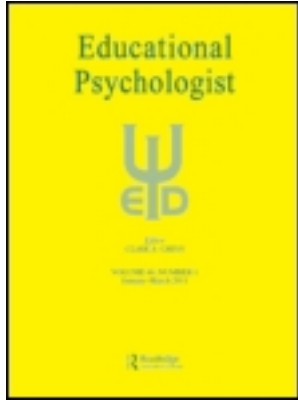


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# How Does Expansive Framing Promote Transfer? Several Proposed Explanations and a Research Agenda for Investigating Them

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When contexts are framed expansively, students are positioned as actively contributing to larger conversations that extend across time, places, and people. A set of recent studies provides empirical evidence that the expansive framing of contexts can foster transfer. In this article, we present five potentially complementary explanations for how expansive framing may promote transfer and outline a research agenda for further investigating them. Specifically, we propose that expansive framing may: (a) foster an expectation that students will continue to use what they learn later, which may affect the learning process in ways that can promote transfer; (b) create links between learning and transfer contexts so that prior learning is viewed as relevant during potential transfer contexts; (c) encourage learners to draw on their prior knowledge during learning, which may involve them transferring in additional examples and making generalizations; (d) make learners accountable for intelligently reporting on the specific content they have authored; and (e) promote authorship as a general practice in which students learn that their role is to generate their own solutions to new problems and adapt their existing knowledge in transfer contexts.

If students are to be successful and if schooling is to have a significant impact on their lives, it is essential that students regularly transfer what they learn (Renkl, Mandl, & Gruber, 1996; Schwartz, Bransford, & Sears, 2005). Transfer occurs when “learning to participate in an activity in one situation [i.e., *learning context*] . . . influence[s] (positively or negatively) one’s ability to participate in another activity in a different situation [i.e., *transfer context*]” (Greeno, Smith, & Moore, 1993, p. 100).

In this article, we examine the idea that transfer can be promoted by the instructional practice of framing learning contexts in an expansive manner, and develop several explanations for how it may do so. First, we quickly summarize the two basic ways that transfer is usually explained. We then explain what we mean by the framing of learning contexts as compared to these approaches and briefly review recent studies that provide evidence that framing indeed affects transfer. In the core of the article, we propose five potentially comple-

mentary explanations for *how* expansive framing may promote transfer, illustrating each with existing data. Finally, we close by proposing a research agenda for further investigating these explanations.

## TWO EXISTING TYPES OF EXPLANATIONS FOR TRANSFER

In this section, we first discuss two types of explanations for transfer that are common in existing research. This then allows us to describe how the framing of learning and transfer contexts relates to these types of explanations in the rest of this article.

### Explanations for Transfer That Focus on Content

Most research on explaining transfer focuses in some way on the substantive content that learners are to transfer (Mestre, 2003; Reeves & Weisberg, 1994; Schwartz & Nasir, 2003). For example, the classic paper by Gick and Holyoak (1983) provided evidence for their hypothesis that “the induction of a general schema from concrete analogs will facilitate

\*Note. Order of authorship is alphabetical as this was a true collaboration, with all four authors contributing equally.

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analogical transfer” (p. 1). Their general idea was that learners are more likely to apply what they have learned from one analogous problem to another if they form a content-based generalization (a.k.a. “schema”) at the appropriate level of abstraction such that it can be applied to a new problem. Gick and Holyoak (1980, 1983) illustrated this idea in a series of clever experiments in which learners were more or less likely to transfer a prior solution to analogous problems depending on the degree of support they were provided for inducing such generalizations. Subsequent research has provided additional evidence for the importance of forming such generalizations (e.g., see Chi & VanLehn, this issue/2012; Gentner, Loewenstein, & Thompson, 2003; Reeves & Weisberg, 1994; Rittle-Johnson & Star, 2007), with recent research showing how instructional interactions can lead learners to focus on making certain kinds of generalizations rather than others (Lobato, Ellis, & Muñoz, 1999).

Since then, most research on explaining transfer has focused, in one way or another, on the substantive content that we hope learners will be able to transfer. In addition to the importance of content-based generalizations, there is a consensus that the most fundamental prerequisite for transfer is that the particular content to be transferred has been learned in a sufficiently deep, strong, and lasting way (Bransford, Brown, & Cocking, 1999. see also Chi & VanLehn, this issue/2012). Second, comparing multiple examples and nonexamples of a potentially transferable idea has been found to be particularly important for inducing three transfer mechanisms: (a) constructing appropriate generalizations (e.g., Chang, 2006; Gick & Holyoak, 1983; Gentner et al., 2003; Goldstone, Landy, & Son, 2009; Goldstone & Wilensky, 2008; Ming, 2009; Richland, Stigler, & Holyoak, this issue/2012; Rittle-Johnson & Star, 2007), (b) forming useful mappings between the examples and generalizations (e.g., Goldstone & Wilensky, 2008; Reeves & Weisberg, 1994; Wagner, 2006), and (c) constructing mappings between examples as part of analogical reasoning (Holyoak, 2005; Reed, 2012). All of these mechanisms aid transfer and affect exactly what particular content is transferred. Finally, it has been shown that specific, content-based hints to use prior learning enhance transfer by specifying the particular pieces(s) of knowledge to be used and encouraging students to immediately apply it to solve a particular problem (Anolli, Antonietti, Crisafulli, & Cantoia, 2001; Campione & Brown, 1984; Catrambone & Holyoak, 1989; Gick & Holyoak, 1980, 1983; Reed, Ernst, & Banarji, 1974; Spencer & Weisberg, 1986). Although different in many other ways, all of these explanations for transfer—learning the content-to-be-transferred more effectively, comparing multiple examples, forming content-based generalizations, and responding to content-based hints—focus in one way or another on the substantive content to be learned and hopefully transferred.

In general, content-based explanations for transfer have the following basic form (see top of Figure 1). First there

is either an explicit or implicit effort to decontextualize<sup>1</sup> the social context (Step 1) by either removing it as a potential distraction (explicit) or simply by focusing exclusively on the content (implicit). Then, learning of the content to be transferred occurs (Step 2). As part of this, whatever content-based mechanisms for fostering transfer are also used (Step 3). Finally, this leads to successful transfer of that content (Step 4).

### Explanations for Transfer That Focus on Physical Aspects of Contexts

In contrast to content considerations, issues of context have been underemphasized in most transfer research. When context is addressed in research on transfer mechanisms, it is primarily treated as a physical reality. In this conceptualization, the *context* includes features that could be captured in a photograph including where a learning or transfer session is being conducted, when it occurs, and who and what is present (Barnett & Ceci, 2002; Catrambone & Holyoak, 1989; Reeves & Weisberg, 1994; Spencer & Weisberg, 1986; Thorndike, 1903/2009). The consensus of empirical research into the effect of physical contexts on transfer is that the likelihood of transfer increases the more that such physical features overlap between learning and transfer contexts (Barnett & Ceci, 2002; Catrambone & Holyoak, 1989; Reeves & Weisberg, 1994; Ross, 1984; Spencer & Weisberg, 1986). This finding has been explained in classical cognitive accounts by the idea that contextual features are stored in memory along with the content being learned so that similar contextual features in a transfer context end up priming or cueing recall of the associated content (Anderson & Bower, 1973; Godden & Baddeley, 1975, 1980; Reeves & Weisberg, 1994; Ross, 1984; Smith, Glenberg, & Bjork, 1978; Tulving & Thomson, 1973). In physical context-based accounts, there are four steps to successful transfer (middle of Figure 1):

1. Associating the physical context at learning with the content to be learned;
2. Learning that content;
3. Noticing physical similarities between the learning and transfer contexts; and
4. Successfully transferring the content because of the content being cued or primed by the physical features of the transfer content.

<sup>1</sup>We want to make it clear that when we say “social context” we are not referring to “problem contexts,” the cover stories in which mathematical and other school-like problems are sometimes expressed (e.g., Goldstone & Wilensky, 2008; Wagner, 2006). Instead, social context is the socially established who, when, where, how, and why of a learning or transfer situation. Given that, in this article, “decontextualization” means somehow removing this surrounding social context so that only the “content” to be learned and (we hope) transferred remains. Part of what would remain after this kind of decontextualization would be any associated problem contexts.

