Learner Alignment with Expansive Framing as a Driver of Transfer

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Abstract: Recent theoretical perspectives on transfer highlight the active role of learners in transferring knowledge. In this study, we focus on the learner by exploring the possibility that when learners align their actions and beliefs with expansive framing, they are more likely to transfer knowledge from one context to another. We define expansive framing as the perspective that learning is connected to other times, places, participants, and topics, and that the role of students is to generate and share knowledge. We examine the degree to which high school biology students aligned themselves with this perspective. Using correlational and discourse analyses of students' performance on transfer assessments in relation to their perceptions of the expansive relevance of their class, we present evidence of a relationship between alignment with expansive framing and transfer. Students who perceived greater temporal relevance across past experiences, current learning, and future opportunities displayed the highest levels of transfer.

Introduction

Research on transfer of learning has a century-long history, dominated primarily by laboratory experiments and a cognitive perspective that views transfer as dependent on the characteristics of learners' mental representations (e.g., Gentner, 1983; Gick & Holyoak, 1983; Reeves & Weisberg, 1994; Ross, 1984). In recent years, a new set of perspectives has emerged including actor-oriented transfer (Lobato, 2012), preparation for future learning (Bransford & Schwartz, 1999), consequential transitions (Beach, 1999), dispositional and motivational views (e.g., Belenky & Nokes-Malach, 2012; Perkins & Salomon, 2012), and expansive framing (Engle, 2006; Engle, Lam, Meyer, & Nix, 2012; Engle, Ngyuen, & Mendelson, 2011). A key feature of these perspectives is a greater focus on the role of the learner in transfer, and the importance of more than purely cognitive factors.

This paper focuses on one of these contemporary approaches: expansive framing, as an explanation for transfer. The underlying premise of this approach is that transfer is facilitated when learners perceive instruction as part of larger intellectual conversations that extend across contexts, and perceive themselves as capable of and accountable for contributing to those conversations (Engle, 2006; Engle at al., 2011). It is hypothesized that instruction that is expansively framed promotes these learners' perceptions and beliefs of intercontextuality between learning and potential transfer opportunities, which then triggers social and cognitive mechanisms that lead to transfer (Engle et al., 2012). Our prior research has focused primarily on expansive framing from the instructor's perspective and how he or she can frame a learning environment to promote transfer (Engle, 2006; Engle et al., 2011). In this paper, we turn our attention away from the discursive moves through which instructors can expansively frame instruction, and focus directly on the perceptions and beliefs of learners in an expansively framed biology classroom. This shift in focus is motivated by the observation that a teacher's pedagogical moves matter only to the extent that these moves are perceived and taken up by students and incorporated into their practices.

We investigated the degree to which students in this classroom *aligned* their own actions and beliefs with expansive framing, and compared their level of alignment with their performance on transfer measures. We found converging evidence of relationships between student alignment with expansive framing and transfer, supporting the premise that learners' perceptions and beliefs of the extended relevance of learning are fundamental for transfer. In our discussion we consider how the instructional approach used by the teacher may have influenced those crucial perceptions and beliefs.

Background and Theoretical Framework

An Emerging Focus on the Learner in Contemporary Transfer Research

The role of learners' perceptions and beliefs in transfer has been gaining increasing attention from transfer researchers in recent years. Perhaps the most fully developed learner-focused perspective on transfer is Joanne Lobato's (2012) *actor-oriented transfer* (AOT). Dissatisfied with the limits of traditional transfer measures, Lobato aims to "understand the interpretative nature of the connections that people construct between learning and transfer situations" independently of whether or not those connections are expected or deemed appropriate by researchers (p. 239). From this perspective, analyses of transfer provide insight about other ways in which students draw on prior learning.

