Experience, Memory, Language, and Learning:

A Theory of Teaching and Learning and the Ethics of Assessment

(draft)

James Paul Gee

Mary Lou Fulton Presidential Professor of Literacy Studies
Regents' Professor
Arizona State University
james.gee@asu.edu

Memory and Experience

Human long-term memory is the basis of human learning. However, the nature of human memory is often not well understood (Gazzaniga 2008, 2011; Gee 2013a; Glenberg 1997; Loftus 1976; Schacter 2002; Simons & Chabris 2011). As the poor record of eye-witness testimony in courts of law attests (Loftus & Ketcham 1991), human memory is not very good at accurate storage of information. In the sense in which digital computers have memory—in the way in which they store information accurately over time—humans do not have memory. A computer does not change the information it stores every time it uses it, but humans do.

Human long-term memory is often oriented more to the future than to the past. Humans store their experiences in memory and use them to think about and plan future actions in new situations. In evolutionary terms, memories that were "mis-remembered" in ways that nonetheless facilitated good problem solving would contribute more to survival than accurate ones that worked poorly for future success (Gazzaniga 2008, 2011; Gee 2013a; Marcus 2008; Renfrew 2009)

Human storage capacity in long-term memory is nearly unlimited (Baddeley, Eysenck, & Anderson 2009). We humans can store massive amounts of experience in our heads—scenarios about what has happened in the past—and use these experiences to get ready for future action (Glenberg 1997; Glenberg & Gallese 2012). We can mix and match elements of past experience to simulate scenarios in our minds, even fantasy ones that take elements from experience and combine them in novel ways (Givon 1992; Kelleher, Costello, & van Genabith 2005; Kintsch & van Dijk 1978; Zwaan & Radvansky 1998).

The simulations we run in our minds to prepare for action—to make hypothesis about what might work and what might not—are more like video games than movies (Gee 2004, 2012). We can role-play in our minds as ourselves or as others. We can role play our own role in a tense negotiation or take the perspective of the opposing party and imagine how they feel and might act. We can even imagine being an object—for instance, some scientists can talk and think about diagrams from the perspective of the motion of electrons the diagram is meant to represent.

Our capacity to use previous experiences stored in long-term memory to get ready for action and to prepare for future learning and problem solving is primordial for us humans and part of the capacity that made us a "higher" primate (Barsalou 1999a, b; Suddendorf 2013; Tomasello 2015). We don't just act, sometimes we think (simulate) before we act.

So, often what is important about a memory is how well it prepares us for future action and learning and not how accurate it is about the past. However, it turns out that the experiences we have and which store in memory as fodder for future learning and problem solving are better when they have certain core features and less good (are less well integrated with our previous memories and less deeply stored in the mind) when they do not have these features. Not all experiences are equal. To render an experience good for future learning we need to pay attention to the elements of the experience in the "right" ways and to edit the experience in our minds when we store it, edit in terms of foregrounding important elements and backgrounding less important ones.

So what characterizes experiences that are good for future learning and problem solving? Such experiences have these features (Damasio 1995, 1999; Gee 2004; Glenberg 1997; Glenberg & Gallese 2012; Kirschner, Sweller, & Clark 2006):

1. There is an action we need to take in the experience.

2. We care about the outcome of the action (i.e., we put an affective coloring on the experience when we store in memory; we process the experience both "cognitively" and "affectively").

3. Someone or something helps us manage our attention in the experience so that we do not become overloaded with details and so that we know what are the relevant and important aspects of the experience and what are not (in terms of the action we need to take).

I will refer to such experiences as "Experience^{GFL}" (GFL = Good for Future Learning) and say that such experiences are "well designed". Saying they are well designed means that someone or something has helped design them or mentor them. There been, in that sense, a "teacher". Parents, school teachers, peers, and mentors can be such designers and we can, when we become expert "deliberate learners", design things for ourselves, that is, serve as our own teachers.

I should mention that, for humans, encounters in the "real" world, in conversations with others, and with media all function as experience. Humans often do not strongly distinguish what they have experienced in media, in conversation, and in the world (Reeves & Nass 1999). This is what makes new digital tools so promising because, like literature before them, they can become "equipment for living", which is just what well-designed experiences are for human beings (Gee 2015a).