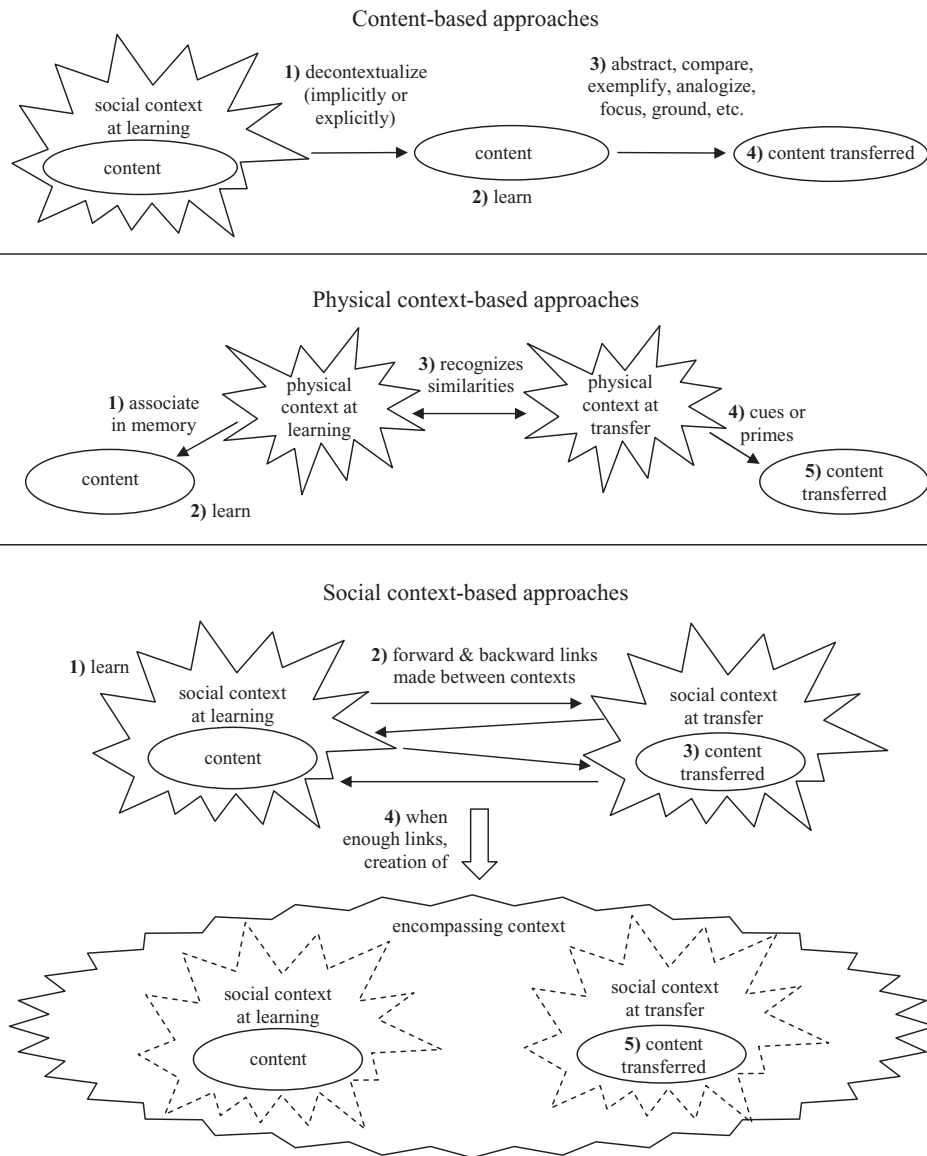


FIGURE 1 Diagrammatic comparisons of three approaches to explaining and fostering transfer.

### FRAMING SOCIAL CONTEXTS AS AN INSTRUCTIONAL PRACTICE THAT AFFECTS TRANSFER

In our research on framing contexts and transfer, we instead conceptualize contexts as social realities (Searle, 1995). Our claim is that learning and transfer contexts can be socially *framed* in different ways and that this will then influence students' propensity to transfer what they learn (Engle, 2006b; Engle, Nguyen, & Mendelson, 2011). Framing is the meta-communicative act of characterizing what is happening in a given context and how different people are participating in it (Bateson, 1972; Goffman, 1974; Goodwin & Duranti, 1992; Kelly & Chen, 1999; Tannen, 1993). For ex-

ample, a teacher can frame a lesson as a one-time event of learning something that students are unlikely to ever use again, or as an initial discussion of an issue that students will be actively engaging with throughout their lives. Our contention is that the first kind of framing, which we refer to as *bounded*, will tend to discourage students from later using what they learn, while the second, which we refer to as *expansive*, will tend to encourage it. Thus, in our view, which builds upon earlier situative and socio-cultural theorizing on transfer (Greeno et al., 1993; Laboratory for Comparative Human Cognition [LCHC], 1983; Lave, 1988; Pea, 1987), it is not just the physical aspects of a context that matter for transfer (Barnett & Ceci, 2002; Catrambone & Holyoak, 1989; Reeves & Weisberg,

1994; Spencer & Weisberg, 1986), but also how social interactions frame learning and transfer contexts as particular kinds of social realities (Gee & Green, 1998; Searle, 1995).

From this perspective, the reason that contexts matter for transfer is that content knowledge is inextricably tied with its contexts of use (Greeno et al., 1993; LCHC, 1983; Lave, 1988; Pea, 1987) as shown in the bottom of Figure 1. Accordingly, how a context is framed ends up having profound effects on whether and how its associated content knowledge is used elsewhere. Specifically, transfer is encouraged to the extent that a learning context and therefore the content learned within it (Step 1) can be recognized as providing resources for productive action in potential future transfer contexts (Engle, 2006b; cf. Hammer, Elby, Scherr, & Redish, 2005). Complementarily, transfer is also encouraged to the extent that transfer contexts are framed as being connected back to past learning contexts (Pea, 1987). Both kinds of framing links—forward in time from learning contexts to potential transfer contexts or backward in time from transfer contexts to prior learning contexts (Step 2)—create what is referred to as intercontextuality between learning and transfer contexts (Beach & Phinney, 1998; Bloome, Power Carter, Morton Christian, Otto, & Shuart-Faris, 2005; Floriani, 1994; Gee & Green, 1998; Leander, 2001; Putney, Green, Dixon, Duran, & Yeager, 2000). This intercontextuality then fosters transfer between the linked learning and transfer contexts (Step 3). When enough links between learning and transfer contexts are made, the degree of intercontextuality can get so strong that a larger encompassing context is formed that seamlessly incorporates learning and transfer contexts (see Step 4 in bottom of Figure 1; Greeno et al., 1993). As a result, further transfer is promoted (Step 5). In contrast to transfer after specific links are made between learning and transfer contexts (Step 3), this time learners are not aware that they are transferring anything as to them they are simply continuing to use the same relevant knowledge within the same (larger) context (Greeno et al., 1993; Lave, 1988; LCHC, 1983).

We believe that there are several different aspects of learning contexts that can be framed to affect transfer. This article focuses on framing that is expansive versus bounded with respect to settings and roles. Because settings comprise times, places, and participants, an expansive framing of a learning setting may extend it to include the past and the future, different places, and additional people. Conversely, an extremely bounded framing of a learning setting may constrain it solely to a short span of the present time, a small part of the available physical space, and just one or two of the people that are physically present.

Framing may also be negotiated around the roles of learners. In an expansive framing of roles, learners are positioned as active participants in a learning context where they serve as authors of their own ideas and respondents to the ideas of others. Within this sort of learning environment, students' authored ideas are recognized and integrated into class discussions and other activities (e.g., Mercer, 1995). In contrast,

in a bounded framing of roles, learners may be positioned on the periphery of a learning context, where, rather than sharing their own ideas, they are expected to report on their learning about the ideas of others, such as those presented by a text or a teacher. As active participants in a learning context, expansively framing learners "crucially make[s] use of the fact that the one form of intercontextuality that always exists between learning and transfer contexts is the presence of the same learner" (Engle, 2006b, p. 457).

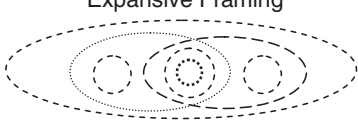

We further specify these contrasting ways of framing in Table 1, which shows how we successfully operationalized these two distinct ways of framing in a one-on-one tutoring experiment (Engle et al., 2011). More bounded or more expansive frames were proposed by a tutor for each participating student, with the framing negotiated between the tutor and student until the student typically acceded to the tutor's proposed framing. In the expansively framed tutoring sessions, students were positioned as integral parts of a university-based learning environment involving a larger research team and were credited for having their own ideas about the topics being discussed in text and diagrams. In contrast, in the tutoring sessions with the bounded framing, tutors narrowly circumscribed the time, place, and participant aspects of settings to here and now and positioned the role of the learners as disconnected reporters of the text and diagrams' ideas. Further, these sessions were also framed as a private matter between each tutor and the student and were restricted to each particular learning session and part of the room. Responses from student surveys and interviews revealed how students perceived and responded to the framing. These data showed that the framing manipulations, based on the contrasts shown in Table 1, were successful.

#### EVIDENCE THAT FRAMING CONTEXTS AFFECTS TRANSFER

A growing series of studies have empirically investigated connections between the framing of contexts and transfer. Two recent experiments systematically tested one or more aspects of this general hypothesis and four classroom research studies provide complementary evidence that transfer may be affected by framing.

The first known experiment related to framing and transfer was conducted by Hart and Albarracín (2009, Experiment 2). They showed that people are more likely to repeat an action they have just engaged in—the most basic form of transfer that there is (cf. Salomon & Perkins 1989)—if they are prompted to describe it using a progressive verb aspect that frames it as a continuing activity ("I was doing . . .") versus a perfective aspect that frames it as a completed action ("I did . . ."). Engle et al. (2011) then created the tutoring experiment, framing manipulation of which was illustrated in Table 1. They showed that students being tutored with an expansive, versus a bounded, framing were about twice as likely

TABLE 1  
Operationalization of Expansive Versus Bounded Framing in the Tutoring Experiment

Aspects of Contexts That Can Be Framed	 Expansive Framing (Shown to Promote Transfer)	 Bounded Framing (Shown to Discourage Transfer)
Setting:	Ask student to specify other settings in which the topic(s) have, are, or will be likely to come up in their lives	Do not ask student to specify other settings in which the topic has, is, or will be likely to come up in their lives
• Time	<ul style="list-style-type: none"> <li>Refer to the study as a whole as including both days</li> <li>Refer to other times, both inside and outside of the experiment</li> <li>Use present progressive verbs (“you’re figuring out”)</li> </ul>	<ul style="list-style-type: none"> <li>Refer to each part of each day’s session as a separate event</li> <li>Make no references to times other than the just completed present</li> <li>Use simple past with completion verbs (“we’re finished with that now”)</li> </ul>
• Place	<ul style="list-style-type: none"> <li>Frame location as at a university</li> <li>Refer to other places—their home, school, doctor’s office, etc.—in which they can use what they’re learning</li> </ul>	<ul style="list-style-type: none"> <li>Frame location as this specific room</li> <li>Do not make references to other places outside of the room</li> </ul>
• Participants	<ul style="list-style-type: none"> <li>Treat larger activity as involving the student, you and the rest of the study team, plus their family, friends, teachers, and anyone else they mention above</li> <li>Ask student how they would explain their ideas to the other people they mentioned as part of the settings</li> <li>When students show understanding of one of the key ideas, note that they can now explain that to whoever they mentioned as an audience</li> </ul>	<ul style="list-style-type: none"> <li>Treat tutoring event as a private matter involving only you and the student, and not other members of study team or other people they know</li> <li>Have student explain the text’s ideas to you just as often and as extensively as in the expansive condition</li> <li>When students show understanding of one of the key ideas, note that they have properly represented what the text said</li> </ul>
Roles	<ul style="list-style-type: none"> <li>Ask student to explain their own evolving ideas about the system using the text sentences as a resource.</li> <li>Revoice student’s explanations, crediting student with authorship and checking with them about whether you reformulated their ideas accurately.</li> </ul>	<ul style="list-style-type: none"> <li>Ask student to explain what the text has said about the system in each sentence.</li> <li>Reformulate what student said as what the text has presented, not giving them an opportunity to correct as the reformulation should be accurate.</li> </ul>

Note. Adapted under Creative Commons License from “The Influence of Framing on Transfer: Initial Evidence From a Tutoring Experiment,” by R. A. Engle, P. D. Nguyen, & A. Mendelson, 2011, *Instructional Science*, 39, p. 612. Copyright 2011 by R. A. Engle, P. D. Nguyen, & A. Mendelson.

to appropriately transfer facts, a conceptual principle, and a learning strategy from one human body system to another.