James' (2008) study on transfer between writing tasks designed to be similar or dissimilar illustrates the benefits of taking an AOT approach. Student interviews showed that students considered many dimensions of the tasks that the researcher had not considered, and that different students identified different similarities and differences between tasks. Independently of which of two tasks each individual student completed, there were greater levels of transfer by students who perceived their assigned task to be similar to instruction than by students who perceived their task as different. This finding suggests that transfer depends on subjective perceptions of similarity more so than researcher-assumed objective similarities (Day & Goldstone, 2012; Pea, 1987).

Perkins and Salomon (2012) call for a focus on the learner by considering learner motivations and dispositions in relation to transfer. They claim that the bulk of transfer research focuses on "learners' ability to make the [researcher's] desired connection" while ignoring the learners' "motivation or disposition to do so" (p. 253). Belenky and Nokes-Malach (2012) illustrate the importance of these factors in their investigation of achievement goals in relation to transfer. Subjects' achievement goals were measured before and while engaging in different activities about statistical concepts. The researchers found that students who displayed higher levels of motivation to develop long-term competence and understanding of statistics, and higher senses of personal relevance and contribution while engaging in activities displayed higher levels of transfer. Together this body of work suggests that transfer is highly dependent on the individual learner, and his or her orientation towards what is being learned and transferred.

The Learner in Expansive Framing

We use the term *framing* to refer to the discursive moves through which interlocutors propose and align themselves with expectations regarding the nature of the interaction in which they are engaged (Bateson, 1972; Goffman, 1974; Tannen, 1993). Framing consists of primarily linguistic cues that index schema of types of interactions (Gumperz, 1982; Ochs, 1996; Tannen, 1993) and activate cognitive resources associated with those schema (Hammer, Elby, Scherr, & Redish, 2005). We refer to framing as *expansive* when it proposes *intercontextuality* (e.g., Floriani, 1994; Gee & Green, 1998), or connections between the current interaction and others (Engle, 2006; Engle et al., 2012; Engle et al., 2011). For example, a classroom teacher can expansively frame a lesson by presenting it as an opportunity for students to take on knowledgeable roles within communities in which they may participate throughout their lives. Doing so expands the scope of the lesson by proposing its relevance across time, space, and social configurations. It is thought that transfer is facilitated when learners perceive and believe in this expanded relevance (Brown, 1989; Greeno, Smith, & Moore, 1993; Laboratory of Comparative Human Cognition, 1983; Pea, 1987). When learners hold these perceptions and beliefs, we say that they are *aligned* with expansive framing, and we present data in this paper that indicate that this alignment is indeed related to transfer.

Table 1. Intercontextualities created by expansive framing and mechanisms for how each may lead to transfer.

Contextual aspect	Proposed intercontextuality	Transfer mechanism
Time: When is the lesson happening?	The lesson is part of an ongoing activity that started in the past and will continue into the future.	Students draw on prior knowledge during the lesson. They learn content expecting to be able to use it in the future.
Place: Where is it happening?	The lesson is relevant outside the classroom (e.g. to rest of school, homes, local community, places around the world, other institutions, etc.).	Students draw on experiences from other places during the lesson. They learn current content expecting it to be applicable in other places.
Participants: Who is participating?	The lesson is relevant to a broad community that extends throughout and beyond the classroom.	Students consider the relevance of interactions with others during the lesson. They learn current content expecting it to be of interest to others.
Topics: What is the topical scope of the lesson?	The lesson is part of larger and interrelated units, topics, and subject areas.	Students see connections between the lesson and other topics they have studied and will study.
Roles: How are learners positioned intellectually?	Learners are authors who are responsible for developing, sharing, and defending their own ideas.	Students feel accountable for using and sharing the ideas they author. They may also adopt the practice of generating and adapting ideas to attempt to solve novel problems.

Empirical work on expansive framing has identified five different aspects of learning contexts that instructors can frame expansively: time, place, participants, topics, and roles (Engle, 2006; Engle et al., 2011).

