007; Hall, 1996), we find it helpful to divide our framework into three categories of codes that explore **what** kind of representations teachers opt to use, **how** they are used, and **why** the teacher selected them.

Our sociocultural theoretical perspective further assumes that while the material form used has some affordances and constraints, or characteristics that lead to it being used in particular ways, representations gain their meaning in and from use (Danish & Enyedy, 2007; Hall, 1996). Thus, a diagram might be treated as a starting point for discussion one day, or as evidence of understanding another. We have identified several coding schemes to help in articulating these different dimensions (see Table 1 for a summary).

What: Several existing coding schemes aim to capture the kinds of representations that students are asked to use or create. We combined these into one category of codes called "RepKind" with sub-codes that reflect form, scale, systems level, and content. The form of a representation is intended to describe the familiar representational types (e.g., a diagram) and whether this is intended to represent reality or an abstraction. The scale identifies the scale of phenomena, either observable under normal circumstances or of scope (size, timescale, etc) that it would be impossible to observe, such as the formation of mountain ranges. Next, content comparison codes are intended to help us understand what aspects of the phenomena are being represented and whether they are being contrasted. Finally, systems level(s) codes are based on work on systems thinking (Authors, 2006; Jacobson & Wilensky, 2006) and mechanistic reasoning (Russ, Scherr, Hammer, & Mikeska, 2008) due to the value of systems thinking as a cross-cutting concept in science (NGSS, 2013) and as a way of describing the richness of the level at which the phenomena is being represented.. Although we recognize that not all science concepts are easily interpreted from a systems perspective, we find that these coding schemes nonetheless support us in separating superficial structural representations from those focused on mechanism.

How: The way that representations are used can be categorized at several different levels including the general representational activity such as whether students are creating, critiquing or revising a representation (ActivityKind). Here we built upon Schwarz et al.'s (2009) framework for exploring modeling, with extensions to capture practices that might fall short of modeling and yet are still an important part of classroom activity. **Why:** The goal of this dimension is to capture the reasons that the teachers indicate why they selected a specific kind of representation (SelectCriteria). These criteria include features of the representation, the teacher's notions about their students' ability to work with the representation, and their ideas about the learning context. We also looked at what aspects of the representations and their use the teachers valued in the current activity (RepCriteria).

Table 1: RepTal framework coding scheme v1.1

	Coding Scheme Name	**Core idea captured**	**Based on**	**Summary of changes to existing framework**
WHAT	RepKind: Form	Form of representation and level of abstraction.	Gilbert (2008)	Categorized forms independently of phenomena level and dimension (e.g. 2D, 3D). Added "tools" category.
	RepKind: Phenomena Scale	Phenomena represented at what level: macro or micro.	Gilbert (2008)	N/A
	RepKind: Systems Level	System level represented: component structure, process, mechanism.	Hmelo-Silver (2017), Russ & Scherr, (2008)	Added "process" level to capture descriptions of *what* happens in a phenomena that are not mechanistic.
	RepKind: Content Comparison	Content compared in the representation (e,g., quality to quality, position over time).	Emergent in RepTaL project	N/A
HOW	ActivityKind	How representations are used in situ (e.g., sensemaking, completing, creating, critiquing, revising).	Schwarz et al., (2009)	"Explaining" has been folded into the other categories.
WHY	SelectCriteria	Why teachers select representations (e.g., understandability, relevance, aesthetics, systems thinking).	Lee & Jones (2018)	Added "student capacity" and "student relevance" categories.
	RepCriteria	Teachers' value and support for student modeling knowledge and practice (e.g., audience, mechanism, evidence, revising).	Schwarz et al., (2009); Pierson et al., (2017)	N/A

Methods

The analysis centers on interviews with rural Midwestern United States primary school teachers (n=6) with experience that ranged from 1-25 years. They were participating in the first year of a RepTaL professional learning program designed to support teachers in incorporating representations into their science teaching. Teachers participated in cycles of instruction on how students learn with representations, immersive experiences with representations as learners, collaborative unit planning, and individually coached planning before, during, and after 4-5 lessons in a unit of instruction. First and second grade teachers' (n=3) units focused on properties of matter, and third and fourth grade teachers' (n=3) units addressed earth processes. To understand what, how, and why participants used representations in their classrooms throughout the course of the project, reflective interviews were conducted at multiple time points. The present analysis compares "pre interviews" (before professional learning) to "post-implementation" interviews (following the teaching of a coached unit). We do not anticipate a dramatic change in practice based on a 2-day professional development session and a handful of coached lessons, though we do hope this is a starting point for longer-term growth. Rather, our goal in presenting both timepoints is to help illustrate the range of practices that teachers engaged in.