In the first classroom study related to framing and its effects on transfer, Hammer et al. (2005) found that when two transfer contexts were reframed as having to do with active student sense making rather than simply the replication of knowledge, students were more likely to “transfer-in” (Schwartz et al., 2005) their prior knowledge in ways that helped them understand new physics concepts. Engle (2006a, 2006b) then presented a case of successful classroom transfer that could not be explained by considering only content-based supports for transfer. She showed how this case of transfer could be explained by also considering the teacher’s framing of the learning context. This teacher expansively framed her interactions with her fifth-grade students studying endangered species by (a) temporally connecting to prior and future interactions in which students could use what they were learning, and (b) positioning students as contributing to a larger community of people interested in what they were learning about. A more recent classroom case study illustrated how a high school biology teacher expansively framed his classroom by (a) making links to settings outside of school; (b) extending temporal horizons to the past, where content was

learned, and to the future, where it remains relevant; (c) connecting curriculum units across time; (d) training students to make connections across topics (cf. Richland et al., 2012/this issue); and (e) positioning students as part of a larger learning community (Engle, Meyer, Clark, White, & Mendelson, 2010; Meyer, Mendelson, Engle, & Clark, 2011). These students scored well on researcher-designed transfer tests as well as on end-of-year standardized tests. Finally, showing that framing matters for subjects other than science, Mendelson (2010) found that student transfer of linguistic forms from online to in-person, second-language learning contexts was supported by an instructor’s expansive framing, where text-based forum activities were framed as being connected to later in-class, face-to-face discussions.

#### HYPOTHESIZED EXPLANATIONS FOR HOW FRAMING CONTEXTS MAY AFFECT TRANSFER

Although prior research has shown that framing contexts differently can affect transfer, it has not explained exactly *how* this process occurs. In this section, we propose five potential

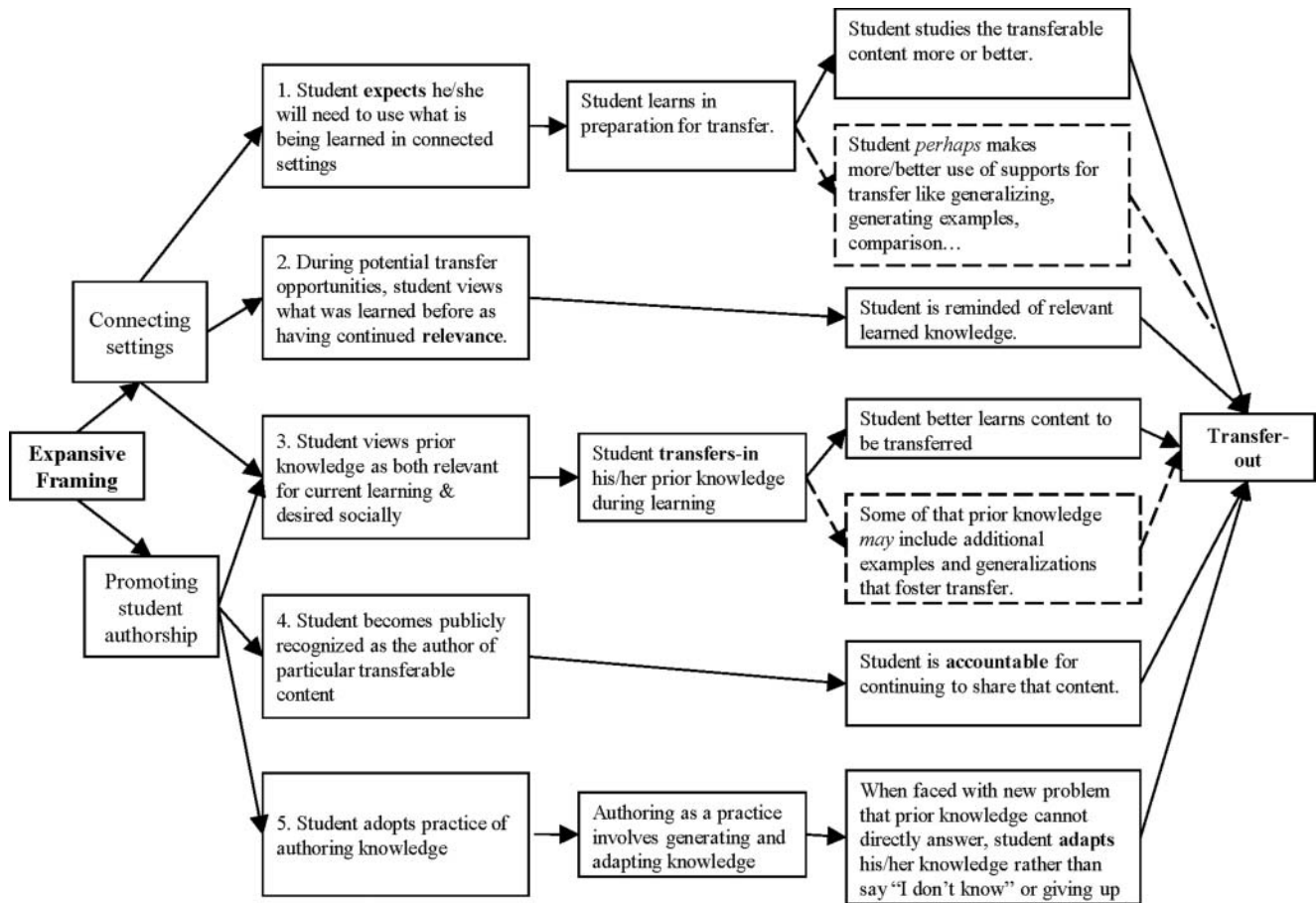


FIGURE 2 Five potential explanations for how expansive framing may foster transfer. *Note.* Dashed arrows and boxes indicate processes that may or may not occur depending on what content-based supports for transfer are available.

explanations for how expansive framing may promote transfer (see Figure 2). Each explanation describes a different series of processes through which expansive framing may lead to transfer. In some cases, these effects are partly mediated by other already documented transfer mechanisms.

It is important to note that these explanations are not mutually exclusive and may even be complementary. Thus, an account of how transfer was promoted by expansive framing for any particular student may involve all five, just one, or any other combination of these explanations.

We first preview each explanation by describing it with reference to relevant literature. We then characterize each set of explanatory processes in more detail by drawing on our existing data from two prior studies of expansively framed classrooms (Engle, 2006b; Engle et al., 2010; Meyer et al., 2011) as well as the tutoring experiment (Engle et al., 2011).

### Overview of Each Explanation

Each proposed process for explaining how expansive framing promotes transfer is prompted by one or two aspects of a full expansive framing. Given that, we first introduce two

explanatory processes that begin by *connecting settings* with each other. We then discuss one explanation that is initiated by both *connecting settings* and *promoting student authorship*. Finally, we consider two explanations that are started simply by *promoting student authorship*.

First, we propose that expansive framing can create *connections between settings* for learners, in which knowledge that is relevant in one setting is recognized as also relevant in other settings, a key aspect of intercontextuality. *Connecting settings* with each other encourages transfer: (a) during learning, when students *expect* they will later need to transfer what they are learning and may be more likely to *prepare* for this possibility, and (b) during potential transfer contexts, when students view prior content as *continuing to be relevant* (Leander, 2001; Pea, 1987; Ross, 1984). These first two explanations and their processes are laid out in the top two trajectories shown in Figure 2.

With respect to the first explanation, existing literature about transfer has already recognized that transfer can be promoted by creating an *expectation* for transfer in which students see that what they are learning will maintain relevance over time (e.g., Bereiter, 1995; Brown, 1989). This

notion is closely related to the concept of *utility value*, or the degree to which a task is perceived as being relevant beyond the immediate situation (Hulleman, Durik, Schweigert, & Harackiewicz, 2008). It is also related to the finding of Pugh, Linnenbrink-Garcia, Koskey, Stewart, and Manzey (2010) that transfer can be promoted in part by framing curricular content as having the potential for transforming students' everyday experiences. This article adds to these prior literatures by explaining how framing settings as connected may foster such an expectation for transfer and showing how it initiates a series of processes that eventually lead to greater transfer.

Fostering an expectation for future transfer by having teachers connect learning settings with future settings in which transfer is desired may lead students to study what they are learning about in potentially more effective ways that support transfer. At the most basic level, students who *expect* they will need to continue using what they have learned may *prepare* for such future use. They are likely to study that material more often and more intensively, which may result in more enduring memory representations that students can draw upon during later transfer tasks. This general idea is consistent with findings from motivational research that shows that students who perceive classroom tasks as having a higher utility value both report that they expend more effort in their science classes (Cole, Bergin, & Whittaker, 2008; Mac Iver, Stipek, & Daniels, 1991) and perform better in them (Bong, 2001; Hulleman et al., 2008; Malka & Covington, 2005; Simons, Dewitte, & Lens, 2003).

Such expectations for transfer *may* have an even greater impact on transfer to the extent that individual students are aware of and able to use content-based strategies for enhancing transfer like generating examples, comparing them, constructing generalizations, and becoming sensitive to the applicability conditions of examples and generalizations (e.g., Gick & Holyoak, 1983; Gentner et al., 2003; Renkl et al., 1996; Wagner, 2006).<sup>2</sup> For example, research has already shown that when students have the expectation that what they are learning will continue being relevant, they put more effort into becoming sensitive to the specific features of examples that make them suitable for applying relevant generalizations (Gilbert et al., 2011; Keiler, 2007). In effect, the expansive framing of settings may make students more likely to use content-based supports for transfer as part of preparing for expected future transfer events (Engle, 2006b).