More recently, Engle and her colleagues (2012) proposed several explanations for how expansive framing can promote transfer. Drawing on this body of research, the following table presents the intercontextual links that are proposed when each of the five aspects is expansively framed, as well as explanations of how learners' alignment with these proposals is believed to promote transfer (Table 1).

Methods

In this paper, we investigate the idea that what ultimately matters for transfer is the degree to which learners align themselves with expansive framing. We focus on relationships between learners' alignment with expansive framing, captured through surveys and interviews, and their performance on learning and transfer assessments. We use correlational analyses of surveys and transfer assessments to investigate the relationship between learner alignment with expansive framing and transfer. Through qualitative analysis of interviews, we explore patterns in the expressions of alignment of students who demonstrated different levels of transfer.

Research Context: An Expansively Framed Biology Class

The data presented in this paper come from a larger, mixed-methods study on framing and transfer in the classroom of an experienced and award winning high school biology teacher who we refer to as Mr. Kent. We first began observing Mr. Kent's classroom in 2008, at which time we recognized many key aspects of expansive framing in his instruction (Engle, Meyer, Clark, White, & Mendelson, 2010). Through our prolonged collaboration with Mr. Kent, we believe that the degree to which his instruction embodies our framework has increased over time (Engle et al., 2012). This paper focuses specifically on Mr. Kent's second period biology class consisting of 32 freshmen and sophomores (22 girls, 10 boys) at a San Francisco Bay Area high school during the 2010-2011 school year.

Data Collection and Analysis

We draw from three data sources in this paper: (1) a series of written assessments, to measure student learning and transfer of knowledge related to osmosis and diffusion; (2) student surveys, to measure student alignment with expansive framing as well as their recognition of Mr. Kent's use of expansive framing in his instruction; and (3) student interviews, to capture more detailed student expressions of alignment with expansive framing.

Assessments of Learning and Transfer

Our analysis of transfer for this paper is based on four written assessments about osmosis and diffusion, a concept that is fairly difficult for students to master (Christianson & Fisher, 1999) and therefore to transfer (Bransford, Brown, & Cocking, 2000). The pre- and post-assessments were administered before and after the instructional unit on osmosis and diffusion and were identical for the purpose of recording changes in student knowledge of the focal content. The initial transfer assessment was administered several months after the post-test, and the follow-up assessment (which measured both transfer and retention) was administered nearly two years later, in 2013 (see Figure 1). Seventeen of the original 32 students from the focal class completed the follow-up assessment.

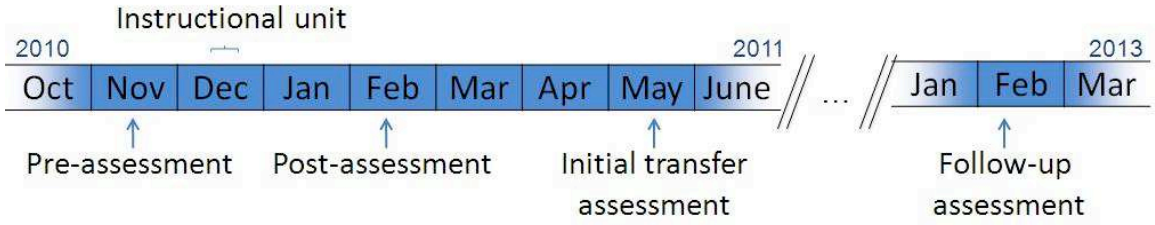

Figure 1. Timeline of written assessments in relation to the instructional unit on osmosis and diffusion.

Questions on the initial and follow-up transfer assessments presented students with a variety of scenarios about concentration gradients that were designed to be more or less analogous to what students had already learned in class (Gick & Holyoak, 1983). Some questions had a similar structure and referred to content that was discussed during the instructional unit. Other questions included content areas not yet addressed in class, and required students to recognize the role of concentration gradients in the problem before being able to solve it. Still others posed a different kind of task, such as drawing a diagram rather than selecting from multiple-choice answers.