Our overarching research question was: How do teachers think about representations in their science classrooms? Interviews were analyzed deductively using ATLASti. We applied all coding schemes described in the RepTaLs framework, revising them until reaching consensus, and recoding based on the final version. Frequencies and co-occurrences were calculated to facilitate comparisons within and across coding schemes and interviews. We also consulted with the team members who had coached the teachers, asking about what they saw as promising, surprising, or disappointing trends and used these impressions to help guide our planned analysis.

Results

What representations do teachers use?

While there were a range of representational forms, the majority were either coded as close to reality, with structures such as a marble maze (20 mentions) and samples such as a tree cookie (6.5 mentions) being the two most popular, or re-representation with diagrams (19.5 mentions) and texts (13.5 mentions) being the next most popular, followed by tables (11.5 mentions) and graphs (4 mentions).

The largest change between the pre- and post- conditions was an increase in teacher's usage of tools as representations--e.g., rulers or measuring instruments, which the coaches had introduced as valuable--but the general stability of these averages suggests that teachers are not drastically changing the kinds of representations they use in response to very basic intervention. This could also indicate that teachers considered certain kinds of representations, in particular, math and math-like representations like equations, as too difficult for their students, while others such as diagrams and texts are viewed as having general utility across content areas. This is consistent with the large role that student capacity played in teachers' selection process (described below).

Table 2: RepKind: Forms and changes over time

	Examples	Average Pre	Average Post
Abstraction	Computer Simulations, equations	0	1
Re-representation	Graphs, tables, text	7.7	7.7
Tools	Measurement (e.g., ruler or graduated cylinder)	0.5	3.5
Close to Reality	Physical models, samples, gestures & movement	7.2	7.3

We would also expect and hope to see some patterns in how teachers used specific representational forms that are well suited to their target content. This pattern did hold up with 1st and 2nd grade teachers who were teaching states of matter using tables (14 mentions compared to older teachers' 7 mentions) and gesture (8 mentions compared to 3 by older teachers) more frequently while 3rd and 4th grade teachers (earth science) used more diagrams (24 mentions compared to 16 by teachers of younger grades) and structural models (28 compared to 11). This suggests that teacher's use of representations was driven in part by their target content; e.g., tables are better suited for states of matter given the general need to compare the three main states and their properties. Future work will be needed to further disentangle the influence of teachers' ideas about their students' capabilities and the content they are studying on their representational choices.

Perhaps unsurprisingly, the teachers' representations focused almost exclusively on macro-scale events. We did not see any uses of the micro-scale in the pre-PD interviews but observed 3 instances in the post-PD interviews. This is a small change but given that there was no mention of micro-level representations before undergoing PD it may suggest the teachers are broadening their understanding of what representations can do in the classroom. We also looked at how deeply the mechanisms of the phenomena in question were presented in the teacher's representations and found that they looked at components and processes in equal measure, but rarely got to the level of describing mechanisms. All three instances of micro-level representations described the components of the system and all instances of mechanistic description were macro-level representations.

Table 3: Shifts in mentions of different RepKind Forms in each interview by teacher

	Teacher 1237 - Mary			*Teacher 1238 - Beth*			*Teacher 1239 - Carol*			*Teacher 1240 - Karen*		
	Pre	Post	***Totals***	Pre	Post	***Totals***	Pre	Post	***Totals***	Pre	Post	***Totals***
Re-Representations	**5**	**5**	**10**	**14**	**13**	**27**	**12**	**9**	**21**	**8**	**6**	**14**
Table	1	1	***2***	2	2	***4***	3	6	***9***	0	1	***1***
Diagram	2	3	***5***	1	1	***2***	3	1	***4***	4	4	***8***
Graph	0	0	***0***	1	2	***3***	2	0	***2***	0	0	***0***
List	0	0	***0***	0	1	***1***	0	0	***0***	0	0	***0***
Other	1	0	***1***	1	4	***5***	0	1	***1***	2	0	***2***
Text	1	1	***2***	9	3	***12***	4	1	***5***	2	1	***3***
Virtual worlds	0	0	***0***	0	0	***0***	0	0	***0***	0	0	***0***
Close to Reality	**10**	**7**	**17**	**8**	**10**	**18**	**3**	**2**	**5**	**8**	**10**	**18**
Gestures & Body	0	0	***0***	0	2	***2***	0	0	***0***	1	3	***4***
Other	1	0	***1***	0	1	***1***	0	0	***0***	0	0	***0***
Photograph	1	2	***3***	1	1	***2***	0	1	***1***	1	0	***1***
Samples	1	1	***2***	1	0	***1***	1	0	***1***	3	3	***6***
Structural/material	6	4	***10***	5	5	***10***	1	1	***2***	2	3	***5***
Video	1	0	***1***	1	1	***2***	1	0	***1***	1	1	***2***
Totals	***15***	***12***	***27***	***22***	***25***	***47***	***16***	***11***	***27***	***16***	***19***	***35***