Turning to Explanation 2 (again see Figure 2), an expansively framed learning environment may also increase the likelihood that, in a potential transfer context, students view what they learned before as having *continued relevance* (Clark, 1996; Leander, 2001). Consequently, students are more likely to be reminded of relevant learned knowledge from the prior learning context (Ross, 1984) and be inclined to use it, especially if the learning context has been posi-

tioned as continuing to have socially desirable knowledge resources (Pea, 1987). As Pea (1987) explained, transfer is promoted when a student is socially influenced to construct "a 'reading' of a problem situation as one for which transfer of previous knowledge is possible, or important, or worth the effort" (p. 655). Thus, by creating links back to prior learning contexts, the expansive framing of past settings may encourage students to make use of transfer opportunities by using their relevant learned knowledge.

The third explanation relies on both framing a learning setting as being connected to prior ones and on framing roles by positioning students as authors of their own ideas (see middle of Figure 2). Both types of framing are likely to lead students to view their own prior knowledge as relevant to current learning, encouraging them to "*transfer-in*" (Schwartz et al., 2005) *more of their prior knowledge during learning* as they construct new understandings. Drawing on prior knowledge in this way generally enhances the quality of initial learning, which is necessary for later transfer-out to new contexts (e.g., Bransford et al., 1999). In drawing more extensively on their prior knowledge, students may also potentially transfer-in additional examples and generalizations related to what they are learning about, which prior research has shown specifically enhances transfer (e.g., Gick & Holyoak, 1980, 1983; Reeves & Weisberg, 1994; Salomon & Perkins, 1989). These examples and generalizations then can provide additional resources that could allow the student to make comparisons between examples (e.g., Chang, 2006; Gentner et al., 2003; Rittle-Johnson & Star, 2007) or consider when examples are most applicable (e.g., Renkl et al., 1996), which are additional content-based ways in which transfer can be promoted.

Our fourth explanation (Figure 2) hypothesizes that by itself authorship may foster *student accountability to particular content*, which then makes students more likely to use this content in transfer contexts. Just like authors of academic papers, individual students become identified with, and then are held accountable for, commenting intelligently on the specific content they have authored (Engle, 2006b; Greeno, 2006; Jacoby & Gonzales, 1991). This accountability then increases opportunities and other people's expectations for them to continue sharing what they know about that topic and related topics in additional settings (Bereiter, 1995; Engle, 2006b; Greeno, 2006). In fact, students may purposely engage more frequently with contexts in which they can use the knowledge they have become identified with, sometimes even helping to construct new settings in which they can use their knowledge (Bereiter, 1995). Thus the identification of particular students with particular topics provides social opportunities and expectations that students will transfer what they know about those topics in situations that ask them to draw on their expertise (Brown et al., 1993).<sup>3</sup>

<sup>2</sup>Because processes may or may not occur in particular cases, a dashed line surrounds the box that encloses them.

<sup>3</sup>We note that this explanation differs from Explanation 1, an expectation for transfer, as the expectation for transfer is more of an individual internal



Finally our fifth explanation (Figure 2 again) proposes that if authorship becomes a general practice that students regularly participate in, it may promote the practices of *generating new knowledge and engaging in adaptive problem solving* (Hatano & Inagaki, 1986; Hatano & Oura, 2003; Schwartz et al., 2005; Schwartz, Chase, & Bransford, 2012/*this issue*). Students may then be more likely to transfer their knowledge when confronted with a completely novel problem situation, because part of the role of being someone who regularly authors knowledge is to generate reasonable responses; in effect, this role encourages such students to *adapt their prior knowledge* to address that new problem (Boaler, 2002; Greeno, 2006). This response contrasts with students who respond to a transfer problem for which they do not have an obvious solution by either saying “I don’t know” or complaining about the unfairness of a question whose answer or exact solution methods have not been taught to them (Boaler, 2002).

Although, as we discuss later, there are undoubtedly complex relationships between these five potential explanations for how expansive framing promotes transfer, the primary goal of this article is to distinguish between the explanations. This differentiation will provide a foundation for being able to systematically investigate the explanations in future research. To advance that agenda, we now characterize the five explanations in more detail using examples from our existing data.

### Explanation 1: Connecting Settings Promotes an Expectation for Future Transfer

The framing of learning contexts in an expansive manner makes it more likely that students will develop an expectation that they will need to transfer what they are currently learning into the future, which then encourages them to prepare for that future use. Our ongoing research in an expansively framed high school biology classroom<sup>4</sup> provides an example of this expectation. At the same time, this teacher undoubtedly employed a range of additional pedagogical strategies for fostering transfer that were probably working concurrently with expansive framing. He set up the expectation that students would need to transfer what they were learning during Biology class to their future Chemistry class. Mr. Kent referred to a future setting when the students would be in Mr. Brown’s Chemistry class, and said,

Most of you . . . will next year have Mr. Brown. This is Mr. Brown. He’s our Chemistry teacher for Health and Medicine. So you guys will have him for chemistry next year. . . . The

one and this involves social expectations. Also an individual expectation for transfer arises from settings being framed as connected and this social expectation for transfer arises from students being framed as authors of particular content that they have learned.

<sup>4</sup>This is the same teacher who was analyzed in Engle et al. (2010), but the teacher’s practices have become more expansively framed in several ways from collaborating with the researchers and learning about their findings.

reason that I’m so [strict] about things like lab safety, no open-toed shoes, data charts, accurate measurements, is because . . . this guy expects you to walk into his class on the very first day of school being able to do this. He cannot afford, in Chemistry, to spend time teaching you this. So if I’m just a nice guy and let you go . . . you’re gonna get to his class and start off [week] 1, week 2 with a D because you can’t do this, and then he’s gonna be upset because he wants you to do well. I’m gonna be upset because he’s gonna come back and say “Didn’t you teach them anything?” . . . This is why we’re so adamant about you guys doing it right.

In this example, by connecting laboratory settings across the two classes, Mr. Kent made it more likely that his students would develop an expectation that they will need to transfer what they would learn about conducting labs in Biology class to their future Chemistry class. Our contention is that this expectation may easily have motivated his students to learn lab safety more effectively in order to prepare for that future transfer.

We then found evidence that Mr. Kent’s students tended to notice this kind of expansive framing of time and also developed an expectation that what they were learning now would be needed in the future. Student surveys were used to detect the extent to which students perceived this aspect of the teacher’s expansive framing of time, and to what extent they reported that they believed that what they were learning would be useful in the future. Students were first asked, “During a typical biology class, how often does your *teacher* tell you that what you are learning might be useful . . .” at various times in the future. Student survey data indicated that students generally recognized that Mr. Kent *often* told them that what they were learning would be useful the next day, in the next few weeks, in the next year, and beyond (see leftmost bars in Figure 3).

Students were then asked, “During a typical biology class, how often do *you* think what you are learning might be useful . . .” at various times in the future. Student responses to this survey question indicated that students had also developed expectations that what they were learning would *often* be useful at various timepoints in the future (see rightmost bars in Figure 3). Our claim from this survey data is that Mr. Kent’s expansive framing may have caused many of his students to develop an *expectation for future transfer* that was equivalent with, or perhaps even stronger than, the degree to which they noticed the teacher emphasizing future usefulness. Further investigation is needed to determine how, if at all, students changed their studying and other learning habits to prepare for that transfer.

Although data from a comparison classroom that employs a bounded framing are not yet available, these data provide initial evidence consistent with the first explanation that the expansive framing of settings can lead students to develop expectations for future transfer. We further offer that this expectation may increase the likelihood that students will

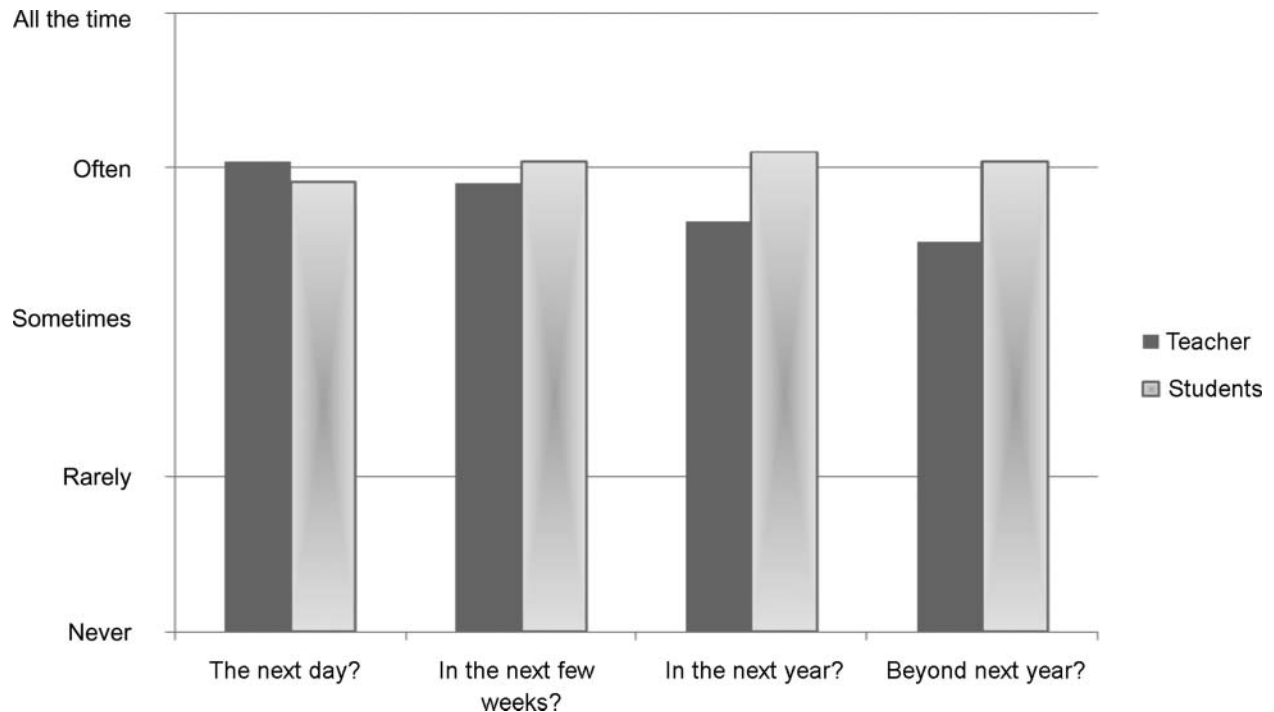


FIGURE 3 Average student perceptions of frequency of teacher telling students what they are learning will be useful in the future, and student reports about how often they think what they are learning will be useful in the future.

study content more often or more deeply. This may potentially also involve students taking better advantage of any content-based supports for transfer that are available in their learning environment.