Our analysis of transfer was based on knowledge elements related to osmosis and diffusion that were reflected in students' responses to assessment questions. We use the term "knowledge element" (KE) to refer to an individual fact or proposition that forms part of the normative understanding of a larger conceptual principle (Engle et al., 2011; Renkema 2004; van Dijk & Kintsch 1983). In our coding scheme, we identified seven of

KEs that together represented the targeted level of understanding of osmosis and diffusion. Students' relative mastery and application of KEs was assessed through their identification of the outcome of a problem scenario by selecting a multiple-choice answer, and their explanation of that outcome in a written response. Two of the authors coded the responses independently, and compared codings to measure interrater reliability. All differences were resolved by mutual agreement. Interrater reliability was 0.937, giving a Cohen's Kappa of 0.861.

As a baseline measure of each student's knowledge about osmosis and diffusion that was available for transfer, we adopted the total set of all KEs that were coded for each student on *any* of the questions of the post-assessment. That is, if a student's response was coded for a particular KE on *any* item on the post-test, that student was identified as having that KE available to transfer. We were then able to compare this baseline with students' answers to each of the questions on the initial and follow-up transfer assessments. We calculated each individual student's transfer by question as the number of KEs received for the particular transfer question divided by the number of total post-assessment KEs. The student's initial transfer score was then computed as the average of the nine ratios. The formula used to calculate transfer for each individual was

$$\text{Transfer score} = \frac{\text{Transfer (average of Knowledge Elements across questions)}}{\text{Post-test (all Knowledge Elements achieved)}}$$

Because the denominator was the same throughout, this overall transfer score also equaled the average number of KEs achieved throughout the transfer assessment divided by the number of post-assessment KEs. In this way, the computed transfer scores are the average number of KEs students applied to new scenarios in relation to what they displayed on the post-test.

Student Surveys

Early in the spring semester (February), Mr. Kent's students completed an online survey in class, designed to capture student recognition of their teacher's discursive moves related to expansive framing as well as students' own alignment with expansive framing across each of the five contextual aspects described earlier. In this paper, we focus primarily on responses to survey questions related to alignment because our framework suggests that alignment is the mechanism for transfer. The survey was comprised of 36 Likert-style questions and showed high internal consistency both within and across all five contextual aspects ($\alpha \geq 0.795$ in all cases). For each student, we created scores for each of the five aspects by averaging the responses to questions that addressed each aspect. These per-aspect framing scores were then compared with individual students' transfer scores through correlation analyses.

Student Interviews

Towards the end of the school year, we conducted individual interviews with 18 students to ask them to elaborate on their survey responses. These students were selected to constitute a representative sample of the class, based on their range of performance on our written assessments, survey responses, and demographics. Interviews were audio recorded and transcribed. We used discourse analysis to code interview transcripts for expressions of alignment with expansive framing and self-reports of transfer.

Findings

In this section we provide evidence of student transfer, and then explore possible relationships between transfer and student alignment with expansive framing as captured through surveys and interviews.

Evidence of Transfer in Mr. Kent's Class

Using the approach described above, we first compared student performance on the initial transfer assessment with their performance on the post-test. The average initial transfer score for the class was 0.43 (*SD*=0.25; *N*=28), indicating that on average students transferred 43% of the KEs that they had displayed on the post-test. This score demonstrates that transfer did, in fact, occur across the post-assessment and initial transfer test. We then used the same approach to compare results of the follow-up transfer question with the post-test. The average follow-up transfer score was 0.45 (*SD*=.43; *N*=16), or 45% of KEs displayed on the post-test. On the retention question students averaged 54% (SD=.43, N=16) of the knowledge elements they had displayed on the post-test.

Relationships between Transfer and Alignment with Expansive Framing

Student Surveys

Table 2 presents class-wide means and standard deviations for student alignment with expansive framing of each of the five contextual aspects in our framework. These data indicate that students perceived the expanded relevance of their learning across time, place, and topics to a degree between "sometimes" and "often." They

perceived expanded relevance across participants, and themselves as authors of biology knowledge to a degree slightly less frequent than "sometimes."