Most notably, the use of text (e.g., textbooks) decreases (16 pre, 4 post) in all teachers while the use of tables and gestures increases overall (no teacher decreases their use of these, but some do not change). This suggests that teachers are relying less on textbooks and more on specific teacher or student-generated representations.

Comparisons

In our early analysis, we noted that many of the representations that teachers had their students create made an implicit or explicit comparison on one or more dimensions. For example, drawing what a plant looked like over time was coded as a comparison between qualitative features (what was drawn) and time. If a plant was measured over time it would have been listed as a comparison between quantity/magnitude and time. Similarly, many of the teachers studying states of matter used tables to compare the properties (qualitative) of the different states (qualitative). The most common choice was "no comparison" (186) meaning that the students represented an object or phenomenon in one way without comparisons, however there were still quite a few comparisons with qualitative (81) and quantity/magnitude (80) comparisons being the most common, followed by time (75) and space/distance (52). Looking beyond the "no comparison" category shows that the highest co-occurrence for each of qualitative, quantity/magnitude, and space/distance is with time. After time, qualitative and quantity/magnitude co-occur with themselves most often while space/distance pairs with quantity/magnitude.

Table 4: Co-Occurrences of mentions of RepKind Comparison Codes

	Qualitative	**Quantity/ Magnitude**	**Same dimension**	**No comparison**	**Space/ distance**	**Time**
Qualitative		6	17	2	8	20
Quantity/Magnitude	6		11	5	8	20
Same dimension	17	11		94	7	1

No comparison	2	5	94		4	2
Space/distance	8	8	7	4		13
Time	20	20	1	2	13	

These data indicate that teachers are primarily limiting their representations to be either a) qualitative, b) quantitative, or either of those compared over time. While these comparisons are generally productive, we saw some missed opportunities to relate qualities to quantities and thus would like to see more of this kind of representation in the future. For instance, teacher Beth describes an activity where students constructed ‘snow shovels’ out of different materials (qualitative) and compared how quickly each material could clear a given area (time) and how much weight it could lift (quantity). Future analysis might also explore why teachers orient towards these kinds of comparisons, and how they support or inhibit students’ explorations of the content.

How are teachers discussing using representations?

Table 5 shows some key a few additional patterns in the kinds of activities that the teachers developed around representations. While sensemaking was the most common, constructing was the next most common, which is well-aligned with constructivist approaches to science learning. However, we felt that teachers used coping more often than was desirable as this did not provide students with opportunities to reflect on the value of different representational features, nor on how representations are constructed to reflect the different characteristics of a phenomenon. We also saw minor changes over time, including an increase in sensemaking and assessment activities. One of these changes was that teachers began to think of representations as summative assessments of student thinking, which we want to encourage, but we fear sometimes overrode their recognition of the value of representations in supporting learning. We suspect that viewing the representations as evidence of student thinking might be a first building block in viewing representational activities as an opportunity for learning.

Given this focus on representations as summative evaluation, it is not surprising that we saw few instances of revising and critiquing, two practices that are crucial for iteratively developing models, an important aspect of learning science (NRC 2015). Furthermore, students were not frequently asked to share what they had created with their teacher or peers, though that increased over time after teachers discussing it with their coach. Our conversations with the teachers suggest that they had limited experience with this kind of sharing, critiquing, and revision process, leading them to feel uncomfortable attempting to support them, and also that they feared it was beyond their students’ capabilities at the time. One goal of future work will be to help teachers overcome these barriers in supporting more robust modeling practices.

First, Second, while students were asked to create some representations, they rarely revised them. Finally, we see that while students did represent some processes when creating or copying representations, they primarily discussed structures/components in their representations. We view this as a missed opportunity as the processes and mechanisms are more complicated for students to understand, and thus can benefit from greater focus (Hmelo-Silver & Azevedo, 2006; Jacobson & Wilensky, 2006).