#### Explanation 2: Connecting Settings Means Prior Content Continues Being Relevant in Potential Transfer Contexts

Findings from the same classroom just described (Engle et al., 2010) also support the viability of the hypothesis that connecting settings fosters transfer by making it more likely that students will view their prior knowledge as being relevant, thus increasing the likelihood that they will be reminded of it during transfer opportunities. One example of connecting to prior settings during potential transfer opportunities was seen when Mr. Kent emphasized the importance of students making connections in their current laboratory work to prior class discussions and homework (Meyer et al., 2011, p. 13):

You have to connect what's going on in lab to what's going on in class. . . . When I'm in lab, I am always thinking, "What is this lab teaching me about what we're discussing?" . . . So when you're in lab today—what is it that we're doing in lab, that connects to what our homework was about this past weekend?

It is important to note that expansive framing across time, places, and activities differs from ideas about both practicing

transfer and providing content-based hints. In this example, Mr. Kent broadly spoke about the idea of students making connections between the lab setting and other course-related settings like class discussions and doing homework. Although there is a family resemblance, this is very different from providing hints to students about specific content connections they should make as it is less specific and less focused on particular content. Instead, this teacher expanded the relevance of what his students were learning across different settings, a practice that was common in his classroom instruction. However, in asking students to specifically think about how what they were doing in lab connected to their prior homework assignment, Mr. Kent also employed the more basic transfer mechanism of asking students to practice transfer. Although practicing transfer is not part of expansive framing per se, Mr. Kent's request served to make it clear that he expected them to try to transfer what they had learned from any settings he had connected to the current one.

During that same lab, we observed students responding to Mr. Kent's instruction by trying to transfer in knowledge from their prior classwork, as in the following excerpt:

Student 1: How do you think this connects to the homework?

Student 2: That is how, like, light reaction happens.

Student 1: Dark and light?

Student 2: Yeah.

Thus, Mr. Kent's connection of the current lab setting to prior activities potentially prompted students to transfer what they

had learned during those earlier activities. As the course proceeded, students continued to make connections without Mr. Kent's prompting. This process occurred because students may have begun to see lab and classroom settings as being interconnected perhaps as a result of Mr. Kent's expansive framing of these particular settings.

These initial analyses of Mr. Kent's instruction are also consistent with our second explanation that expansive framing causes students to view learned knowledge as having ongoing relevance across settings. We hypothesize that with this view, students are more likely to be reminded of relevant learned knowledge in potential transfer contexts, which will, in turn, increase their propensity to transfer this learned content.

### Explanation 3: Authorship and Connecting to Prior Settings During Learning Leads to Transfer-in of Prior Knowledge in Ways That Support Later Transfer-out

The third explanation hypothesizes that in an expansive environment, one in which students are positioned as authors whose knowledge from prior settings is considered welcome, students are more likely to transfer-in knowledge during learning in ways that can enhance later transfer-out. In our tutoring experiment (Engle et al., 2011), we found students transferring-in prior knowledge in ways that would be expected to enhance transfer-out. These students, who were all in the expansive framing condition in which both authorship and connecting to past settings was supported (see Figure 2), sometimes brought in their own outside examples to form generalizations about the topics they were learning. Data showed that these students were also more likely to transfer certain facts, principles, and a learning strategy to a new context.

For example, one student in the expansively framed condition transferred-in his own example of the structure of a school to generalize his understanding of the structure of the heart:

How is the heart structured? The name atrium . . . it reminds me of all schools . . . like my school has a big atrium . . . kinda big. [*motions "big" with his hands*] and [*it's*] someplace you go and it separates out to all the classes. So I guess you can

kinda picture that. [*Tutor nods*] You can store all the stuff in the atrium before it goes out to the right place.

By being positioned as an author whose past knowledge was relevant, this student was in effect encouraged to transfer-in whatever he already knew that could be relevant for his learning. In comparing the heart's structure with his school's architecture, he was able to make the generalization that both kinds of atriums store things (students or blood) before distributing them to the next place. With this generalization supporting his learning, this student then successfully transferred what he had learned about the circulatory system to later transfer assessments about the respiratory system.

Given that the sample size for the tutoring study was not particularly large, it was reassuring to find evidence of a similar dynamic occurring in Mr. Kent's biology class (Meyer et al., 2011). Like tutors in the expansive framing condition, Mr. Kent also positioned students as authors of their own learning and made connections with prior settings. Furthermore, survey data show that students in this class tended to transfer-in their prior knowledge. Specifically, students reported that during a typical biology class they *often* transferred-in ideas they already knew from the previous few days and weeks and *sometimes* transferred-in ideas they already knew from within the past year or longer than a year before (see Table 2). Although comparisons to bounded classrooms would be informative, these results are consistent with the idea that in an expansively framed classroom, students may be likely to transfer-in ideas from prior learning, which would then improve the quality of their learning in ways that would promote transfer-out later.

Thus, preliminary results from our tutoring experiment and our analyses of Mr. Kent's teaching are both consistent with our third explanation that, by positioning students as authors of their own learning and making connections with prior settings, expansive framing encourages students to bring in prior knowledge, including outside examples and abstract generalizations, which previous research has shown increases students' propensity to transfer.

### Explanation 4: Authorship Promotes Accountability to Particular Content

Positioning students as authors through the use of expansive framing may also promote accountability in ways that lead to

TABLE 2  
Student Reports About How Often They Transfer-In Their Prior Knowledge

How Often During a Typical Biology Class Do YOU Think About or Use Ideas That You Already Knew From . . .	Never	Rarely	Sometimes	Often	All the Time
Within the previous few days?	0.0%	0.0%	27.3%	33.3%	39.4%
Within the previous few weeks?	0.0%	3.0%	39.4%	33.3%	24.2%
Within the last year?	0.0%	28.1%	43.8%	9.4%	18.8%
Longer than a year before?	16.1%	29.0%	35.5%	16.1%	3.2%

transfer. If a student shares particular content knowledge, that student can be framed as the author of that content and be publicly recognized as such. The student then becomes expected to be able to use that content during transfer opportunities.

For example, Engle (2006b; Engle & Conant, 2002) described a classroom where student groups were each assigned research projects about a particular endangered animal population. Within these groups, individual students were assigned particular topics about the populations for which they were to author oral explanations and written reports. The positioning of students as authors included language that attributed explanations about content to specific students or groups of students, rather than to the teacher or textbook (e.g., Teacher: You've [the student or student group has] just explained something to me [adapted from Engle, 2006b, p. 486]). Over time, these students became positioned as local experts about the content they had authored (Brown et al., 1993; Engle & Conant, 2002). Whenever anyone visited the classroom, each student-expert was expected to teach the visitor about their topic (Engle & Conant, 2002), which provided opportunities for students to transfer what they had learned. In later individual transfer assessments, Engle (2006a) found that students regularly referenced their own research as with one whale group student who explained why birthrate matters for species survival and endangerment by saying, "Like, that's like the whales. They only have like one calf every four out of five years. And by people hunting them, they can die off quickly" (p. 18). Thus, through authorship, students in this class were held accountable to the explanations they had previously authored and were able to transfer these explanations to new contexts.

This example illustrates the proposal that students who are positioned as authors of particular content during learning are then held accountable for that content by others. As a result, this accountability increases the likelihood that students will transfer the particular content they authored in future contexts.

#### Explanation 5: Authorship as a Practice Promotes Generation and Adaptation of Knowledge in Transfer Contexts

Finally, expansive framing may allow students to author content regularly such that they eventually assume authorship as a standard practice. This authorship role means that when students are faced with potentially new transfer problems they are ready to generate a response by adapting their existing knowledge. As compared to Explanation 4, we do not intend to suggest that students are being prepared to transfer specific content in specific transfer-related tasks. Rather, we are proposing that through regularly practicing authorship as a result of expansive framing, students begin to see themselves as being capable of addressing unfamiliar situations using what they already know, just as authors do. In Mr. Kent's classroom, authorship of ideas became a regular practice. In

the following example, we see a pair of his students adapting their prior knowledge and generating new knowledge while responding to a transfer problem in which they were asked to make connections between materials from three different units:

- 1 Edward: Meiosis is sex cells.
- 2 Adrienne: Meiosis is made [*inaudible*] protein synthesis?
- 3 Edward: Protein synthesis is how when DNA makes RNA?  
And RNA goes to the ribosomes,
- 4 Adrienne: Okay.
- 5 Edward: And makes [*inaudible*].
- 6 Adrienne: That kinda links because- To make the- to make the zygote or whatever, DNA is (..) chromosomes from the parents, right?
- 7 Edward: (..) Wait, what? [*laughs*]
- 8 Adrienne: Hmm chromosomes from the parent, so it like produces protein. (...) It makes it, that makes the kid?
- 9 Edward: So you're saying protein synthesis makes a kid?
- 10 Adrienne: Yeah.
- 11 Edward: Makes the body?
- 12 Adrienne: Yeah, doesn't it?
- 13 Edward: So- so protein- how does protein synthesis links to genetic heredity?
- 14 Adrienne: Because DNA,
- 15 Edward: Well yeah.
- 16 Adrienne: that's what DNA is like, right? DNA is (..) the kid, you get the baby . . .
- 17 Edward: So (..) meiosis links to genetic heredity because of um the sex cells?
- 18 Adrienne: Yeah.
- 19 Edward: And then protein synthesis is for building the body?
- 20 Adrienne: Mhmm. [*in agreement*]

In this example, we see this pair of students combine their knowledge and adapt their understandings of concepts that they learned from previous units to related concepts in the current unit. Edward brought in his knowledge about the Central Dogma of molecular biology from what he learned in the Protein Synthesis Unit by describing the process of DNA leading to protein synthesis (Turn 3). Adrienne then "linked" this idea to meiosis by connecting DNA to the formation of zygotes (Turn 6). The students then generated the idea that the chromosomes or DNA that are involved in the synthesis of proteins also produce proteins that "makes a kid" or "the body" (Turns 8–12). Next, they added genetic heredity to the conversation by connecting it to meiosis through the presence of DNA and sex cells (Turns 13–18). The students finally conclude that protein synthesis is what builds the body (Turns 19–20). Thus, in part because of the supported practice of authorship, Edward and Adrienne were able to approach a novel situation, in which they were asked to connect various topics learned at different times in the school year, by adapting their prior knowledge about several topics

and generating connections between them and the units from which they were drawn.