Table 2: Results from student survey measuring student alignment with expansive framing

	Time	Place	Participants	Role	Topics	Average
Alignment	3.72 (0.72)	3.51 (0.73)	2.87 (0.70)	2.92 (0.75)	3.45 (0.99)	3.29 (0.55)

After calculating framing scores for each student for each of the five contextual aspects, we ran correlations between these scores and student scores on our initial transfer assessment and our follow-up assessment. Correlation analyses revealed alignment with expansive framing of time, per our survey, as having the strongest relationship with the results of our transfer assessments. We found strong and statistically significant correlations between student alignment with the expansive framing of time and initial transfer scores ($r[26]=0.376$, $p<0.05$), follow-up transfer score ($r[14]=0.589$, $p<0.01$), and retention scores ($r[14]=0.444$, $p<0.05$). In other words, those students who indicated on our survey that they perceived higher degrees of temporal relevance of their biology class, both in terms of biology being related to what they already knew and in terms of the future applicability of biology content, were the same students who had higher scores on our assessments of transfer.

We found one additional statistically significant correlation in these data, between alignment with expansive framing of role (i.e., perceiving oneself as an author of biology knowledge) and the retention question on the follow-up assessment ($r[14]= 0.440$; $p<0.05$). That is, those students who indicated on our survey that they most perceived themselves as playing an active and accountable role in authoring biology knowledge were the same students who displayed the highest level of retaining what they had learned about osmosis and diffusion after nearly two years.

Student Interviews

In this section we present patterns from our interview data related to time, authorship, and transfer because of the importance and interrelatedness of these factors as suggested by our correlation analysis. Our goals in this section are to complement our survey data with concrete examples of students' expressions of alignment with expansive framing; and to complement our statistical analysis with descriptions of the patterns in our interview data. Here, we present our findings by three themes: 1) alignment with the expansive framing of time, 2) alignment with the expansive framing of role, and 3) self-reports of transfer.

With regard to perceiving the long-term temporal relevance of biology content, most students expressed some alignment with expansive framing, but there were some salient differences by level of performance on the transfer assessment. One difference was that students who displayed higher levels of transfer on the assessment spoke about the future relevance of biology in much more concrete terms than students who had lower transfer scores. For example, high transfer students were quite definitive about their anticipated future use of biology content in college, making comments such as, "for college, yeah, I'm gonna use this stuff" (Lindy). In contrast, while students with average to low transfer scores also spoke about the applicability of biology content to college, they tended to give hedged or conditional responses, such as: "Biology will probably be involved" (Deena); "I might use that later on in the future, maybe" (Bianca); and "If I go to college…it'll help me" (Pedro).

In addition to the specificity with which they anticipated the future relevance of biology, some high transfer students also expressed the perception of continuity of course content throughout the school year. This sentiment was best illustrated by Elaine: "The only time it's really brand new is in the beginning of the year. Like, we'll um, we always refer back to certain stuff. (…) We always just kinda add something new, but it builds on what we already know." Dorthee echoed this sentiment by referring to learning about cells as "just the beginning" of biology-related knowledge. We did not find similar comments in the interviews of students with lower transfer scores.

What we did find from some of the lowest transfer students, however, were examples of questioning and even rejecting the future relevance of biology. For example, Carolina expressed that she was unlikely to pursue a future for which biology would be relevant: "Like, be a scientist? Mmm, no I don't think so…I don't think it's for me." She later added "I think there are some thing [from class] we don't need to know later on in life. Like I don't think it'll be useful for some of us students that aren't gonna be needing that stuff later on."