The Probe Cycle

So we have seen that humans (like some other animals) can run scenarios in their minds to plan and get ready for action (Suddendorf 2013; Tomasello 2014). I have also argued that certain experiences are experience^{GLF}. I want now to explore the nature of such experiences in more depth. In such experiences we engage in what I will call the "cycle of reflective action" or (for short) "the probe cycle". This cycle involves the following steps (Gee 2004, 2015a; Schon 1983):

1. Have a clear goal (one you care about)
2. Simulate (Use Experience^{GFL}) in your mind possible actions and outcomes
3. Form a hypothesis about how to proceed
4 Act
5. Appreciate or assess the outcome of the action—the response from the world—in terms of whether it was good, bad, or indifferent for your goal
6. Based on your appreciation of the world's response, choose a next action or rethink your goal (using the probe cycle again)

The probe cycle is crucial to human intelligence and survival and is a core capacity that schools and society need to "train up" for complex thinking, complex problem solving, and collaboration that can lead to collective actions and intelligence. It is also (in a more formalized way) the basis for science. As with many elements of intelligence, the probe cycle can be supplemented and expanded by external devices and technologies.

The probe cycle is important in any theory of learning for several reasons. First, as I have already pointed out, there is ample evidence that humans learn best when they are having an experience where they have clear goals and need to take an action (or actions) whose accomplishment they care about in the sense that something is meaningfully "at stake" for them in accomplishing it (Cosmides 1989; Hattie & Yates 2013; Wasson 1966, 1968).

Second, the probe cycle is important for theories of learning in that it stresses the necessity that learners must be able to evaluate or assess whether what they have done and how the world has reacted to it is good or bad for their goal. And they must be able, in terms of this assessment, to figure out what to do next. This capacity is an "appreciative capacity", the capacity to appreciate in effective ways the goal-based outcomes of action in a sequence of actions (Schon 1983). In Wittgenstein's (1953) work, the capacity to know what to do next is virtually definitive of whether or not someone knows a specific "language game" and its related "form of life". Learners need to be taught (and have modeled for them) the norms or standards for what constitutes successful outcomes and good next moves in a given domain or for a given social group.

Third, learning from experience can be too complex for newcomers (Kirschner, Sweller, & Clark 2006). There can be too many things to pay attention to. Beginners need help knowing how to manage their attention, that is, they need help knowing what to pay attention to and how and why they should pay attention to it in their experiences. Thus, parents, teachers, mentors, and social groups often design experiences that are constrained in some respects and that are well mentored to facilitate learning. For example, a new birder (engaged in "birding" or bird-watching) is taken out in just the right environment to maximize chances of seeing a certain type of bird (e.g., shore birds) and helped to know where the best spots to search are (e.g., shore line for waders, further out to sea for gulls, terns, and pelicans). Here, again, technology can often help. For example, in virtual worlds experiences can be constrained, samples can be concentrated, and important things can be highlighted. Learners need help in managing—and learning how to manage for themselves—their attentional economies.

So here get a set of supplementary principles for learning from experience in effective ways, at least early on in a learning progression: 1) assure that there are actions learners want and need to take and clear goals (that, of course, they can rethink in some circumstances as they probe the world with actions); 2) help learners understand and develop the norms and standards for outcomes and next moves that constitute a good appreciative system; 3) design well-structured and well-constrained experiences and help learners to manage their attention in these experiences (what to focus on). All of this is ultimately part of having experiences which are experience^{GFL}.

Language

Some animals can, without doubt, engage in the probe cycle (Tomasello 2014). They can work out some possible actions and outcomes in their heads before acting and suffering adverse outcomes. Our fellow primates can most certainly do this. Furthermore, for many baby animals their early limitations serve as ways to constrain their experiences to manageable proportions (just as children's early limitations in speech production and reception constrain what aspects of the input can become intake to be processed). But humans are far superior in this regard and the reason this is so, I would argue, is because we have language. Indeed, if we want a theory of learning that differentiates between general primate learning and more specific forms of human learning, then language is surely a key, since humans alone have language in the sense that the term "natural language" is used in linguistics (Pinker 1994).