Although the number of students examined is small, this example is consistent with our hypothesis that students who are regularly positioned as authors are likely to adopt authorship as a practice. As a result, these students may become proficient at adapting their knowledge to fit novel situations or, in other words, to transfer appropriate knowledge in future contexts.

### POTENTIAL INTERACTIONS BETWEEN THE FIVE EXPLANATIONS

Although a detailed discussion of the interactions between these five explanations for how expansive framing promotes transfer requires further research, we have identified several ways that they could potentially interact. First, as shown in Figure 2, the two main aspects that make up expansive framing group the explanations based on their origins in framing settings as connected or in promoting student authorship. Specifically, Explanations 1 and 2 derive from connecting settings whereas Explanations 4 and 5 derive from promoting student authorship. Explanation 3, in contrast, has its origins in both of these aspects of expansive framing.

Second, two of the explanations function by improving students' learning, which then enhances transfer. Specifically, in Explanation 1, when a student expects that he or she will need to use what is being learned in connected settings, the student improves his or her learning process in preparation for transfer. Similarly, in Explanation 3, by transferring-in his or her prior knowledge during learning, the student improves his or her learning process.

A third connection that we identified reveals that three of the explanations depend on expansive framing occurring specifically in the learning context rather than in the transfer context. Students expecting that they will need to use what they learn later (Explanation 1), viewing their knowledge as both relevant and desired socially (Explanation 3), and adopting the practice of authoring knowledge (Explanation 5), all require that the learning context be framed expansively. In contrast, when a student views what was learned before as relevant in a potential transfer context (Explanation 2), or when a student becomes publicly recognized as the author of particular transferable content (Explanation 4), it is not essential that expansive framing occur when the content was actually learned.

Fourth, if students are frequently recognized in public as the author of content (Explanation 4), it is likely that the student will eventually adopt authorship as a general practice (Explanation 5).

Finally, several explanations may connect to one another over time. For example, a student may find her prior knowledge to have continued relevance in a particular social context (Explanation 2) in which someone requests that she explain

her understanding of a topic. By responding to this request, it is likely that the student now begins to view her knowledge as socially desired (Explanation 3). Finally, the other person in the conversation may come to recognize her for the explanation she authored and, from then on, hold her accountable for the content she shared (Explanation 4).

### A RESEARCH AGENDA FOR INVESTIGATING HOW FRAMING AFFECTS TRANSFER

In this article, we have gone beyond prior work that focuses on documenting that there is an effect of framing contexts on transfer to begin constructing several explanations of exactly *how* expansive framing may promote transfer. In so doing, we have been careful to consider how framing may work both independently of and in coordination with other known transfer mechanisms. We also recognize that these explanations may often work in concert and that there are undoubtedly complex relationships between them, some of which we have identified. Because of this, we now propose a research agenda for investigating each explanation and the relationships between them.

We suggest three kinds of studies that are likely to be especially fruitful: (a) experiments focused on disentangling the effects of different aspects of framing, (b) comparative studies in classroom settings, and (c) microgenetic investigations that provide data-grounded explanations of how each set of processes unfolds, separately or in concert, to foster transfer.

#### Disentangling Experiments

Considering that current research suggests that expansive framing as a whole enhances transfer, a key next step is to manipulate the framing of different aspects of contexts separately and in coordination with one another in order to ascertain their individual and combined effects on transfer. In particular, given that three of the proposed explanations for how framing affects transfer are prompted by the framing of student roles as authors and three of the proposed explanations are prompted by framing settings (with Explanation 3 being prompted by both), a clear next step is to run a  $2 \times 2$  experimental design in which student roles (expansive: author vs. bounded: spokesperson) are crossed with the framing of settings (expansive: linked vs. bounded: disconnected). This design will allow us to see which of these aspects of framing matter for which kinds of transfer and whether they each make independent contributions or if the whole is greater than the sum of the parts. Additional follow-up experiments can be run to further disentangle these effects.

A second kind of disentangling experiment that would be valuable would be one in which the timing of expansive framing is manipulated, with the effects on different kinds

of transfer assessed.<sup>5</sup> As previously described, some of the proposed explanations rely on expansive framing during the learning process (Explanations 1, 3 and 5), whereas others would still be at least partially effective even if expansive framing is provided after learning (definitely Explanation 2 and perhaps also Explanation 4). Given that, manipulating when expansive framing occurs would allow us to further distinguish between these explanations.

As noted in Engle et al. (2011), such experiments “will simultaneously advance understanding of how exactly framing works, provide additional replication of the effects of framing on transfer, and guide educators about which aspects of framing to focus on” (p. 621).

### Comparative Classroom Studies

Another way to learn whether and how framing affects transfer is to make systematic comparisons between and within classroom-based case studies. To compare the effects between bounded and expansive framing, teachers teaching multiple sections of the same course can be encouraged to implement more bounded or more expansive framing in order to see what benefit, if any, the expansive implementation has on students' propensity to demonstrate different kinds of transfer.

At the same time, within studies of particular classrooms in which expansive framing is employed, it is possible to see whether there are correlations between the degree to which each student transfers and the degree of each student's awareness and uptake of expansive framing. Specifically, one could examine the degree to which different students appear to detect the existence of different aspects of the expansive framing and show evidence of “taking it up” (Austin, 1962; Clark, 1996) in their own behavior through a combination of surveys and interviews. This research then would allow one to see whether those students who notice and respond to the expansive framing more strongly are also the same students who show greater evidence of transfer on assessments after controlling for other predictors of transfer.<sup>6</sup>

<sup>5</sup>We thank Rob Goldstone for this suggestion.

<sup>6</sup>Evidence of this sort is currently being generated (Meyer, 2012). Preliminary results of exploratory correlational and regression analyses (Engle, Meyer, & Chong, 2012) showed correlations between three different measures of transfer and students' responsiveness to 10 different instances of expansive framing that spanned both roles and the three main aspects of setting (time, place, and participants). Most correlations were positive and involved students reporting that they had adopted the framing in their actions rather than just agreed with it. Knowing the content to be transferred was correlated with two of the three measures of transfer while many potential predictors of learning like prior grades, test scores, motivational variables, and standard demographic variables did not correlate with transfer. The best regression models all involved expansive framing as predictors and were able to account for between 26% and 60% of the variance in transfer. However, these results are preliminary as we have not yet been able to include in our analyses useful measures of each student's exposure to classical transfer mechanisms like generalizing and comparing examples.

### Microgenetic Investigations

Finally, both kinds of studies can embed microgenetic investigations that are focused on directly observing the hypothesized processes in action (Maxwell, 2004a, 2004b; Saxe, 2002; Siegler Shadish, Cook & Campbell, 2002, 2006). Intensive videotaping combined with interviewing and documentation of student work and instructional materials during the complete span in which learning and transfer take place can allow one to develop explanations for cases in which expansive framing has been shown to relate to subsequent transfer, which would be documented not just with formal assessments but also by examining subsequent activity after instruction for evidence of students using what they had learned in their own ways (Lobato, 2012/*this issue*).

Such explanations would trace how an instructor's framing was responded to by a student in ways that then affected their learning processes, the use of any known or hypothesized transfer mechanisms, and eventually how and what they were able to transfer. We have already begun this work by explaining the surprising transfer of one struggling student in another of Mr. Kent's high school biology classes (Lam et al., 2012). The validity of such explanations can be further increased by also explaining contrasting cases in which transfer did not occur.

Interviews with students in which they are asked to explain how they themselves addressed transfer situations may also help inform which of the proposed processes were involved (Lobato, 2012/*this issue*). Such microgenetic investigations have the potential for further specifying how each process works for individual students, based on how they themselves interpret and respond to different framings (cf. Lobato, 2012/*this issue*; Lobato et al., 1999). It may also lead to potentially identifying other ways in which expansive framing promotes transfer. In addition, these investigations provide especially fertile ground for investigating how the five proposed explanations can interact with one another, in real time, and for particular students.

### CONCLUDING THOUGHTS

By focusing on the effects of expansive framing on transfer, we are addressing an institutional problem that exists in much formal education, especially in high schools and beyond (Sizer, 1984), in which bounded framing has become the working norm. Students' classes are often framed as being completely separate from one another such that they are considered to involve completely different people, be about disconnected topics (cf. Richland et al., 2012/*this issue*), and happen in distinct places and times. Prior to the institution of schooling, learning may not have been as compartmentalized as in this age, and as a result, studies of transfer across contexts may have been moot because of the much broader way that learning was understood by both learners and teachers.

Compared to other methods of fostering transfer, expansive framing is widely applicable to all academic subjects and adaptable to a variety of instructional methods. Standard content-based instructional methods for fostering transfer need to be precisely specified for that particular content, a very time-consuming process. In contrast, methods for expansively framing learning contexts can be implemented in similar ways, no matter what topic or discipline is being learned. In addition, the expansive framing of settings in particular can be used across all forms of instruction from traditional lectures to discovery-based approaches or any other variation or combination of these. All the instructor needs to do is connect the learning environment to other times, places, and participants in ways that his or her students will believe and be ready to act upon (Zheng, Meyer, & Engle, 2012). In effect, expansive framing allows instructors to better leverage whatever student learning they are able to achieve through whatever means.

At the same time, however, we do not claim that expansive framing is the be-all or end-all for instruction. Our informal observations of tutoring and classroom instruction as well as broader theoretical considerations suggest that there may be costs as well as benefits of expansive framing for both learning and transfer. For example, we observed that a few learners in the expansive framing condition of the Engle et al., (2011) tutoring experiment had a tendency to bring in so much prior knowledge during learning that they became cognitively overwhelmed or had difficulty focusing on what the provided text and diagrams could contribute to their understanding. Thus, it may make sense for the beginnings and endings of lessons or curriculum units to be framed more expansively but to use a somewhat less expansive framing when students need to focus on learning important new material. In such circumstances, the advantage for learning in a more bounded framing is that it could help students to focus exclusively on the content at hand without being distracted by other knowledge.