Table 5: Mentions of Activity Kinds

	Pre	**Post**	**Totals**
Assessment	4 *(4.21%)*	7 *(7.37%)*	11
Completing	10 *(10.53%)*	4 *(4.21%)*	14
Constructing/Creating	26 *(27.37%)*	34 *(35.79%)*	60
Critiquing	1 *(1.05%)*	1 *(1.05%)*	2
Sensemaking	33 *(34.74%)*	44 *(46.32%)*	77
Other	0	0	0
Other discipline	9 *(9.47%)*	3 *(3.16%)*	12
Revising	2 *(2.11%)*	0	2
Underspecified	10 *(10.53%)*	2 *(2.11%)*	12
Totals	***95***	***95***	***190***

Why are teachers indicating they are selecting specific representations?

Finally, we wanted to understand why teachers identified a specific representational form or activity as good for their students and planned objectives. The results are summarized in Table 6. Here we see that teachers attend to a broad range of ideas in identifying the representations they chose. The most commonly used selection criteria was student capacity (106, 42.4%), followed by teacher preference (27, 10.8%), curricular relevance (22, 8.8%), and student relevance (20, 9.6%). However, the most interesting and potentially valuable shift that we noticed is that, initially, negative student capacity outnumbers positive student capacity, but these counts swap in the post-intervention case, indicating that teachers have shifted away from deficit thinking toward considering their students' positive abilities. This was also evident in a number of teacher comments that expressed surprise and pleasure at all that their students were capable of. The occurrence of positive understandability codes, where teachers chose representations specifically because they were easier to understand also more than triples (5 to 19), while the occurrence of curricular relevance codes decreases by nearly one quarter (18 to 4) from pre- to post-intervention measurements, indicating that teachers have begun to consider how representations can be used to enhance or support learning rather than simple something provided by the textbook as part of a curricular unit.

Table 6: Most common Select Criteria

	Examples	Pre	Post	Totals
Relevance curricular (+)	"...I snuck science into reading again"	18 *(14.63%)*	4 *(3.15%)*	22
Teacher preference	"I would have to learn more before I would use that" "...that's just too much of a mess for me"	17 *(13.82%)*	10 *(7.87%)*	27
Understandability of rep (+)	"Well, on this one, I it had just the four major cycles… so that was OK as far as just simple, the four major steps."	5 *(4.07%)*	19 *(14.96%)*	24
Relevance student (+)	"we have a lot of farm kids in our school. They may already know things like the chicken lays the egg. They will be excited to learn about this."	12 *(9.76%)*	8 *(6.30%)*	20
Student capacity (+)	"I started to switch to think about how I can have more my students be in charge of the learning versus me, by dragging them through it…"	20 *(16.26%)*	33 *(25.98%)*	53
Student capacity (-)	"this number amount to them like, 2,500, I think that might blow their minds.. we're just starting to talk about hundreds and thousands with the Base 10 blocks, and kind of adding and subtracting…"	30 *(24.39%)*	23 *(18.11%)*	53
Totals		***102 (82.93%)***	***97 (76.38%)***	***199***

In addition to the select criteria, teachers' reason was also tracked through RepCriteria codes. These codes , salience-generality, evidence, mechanistic, audience, and revision, which are described in the next paragraph, position the teacher's use of representations along a learning progression and are applied when teachers discuss the purpose, use, or creation of representations. Implemented in this manner, the presence of RepCriteria codes in the interviews suggest that teachers place value on the features being coded. For instance, if a teacher mentions that they have designed an activity where students create representations and then share them with classmates, it reveals that this teacher places value on the audience criteria and that their progress is fairly high (e.g., level 3).

Overall, the data describe a shift upwards along the RepCriteria progression, with pre- to post-intervention decreases in level 1 and increases in levels 2 & 3. **Salience-Generality**, building on Pierson et al., (2017) indicates whether the representation explicitly captures a limited number of specific, concrete features (those that are most salient) or is intended to be an abstraction that can apply across conditions and phenomena (abstract), with higher scores reflecting higher levels of abstraction, and an increased awareness that multiple models might represent a single phenomenon or one model might represent multiple phenomena. For example, Mary noted how student learning about mountain formation was supported by using a physical model, an embodied model (student hands representing plates) and diagrams of mountain formation, showing how multiple representations can represent the same phenomenon--a level 3 example of salience. Some of the largest shifts were observed in this category with the use of salience level 2 increasing drastically (1 to 14) and level 3 appearing (0 to 2), while level 1 decreased by nearly 50% (74 to 56).