In terms of perceiving themselves as taking on roles as authors of biology knowledge, most of the students we interviewed expressed a belief in the value of sharing ideas with their classmates, a practice that was very much emphasized by Mr. Kent. However, their explanations of the value of this practice varied. Mid to low transfer students saw sharing their ideas primarily as a way to "learn from mistakes" (e.g., Luis, Deena, Carolina), an idea also emphasized by Mr. Kent. In contrast, high transfer students depicted interacting with their classmates as an active process of collaborative knowledge construction. According to Dorthee, sharing ideas with her classmates meant "if they have a different view they tell me why and (…) You can combine your

ideas to make a better answer." Baara added, "We actually have to discuss [questions] amongst the whole class and we have to come up with an outcome on our own. (…) It's not like we're really dependent on our teacher all the time. We become more able to think for ourselves." It is worth noting the way in which these high transfer students' commonly used first person pronouns and possessives to position themselves as owning and taking responsibility for their ideas. Elaine used similar language when referring to "my understanding" of a biology-related phenomenon, as did Lindy in anticipating that she would "refer back to my notes" when taking future science classes.

The high transfer students also positioned themselves as capable of productively disseminating those ideas to others, both inside and out of class. Lindy anticipated "help[ing] my sister with biology," and Baara believed that by sharing what she knew in the classroom she could "help out the class." With the exception of Deena, who also claimed, "I could teach other people," the mid and low transfer students did not make similar comments about knowledge dissemination. One low transfer student, Carolina, actually rejected some aspects of authorship, stating, "I don't think that if you don't talk about ideas -- like if you don't say ideas you don't go anywhere. I'm pretty sure you'll go somewhere in life."

Self-reports of transfer were relatively scarce in the student interviews, but even so some differences were observed between higher and lower performing students on the transfer assessment. First, such reports were slightly more common from high transfer students than from others. Second, and perhaps more importantly, was a qualitative difference: high transfer students reported actually applying biology knowledge to novel situations, while mid and low transfer students reported retelling facts learned in class. Of the high transfer students, Lindy had by far the highest number of self-reports of transfer. As a softball player, she reported, "[Mr. Kent] says 'oh you need a lot of carbohydrates and nutrients and stuff, for, if you're athletic' and (…) I look online and try to find out what's the daily stuff if you do sports and stuff. And I just look on that and see how many servings I need and everything." Here we see Lindy's practical application of what she has learned about nutrition in her biology class to her needs as an athlete outside of class. This particular report also exemplifies transfer in the form of preparation for future learning (Bransford & Schwartz, 1999) as Lindy used what she had learned about nutrition to search online for specific answers to her needs.

The only low transfer student we interviewed who made self-reports of transfer was Pedro, who, like Lindy, reported some transfer to his experiences as an athlete. However, in contrast to Lindy's practical application, Pedro's reports were limited to retelling facts and terms. For example, with teammates who also studied biology, he reported answering their definitional questions such as "What are carbohydrates?" saying, "I'll just try to sound smart and like, tell them all of these terms I learned." Pedro's transfer is therefore limited to repeating facts that has learned, but does not necessarily display any sort of application of biology knowledge to solving novel problems.

In summary, our interview analysis revealed several characteristics that seem to generalize fairly well across those interviewees who displayed high levels of transfer on the assessment. These students not only perceived biology as generally relevant to the future, but actually imagined themselves in concrete future situations in which they anticipated using that content. They also perceived biology instruction as continuous across the school year, as earlier lessons connected to later ones. These students perceived themselves as active participants in the construction of biology-related knowledge. They took ownership of their ideas and productively shared them for the benefit of others. Finally, when they reported transferring biology knowledge to other aspects of their lives, they did so in ways that implied practical application to meet actual needs.

In contrast, lower transfer students either expressed the future relevance of biology content in much more conditional terms, or, in some cases, actually rejected that future relevance. They shared ideas with classmates in order to learn from mistakes, but did not position themselves as actively constructing and disseminating knowledge. Very few of them reported transferring their knowledge of biology, and those reports were limited to retelling facts more so than solving novel problems.