In addition, by itself expansive framing encourages learners to regularly use what they already know, but it does not provide resources for students to judge which prior knowledge is the most *appropriate* for a particular problem or issue. By itself, then, expansive framing can lead to overgeneralization (Engle, 2006b) or what is also called “negative transfer” (see also Schwartz et al., 2012/*this issue*). Therefore expansive framing should be regularly paired with activities in which learners critically evaluate the knowledge they have transferred-in for its relevance and validity. Some of the techniques that Schwartz et al. (2012/*this issue*) suggest for avoiding negative transfer, like proactively seeking feedback, are likely to be particularly helpful in this regard.

For this reason, it also may make sense for instruction to employ more targeted expansive framings in which students are provided with specific contexts for when generalization from the learned content will be most appropriate, such as specifying that a particular topic will be relevant both in a

future Chemistry class and for helping themselves or loved ones address a common disease. This targeted expansive framing contrasts with a more general expansive framing where only vague contexts are provided and thus expands to include all contexts, such as telling students that what they are learning will be useful “in the future” or “almost everywhere.” A targeted expansive framing may reduce negative transfer that occurs when irrelevant content is transferred, or is transferred inappropriately. However, it is possible that only using targeted expansive framing may constrain scientific discovery, which often involves creating deep analogies across contexts that were not initially thought to be relevant to one another (e.g., Goldstone & Wilensky, 2008). In this case, an expansive framing that encompasses all contexts may be more effective.<sup>7</sup>

Nonetheless, it has long been recognized that the key challenge to transfer is in students being reminded of and actually bringing in their knowledge in the first place (e.g., Loewenstein, 2010; Reeves & Weisberg, 1994; Ross, 1984). It is in addressing this key challenge that expansive framing is particularly powerful.

In closing, we hope this article will advance future investigations of the relationships between framing and transfer. We believe it provides a basis for researchers to be able to provide clear demonstrations of the multiple ways in which framing affects transfer and how they interact with each other in real learning situations.

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<sup>7</sup>Perhaps a way to get the best of both extremes would be to specify a few key transfer contexts for the knowledge being learned and then specifically open up the possibility of additional contexts with phrases like “and beyond” or “and more.” If done in a believable way, this phrasing may also prompt students to think about additional contexts in which they can use what they are learning.

Goldwasser, Richard Hsu, Christina Lin, Erica Naves, Sarah Perez, Hernan Rosas, Sadaf Sareshwala, Danny Tan, Mai Nhia Vang, Sue Wang, Lynn Yu, and Kathleen Zheng.

## REFERENCES

- Anderson, R. C., & Bower, G. H. (1973). *Human associative memory*. New York, NY: Wiley.
- Anolli, A., Antonietti, A., Crisafulli, L. & Cantoia, M. (2001). Accessing source information in analogical problem-solving. *Quarterly Journal of Experimental Psychology*, 54A, 237–261.
- Austin, J. L. (1962). *How to do things with words*. Cambridge, MA: Harvard University Press.
- Barnett, S. M., & Ceci, S. J. (2002). When and where do we apply what we learn? A taxonomy for far transfer. *Psychological Bulletin*, 128, 612–637.
- Bateson, G. (1972). A theory of play and fantasy. In *Steps to an ecology of mind: Collected essays in anthropology, psychiatry, evolution, and epistemology* (pp. 177–193). New York, NY: Ballantine.
- Beach, R. & Phinney, M. (1998). Framing literary text worlds through real-life social negotiations. *Linguistics and Education*, 9, 159–198.
- Bereiter, C. (1995). A dispositional view of transfer. In A. McKeough, J. Lupart, & A. Marini (Eds.), *Teaching for transfer: Fostering generalization in learning* (pp. 21–34). Mahwah, NJ: Erlbaum.
- Bloome, D., Power Carter, S., Morton Christian, B., Otto, S., & Shuart-Faris, N. (2005). *Discourse analysis and the study of classroom language and literacy events: A microethnographic perspective*. Mahwah, NJ: Erlbaum.
- Boaler, J. (2002). *Experiencing school mathematics: Traditional and reform approaches to teaching and their effect on student learning*. Mahwah, NJ: Erlbaum.
- Bong, B. (2001). Role of self-efficacy and task value in predicting college students' course enrollments and intentions. *Contemporary Educational Psychology*, 26, 553–570.
- Bransford, J., Brown, A. L., & Cocking, R. (Eds.). (1999). *Learning and transfer. In How people learn: Brain, mind, experience, and school* (pp. 39–66). Washington, DC: National Academy Press.
- Brown, A. L. (1989). Analogical learning and transfer: What develops? In S. Vosniadou & A. Ortony (Eds.), *Similarity and analogical reasoning* (pp. 369–412). Cambridge, UK: Cambridge University Press.
- Brown, A. L., Ash, D., Rutherford, M., Nakagawa, K., Gordon, A., & Campione, J. C. (1993). Distributed expertise in the classroom. In G. Salomon (Ed.), *Distributed cognitions: Psychological and educational considerations* (pp. 188–228). New York, NY: Cambridge University Press.
- Campione, J. C., & Brown, A. L. (1984). Learning ability and transfer propensity as sources of individual differences in intelligence. In P. H. Brooks, R. D. Sperber, & C. McCauley (Eds.), *Learning and cognition in the mentally retarded* (pp. 265–294). Baltimore, MD: University Park Press.
- Catrambone, R. & Holyoak, K. J. (1989). Overcoming contextual limitations on problem-solving transfer. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 15, 1147–1156.
- Chang, N. M. (2006). *Learning to discriminate and generalize through problem comparisons* (Unpublished doctoral dissertation). Pittsburgh, PA: Carnegie Mellon University.
- Chi, M. T. H., & VanLehn, K. A. (2012/this issue). Seeing deep structure from the interactions of surface features. *Educational Psychologist*, 47, 177–188.
- Clark, H. H. (1996). *Using language*. Cambridge, UK: Cambridge University Press.
- Cole, J. S., Bergin, D. A., & Whittaker, T. A. (2008). Predicting student achievement for low stakes testing with effort and task value. *Contemporary Educational Psychology*, 33, 609–624.
- Engle, R. A. (2006a). *Findings about the nature of the whale group's transfer* [Supplement]. Available from the author.
- Engle, R. A. (2006b). Framing interactions to foster generative learning: A situative account of transfer in a community of learners classroom. *The Journal of the Learning Sciences*, 15, 451–498.
- Engle, R. A., & Conant, F. R. (2002). Guiding principles for fostering productive disciplinary engagement: Explaining an emergent argument in a community of learners classroom. *Cognition and Instruction*, 20, 399–483.
- Engle, R. A., Meyer, X. S., & Chong, A. M. (2012, March). Connecting expansive framing to transfer: A progress report. In X. S. Meyer (Chair), *Connecting expansive framing to transfer in a high school biology classroom*. Related paper-set presented at the National Association for Research in Science Teaching International Conference, Indianapolis, IN.
- Engle, R. A., Meyer, X., Clark, J., White, J. & Mendelson, A. (2010, March). Expansive framing and transfer in a high school biology class: Hybridizing settings and promoting connections within a larger learning community. In R. A. Engle (organizer), *Applying new mechanisms and conceptualizations of the 'transfer-of-learning' to science classrooms: The dynamic role of contexts and interactions*. Symposium presented at the National Association for Research in Science Teaching Annual International Conference, Philadelphia, PA.
- Engle, R. A., Nguyen, P. D., & Mendelson, A. (2011). The influence of framing on transfer: Initial evidence from a tutoring experiment. *Instructional Science*, 39, 603–628. Retrieved from <http://www.springerlink.com/content/b451q46006907539/>
- Floriani, A. (1994). Negotiating what counts: Roles and relationships, texts and contexts, content and meaning. *Linguistics and Education*, 5, 241–274.
- Gee, J. P., & Green, J. L. (1998). Discourse analysis, learning, and social practice: A methodological study. *Review of Research in Education*, 23, 119–169.
- Gentner, D., Loewenstein, J., & Thompson, L. (2003). Learning and transfer: A general role for analogical encoding. *Journal of Educational Psychology*, 95, 393–408.
- Gick, M. L., & Holyoak, K. (1980). Analogical problem solving. *Cognitive Psychology*, 12, 306–355.
- Gick, M. L. & Holyoak, K. (1983). Schema induction and analogical transfer. *Cognitive Psychology*, 15, 1–38.
- Gilbert, J. K., Bulte, A. M. W., & Pilot, A. (2011). Concept development and transfer in context-based science education. *International Journal of Science Education*, 33, 817–837.
- Godden, D. R., & Baddeley, A. D. (1975). Context-dependent memory in two natural environments: On land and underwater. *British Journal of Psychology*, 66, 325–331.
- Godden, D. R., & Baddeley, A. D. (1980). When does context influence recognition memory? *British Journal of Psychology*, 71, 99–104.
- Goffman, E. (1974). *Frame analysis: An essay on the organization of experience*. New York, NY: Harper & Row.
- Goldstone, R. L., Landy, D. H., & Son, J. Y. (2009). The education of perception. *Topics in Cognitive Science*, 2, 265–284.
- Goldstone, R. L. & Wilensky, U. (2008). Promoting transfer by grounding complex systems principles. *The Journal of the Learning Sciences*, 17, 465–516.
- Goodwin, C., & Duranti, A. (1992). Rethinking context: An introduction. In A. Duranti & C. Goodwin (Eds.), *Rethinking context: Language as interactive phenomenon* (pp. 1–42). Cambridge, UK: Cambridge University Press.
- Greeno, J. G. (2006). Authoritative, accountable positioning and connected, general knowing: Progressive themes in understanding transfer. *The Journal of the Learning Sciences*, 15, 537–547.
- Greeno, J. G., Smith, D. R., & Moore, J. L. (1993). Transfer of situated learning. In D. K. Detterman & R. J. Sternberg (Eds.), *Transfer on trial: Intelligence, cognition, and instruction* (pp. 99–127). Norwood, NJ: Ablex.
- Hammer, D., Elby, A., Scherr, R. E., & Redish, E. F. (2005). Resources, framing, and transfer. In J. Mestre (Ed.), *Transfer of learning: Research and perspectives* (pp. 89–120). Greenwich, CT: Information Age.