The **evidence** category describes how much emphasis teachers placed on the justification and grounding of evidence in their representations. At level 2, one teacher had students draw pictures of sprouting seeds each day of class, noting the changes observed, asking the students to justify their representations based on their own observations. The data shows some increases where instances of level 2 evidence nearly double from 8 to 15. The **mechanistic** category describes the teacher's attention to the explanatory value of the representation. Is the representation merely describing (level 1) or is it showing mechanisms (level 3) and being used predictively (level 4)? Unsurprisingly, given the RepForm results, there is not much change in this category. Usage of levels 1 & 2 remains the same but there is an increase of one in level 3 (up from zero) which shows the teachers are making attempts in this area. **Audience** indicates how important the consumer of the representation are to the teacher's process. In an instance of level 2 criteria, a teacher has her students draw a circuit diagram and then explain their diagram to another student, showing that the diagrams' intended audience was other students. The data shows a small shift down in level 1 (72 to 63) and up in level 2 (3 to 7). Lastly, **revision** looks at how important it is to revise representations. In one of the best examples of this criterion, teacher Beth discusses an activity where students build roller coasters. She recalls that students noticed that the data table in the textbook did not account for all key variables (e.g., height of the coaster). From the pre- to the post instances of level 1 go down slightly (72 to 67), though instances of levels 2 and 3 remain essentially unchanged (going from 2 to 1 or 1 to 2).

Where do we see co-occurrence/synergy?

In general, teachers began the study indicating that they didn't know a lot about representations and primarily used those that were provided by the curricular materials, or that they were already familiar with. This is reflected in the code counts that show the teachers not yet reaching the more robust levels of the scale. However, the teachers were willing to try using representations in new and more complex ways when encouraged to do so by the coaches. The shift to more complex representations and more advanced features tended to coincide with increased beliefs about what the students were capable of accomplishing with representations. That is,
higher levels of RepCriteria co-occurred with Student capacity + and or Understandability + at higher rates than any other select criteria. In particular, higher levels of revision and salience are associated with positive views of student capacity. For instance, teacher Beth in her model roller coaster unit mentions above is about to get to a high level of revision because she believes that her students are capable of making suggestions on the representations she uses. This suggests that teachers' conceptions of what can be done with representations, in general, are inter-connected with their beliefs about what their students are capable of accomplishing with representations. Future work can explore this relationship in greater detail, and in particular, can focus on how teachers can be encouraged to support increasingly robust representational practices by their students.

Discussion and conclusions

In general, our results indicate that teachers are not familiar with the idea of "representations" as a field of study, and thus do not typically give a great deal of thought to what representations they will use in their science classrooms nor how often relying upon what curriculum makers have provided. Nonetheless, our findings suggest teachers don't begin with "no" ideas about representations. Rather, with the help of the RepTal framework we are able to see a broad range of representations and practices for employing them in the classroom. Furthermore, we see some important intersections across dimensions of the framework, suggesting that it is valuable to use all of these dimensions to describe teachers' practices rather than attempting to document solely one dimension at a time. For example, our findings indicated a multidimensional relationship between representational form, content considerations, beliefs about learners, and beliefs about representations. Thus, the 1st and 2nd grade teachers selected tables to study the states of matter not solely because they thought tables might help make comparisons, but because they thought their students could create those tables, and that they supported comparisons that are important for exploring states of matter. This is a valuable first step in supporting teachers in leveraging the full potential of representations and representational practices in their science classrooms.

Despite this complexity, the RepTal framework also helped to highlight how teachers did not yet use the full range of representational forms, nor, across forms, did they engage in all of the practices we'd hope. In particular, critique and revision were absent. However, the issue is not that teachers cannot appreciate these nuances, just that they have not been exposed to them and not have not had opportunities to explore them. In addition, this lack of familiarity appears to be initially paired with a concern that students won't be capable of engaging in robust representational practices. Nonetheless, there is reason to be optimistic about the potential for helping teachers to support more robust representational practices within their science classrooms. With encouragement, the teachers in our study were willing to try more advanced practices , and this led to some stumbling, but also some nice increases in expectations about what their students can do, and thus a greater willingness to try those more robust activities.

We view these findings as quite optimistic, suggesting both that robust representational practices are not out of reach for teachers, and that the RepTal framework can help shed light on both what teachers are doing (and why), and what they might be capable of with some support. Previous frameworks were helpful in identifying one or two dimensions of these possibilities, but we see real power in looking across them, and at their intersections. If we looked solely at how teachers viewed representations, for example, we would not have seen how this was interconnected with their beliefs about students capabilities, suggesting that a multidimensional framework such as RepTal has real value in studying teachers use of representations in the science classroom. Our goal in future work is to see how teachers' practices change as they are introduced to the potential power of using representations in science teaching. We also want to move away from teachers' self-reports and apply this framework to analyzing their ongoing classroom practices and reflections. We suspect that there are some important differences across contexts, and that making them visible will help us continue to better understand teacher cognition and learning.

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