Discussion and Conclusion

Our analyses of students' surveys and interviews in relation to their performance on our measures of transfer provide converging evidence of a relationship between alignment with expansive framing and transfer. Our strongest finding is that those students who reported perceiving more temporal relevance between past experiences, current learning, and future opportunities for application were the same students who displayed the highest levels of transfer. This finding is consistent with prior empirical and theoretical work that posits perceived relationships being central to transfer (e.g., Day & Goldstone, 2012; James, 2008; Lobato, 2012; Pea, 1987). Additionally we found higher levels of transfer, although perhaps only in the form of retention, from students who indicated that they perceived themselves as taking on actives role in constructing and disseminating biology-related knowledge. This finding resonates with work that links transfer to students' perceptions of autonomy and authority with regard to learning and knowledge (e.g., Belenky & Nokes-Malach, 2012; Perkins & Salomon, 2012).

Our findings also indicate that Mr. Kent's attempts to expansively frame his instruction contributed to his students' beliefs and perceptions of expansive relevance. While we found no statistically significant correlations between students' recognition of Mr. Kent's expansive framing and their performance on our transfer assessment, we did find a strong correlation between their recognition and their alignment with expansive framing ($r[28]=0.558$, $p<0.01$). The relationship between their recognition and their reported perceptions of temporal relevance was even stronger ($r[29]=0.632$, $p<0.001$). In other words, those students who showed the highest degree of alignment with the expansive framing of time – a factor that we've shown to be related to transfer – were the same students who were most aware of Mr. Kent's discursive positioning of the expansive relevance of learning in his classroom. This finding is consistent with suggestions that while learner perceptions may be at the heart of transfer, instruction can play a role in shaping those perceptions (e.g., Belenky & Nokes-Malach, 2012; Lobato, Rhodehamel, & Hohensee, 2012). Future research could better investigate the relationship between instruction and learner alignment with expansive framing by including pre- and post-measures of alignment, and by comparing alignment of students in classrooms that are more and less expansively framed by their instructors. Additionally, video analysis of classroom behaviors could provide a more intimate understanding of the degrees to which students discursively took up Mr. Kent's proposed framing (Clark, 1996). If students were to discursively reciprocate their instructor's expansive proposals, it is conceivable that higher levels of perceived relevance might spread throughout the class, thus establishing a classroom culture of transfer (Pea, 1987). We plan to explore this premise through future analyses of our current data and in future studies.

Given that our framework includes five contextual aspects that can be expansively framed (time, place, participants, topics, roles), we must also consider possible explanations for the fact that in our data we only found relationships between transfer and alignment with two of these factors (time and role). Is an alignment with the expansive framing of time and role more important for transfer than an alignment the other aspects of contextual framing? What relationships exist among the different contextual aspects? In a concurrent research project, we aim to disentangle the effects of an expansive framing of role or settings (time, places, and participants), separately and in conjunction with one another, on transfer. The study involves one-on-one tutoring with students, where the tutor frames the role or settings in either an expansive or bounded manner. Knowledge assessments are used to measure learning and transfer, and online surveys record student recognition and alignment with expansive framing. The strong correlation between recognition of and alignment with expansive framing that we presented in this paper suggests that we may see changes in student alignment with expansive framing in each of these experimental conditions, and we plan to investigate the relationship between these levels of alignment and levels of transfer.

Finally, we must acknowledge that our measures of transfer for this study are limited in only considering performance on researcher-designed assessments as opposed to also considering additional forms of transfer that students may have been capable of (Lobato, 2012). We did draw on Lobato's notion of Actor-Oriented Transfer in analyzing interviews, but because those interviews were structured around our surveys, they did not provide students with many opportunities for self-reported transfer. Similarly, we have not yet conducted sufficient video analysis of student behaviors in class to systematically identify other possible manifestations of transfer. It is possible that including a greater variety of measures of transfer may illuminate additional relationships between transfer and alignment with expansive framing.

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