- Hart, W., & Albarracín, D. (2009). What was doing vs. what I did: Verb aspect influences memory and future actions. *Psychological Science, 20*, 238–244.
- Hatano, G., & Inagaki, K. (1986). Two courses of expertise. In H. W. Stevenson, H. Azuma, & K. Hakuta (Eds.), *Child development and education in Japan: A series of books in psychology* (pp. 262–272). New York, NY: W.H. Freeman.
- Hatano, G., & Oura, Y. (2003). Commentary: Reconceptualizing school learning using insight from expertise research. *Educational Researcher, 32*(8), 26–29.
- Holyoak, K. J. (2005). Analogy. In K. J. Holyoak & R. G. Morrison (Eds.), *The Cambridge handbook of thinking and reasoning* (pp. 117–142). New York, NY: Cambridge University Press.
- Hulleman, C. S., Durik, A. M., Schweigert, S. A., & Harackiewicz, J. M. (2008). Task values, achievement goals, and interest: An integrative analysis. *Journal of Educational Psychology, 100*, 398–416.
- Jacoby, S., & Gonzales, P. (1991). The construction of expert–novice in scientific discourse. *Issues in Applied Linguistics, 2*, 149–181.
- Keiler, L. (2007). Students' explanations of their data handling: Implications for transfer of learning. *International Journal of Science Education, 29*, 151–172.
- Kelly, G. J., & Chen, C. (1999). The sound of music: Constructing science as sociocultural practices through oral and written discourse. *Journal of Research in Science Teaching, 36*, 883–915.
- Laboratory of Comparative Human Cognition. (1983). Culture and cognitive development. In P. H. Mussen (Ed.), *Handbook of child psychology: Vol. 1. History, theory and methods* (pp. 295–356). New York, NY: Wiley.
- Lam, D. P., Meyer, X. S., Engle, R. A., Goldwasser, L., Perez, S., Zheng, K., . . . Tan, D. (2012). A microgenetic analysis of how expansive framing led to transfer for one struggling student. In J. van Aalst, K. Thompson, M. J. Jacobson, & P. Reimann (Eds.), *The future of learning: Proceedings of the 10th International Conference of the Learning Sciences (ICLS 2012) – Volume 1, Full papers* (pp. 40–47). Sydney, Australia: International Society of the Learning Sciences.
- Lave, J. (1988). *Cognition in practice: Mind, mathematics, and culture in everyday life*. New York, NY: Cambridge University Press.
- Leander, K. M. (2001). “This is our freedom bus going home right now”: Producing and hybridizing space-time contexts in pedagogical discourse. *Journal of Literacy Research, 33*, 637–679.
- Lobato, J. (2012/this issue). The actor-oriented transfer perspective and its contributions to educational research and practice. *Educational Psychologist, 47*, 232–247.
- Lobato, J., Ellis, A., & Muñoz, R. (2003). How “focusing phenomena” in the instructional environment support individual students' generalizations. *Mathematical Thinking and Learning, 5*, 1–36.
- Loewenstein, J. (2010). How one's hook is baited matters for catching an analogy. In B. H. Ross (Ed.), *The psychology of learning and motivation: Advances in research and theory* (Vol. 53, pp. 149–182). San Diego, CA: Elsevier Academic.
- Mac Iver, D. J., Stipek, D. J., & Daniels, D. H. (1991). Explaining within-semester changes in student effort in junior high school and senior high school courses. *Journal of Educational Psychology, 83*, 201–211.
- Malka, A., & Covington, M. V. (2005). Perceiving school performance as instrumental to future goal attainment: Effects on graded performance. *Contemporary Educational Psychology, 30*, 60–80.
- Maxwell, J. A. (2004a). Causal explanation, qualitative research, and scientific inquiry in education. *Educational Researcher, 33*(2), 3–11.
- Maxwell, J. A. (2004b). Using qualitative methods for causal explanation. *Field Methods, 16*, 243–264.
- Mendelson, A. (2010). Using online forums to scaffold oral participation in foreign language instruction. *L2 Journal, 2*(1), 23–44.
- Mercer, N. (1995). *The guided construction of knowledge: talk amongst teachers and learners*. Bristol, UK: Multilingual Matters.
- Mestre, J. (2003). *Transfer of learning: Issues and research agenda: Report of a workshop held at the National Science Foundation*. Arlington, VA: National Science Foundation. Retrieved from <http://www.nsf.gov/pubs/2003/nsf03212/nsf03212.pdf>
- Meyer, X. S. (2012, March). *Connecting expansive framing to transfer in a high school biology classroom*. Related paper-set presented at the National Association for Research in Science Teaching International Conference, Indianapolis, IN.
- Meyer, X., Mendelson, A., Engle, R. A., & Clark, J. (2011). *Expansive framing and transfer in a high school biology class: Promoting connections within and beyond the classroom*. Manuscript in preparation.
- Ming, N. C. (2009). Analogies vs. contrasts: A comparison of their learning benefits. In B. Kokinov, D. Gentner, & K. Holyoak (Eds.), *New frontiers in analogy research: Proceedings of the second international conference on analogy* (pp. 338–347). Sofia, Bulgaria: New Bulgarian University.
- Pea, R. D. (1987). Socializing the knowledge transfer problem. *International Journal of Educational Research, 11*, 639–663.
- Pugh, K. J., Linnenbrink-Garcia, L., Koskey, K. L. K., Stewart, V. C., & Manzey, C. (2010). Teaching for transformative experiences and conceptual change: A case study and evaluation of a high school biology teacher's experience. *Cognition and Instruction, 28*, 273–316.
- Putney, L. G., Green, J., Dixon, C., Duran, R., & Yeager, B. (2000). Consequential progressions: Exploring collective-individual development in bilingual classrooms. In C. D. Lee & P. Smagorinsky (Eds.), *Vygotskian perspectives on literacy research: Constructing meaning through collaborative inquiry* (pp. 86–126). Cambridge, UK: Cambridge University Press.
- Reed, S. K. (2012). Learning by mapping across situations. *The Journal of the Learning Sciences, 21*, 353–398.
- Reed, S. K., Ernst, G. W., & Banarji, R. (1974). The role of analogy in transfer between similar problem states. *Cognitive Psychology, 6*, 436–450.
- Reeves, L. M., & Weisberg, R. W. (1994). The role of content and abstract information in analogical transfer. *Psychological Bulletin, 115*, 381–400.
- Renkl, A., Mandl, H., & Gruber, H. (1996). Inert knowledge: Analysis and remedies. *Educational Psychologist, 31*, 115–122.
- Richland, L. E., Stigler, J. W., & Holyoak, K. J. (2012/this issue). Teaching the conceptual structure of mathematics. *Educational Psychologist, 47*, 189–203.
- Rittle-Johnson, B., & Star, J. R. (2007). Does comparing solution methods facilitate conceptual and procedural knowledge? An experimental study on learning to solve equations. *Journal of Educational Psychology, 99*, 561–574.
- Ross, B. H. (1984). Reminding and their effects in learning a cognitive skill. *Cognitive Psychology, 16*, 371–416.
- Salomon, G., & Perkins, D. N. (1989). Rocky roads to transfer: Rethinking mechanisms of a neglected phenomenon. *Educational Psychologist, 24*, 113–142.
- Saxe, G. (2002). Children's developing mathematics in collective practices: A framework for analysis. *The Journal of the Learning Sciences, 11*, 175–200.
- Schwartz, D. L., Bransford, J. D., & Sears, D. L. (2005). Efficiency and innovation in transfer. In J. Mestre (Ed.), *Transfer of learning from a modern multidisciplinary perspective* (pp. 1–51). Greenwich, CT: Information Age.
- Schwartz, D. L., Chase, C. C., & Bransford, J. D. (2012/this issue). Resisting overzealous transfer: Coordinating previously successful routines with needs for new learning. *Educational Psychologist, 47*, 204–214.
- Schwartz, D. L., & Nasir, N. (2003). Transfer of learning. In W. Guthrie (Ed.), *Encyclopedia of education* (2nd ed., pp. 1449–1452). NY: Macmillan.
- Searle, J. (1995). *The construction of social reality*. New York, NY: The Free Press.
- Shadish, W. R., Cook, T. D., & Campbell, D. T. (2002). *Experimental and quasi-experimental designs for generalized causal inference*. Boston, MA: Houghton-Mifflin.
- Siegler, R. S. (2006). Microgenetic analyses of learning. In W. Damon & R. M. Lerner (Series Eds.) & D. Kuhn & R. S. Siegler (Vol. Eds.), *Handbook of child psychology: Volume 2: Cognition, perception, and language* (6th ed., pp. 464–510). Hoboken, NJ: Wiley.

- Simons, J., Dewitte, S., & Lens, W. (2003). "Don't do it for me. Do it for yourself!" Stressing the personal relevance enhances motivation in physical education. *Journal of Sport and Exercise Psychology, 25*, 145–160.
- Sizer, T. (1984). *Horace's compromise: The dilemma of the American high school*. New York, NY: Houghton Mifflin.
- Smith, S. M., Glenberg, A., & Bjork, R. A. (1978). Environmental context and human memory. *Memory and Cognition, 6*, 342–353.
- Spencer, R. M., & Weisberg, R. W. (1986). Context-dependent effects on analogical transfer. *Memory and Cognition, 14*, 442–449.
- Tannen, D. (1993). Introduction. In D. Tannen (Ed.), *Framing in discourse* (pp. 3–13). New York, NY: Oxford University Press.
- Thorndike, E. L. (2009). *Educational psychology*. Charleston, SC: BiblioLife. (Original work published 1903)
- Tulving, E., & Thomson, D. M. (1973). Encoding specificity and retrieval processes in episodic memory. *Psychological Review, 80*, 353–370.
- Wagner, J. (2006). Transfer in pieces. *Cognition and Instruction, 24*, 1–71.
- Zheng, K., Meyer, X. S., & Engle, R. A. (2012, March). Student responsiveness to the teacher's expansive framing. In X. S. Meyer (Chair), *Connecting expansive framing to transfer in a high school biology classroom*. Related paper-set presented at the National Association for Research in Science Teaching International Conference, Indianapolis, IN.