To see the crucial role of language in thinking and learning we need first to see how meaning works in language and the role of what I will call "situational meaning" (Bergen 2013; Gee 2004, 2014, 2015b). There are two types of meaning a word can have. First, a word can have what I will call a "basic meaning" (other terms here that mean much the same thing: literal meaning, utterance-type meaning, lexical meaning, dictionary meaning, or system meaning). Thus, a word like "cat", in terms of basic meaning, means a certain type of animal, a feline. This type (cat) is not specified in our heads, in terms of vernacular language, by its genotype, though it is so specified by biologists. Indeed, there are various theories of how people represent basic meanings in their heads. These theories include various sorts of verbal definitions, sets of features, or prototype examples (Cruse 1986; Murphy 2010; Smith & Medin 1981). However we think basic meanings are stored in the head, they set the range of possible situational meanings a word can have and the parameters via which new situational meanings can be formed in new contexts (for logical formulations of this process, see: Barwise 1981, 1988; Barwise & Perry 1983)

Situational meanings, on the other hand, are the contextually-derived meanings speakers and readers give words in actual contexts of use (Bergen 2012; Gee 2004, 2014a). Thus, to take a very simple example, we give different situational meanings to the word "coffee" in the examples below (Clark 1989):

1. The coffee spilled, go get a mop.
2. The coffee spilled, go get a broom.
3. The coffee spilled, go stack it again.
4. Big Coffee is as bad as Big Oil.
5. Her coffee skin gleamed in the moonlight.
6. The coffee ice-cream is delicious.
7. What the Americans call "coffee" isn't really coffee (i.e., it is not strong enough).

All words take on nuanced meanings in context and they can take on new meanings in new contexts. Situational meaning is accomplished by active work by listeners and readers. Some of this work is routine and has been done many times in the past, some is less routine and more innovative. For example, an utterance like "Any political system without strong protections for private property is not a democracy" requires a good deal of work to assign an appropriate situational meaning to the word "democracy". Since the basic meaning of the word "democracy" is "a system where people vote", it is not at all clear why a country with no private property could not have voting and, thus, in the basic sense, be a democracy. If you know Milton Freedman's work and that of the school of economics he founded ("the Chicago School"), then you can readily give a situational meaning to the word "democracy" here based on Freeman's theories or related theories (Klein 2007). If you don't, you can't. This example, by the way, makes clear how little basic meanings buy you when you need to understand complex language and complex ideas, a hallmark of education.

Another example: "Corporations are persons" is clearly false on any sense of basic meaning, but it is now enshrined in law in the United States thanks to the Supreme Court. Assigning the word "person" here a situational meaning requires knowing a good deal about U.S. history and politics ("person" here means "bearer of civil rights", thus, in U.S. history, the 14th Amendment to the Constitution has been used in court many more times to protect the civil rights of corporations than it has been to protect the civil rights of African-Americans, for whom it was originally formulated, see: Hartmann 2010).

There is one quite clear way to see the role and importance of situational meaning—that is, the capacity to situate meanings based on one's assessment of the context—and that is any technical manual. The first passage below is from the manual from a video game. The second passage is from a textbook. Any gamer will tell you that the language in the game manual is pretty useless until you have actually played the game (Gee 2003). This is so because the language in the manual is about the game world and its images and actions. When you can substituted such images and actions for the words and phrases in the manual you can give them situational meanings in terms of which you know how to operate with them to accomplish goals. Otherwise, you must try to understand the manual by translating words not into images and actions, but into other words that act like definitions. I will call this a purely "verbal understanding" and will argue that a situational understanding is what leads to deep understanding and the ability to effectively use the language of the text for goal accomplishment. Verbal understanding alone are much less deep and useful (unless and until one has had lots of experience in the relevant domain).

So, too, for the passage from the textbook. When I read this I have only a verbal understanding. I ask myself, in confusion, isn't "removal of weathered material" just a form of "erosion" (but they are treated as two separate things here)? What is a "transporting agent"? I would have thought the production of rock waste was a form of erosion, but again they are contrasted here and the production of rock waste is weathering, not erosion. Why are chemical changes not "transporting agents"? It would really help if I could "see" what these words and phrases mean, that is, I could situate their meaning through running scenarios (perspectival images and other sensations) about them in my mind. Clearly a verbal understanding might allow me to pass a multiple-choice test, but it will not lead to effective understanding and problem solving, that is, to action-oriented goal accomplishment in the world.

> Your internal nano-processors keep a very detailed record of your condition, equipment and recent history. You can access this data at any time during play by hitting F1 to get to the Inventory screen or F2 to get to the Goals/Notes screen. Once you have accessed your information screens, you can move between the screens by clicking on the tabs at

> the top of the screen. You can map other information screens to hotkeys using Settings, Keyboard/Mouse (p. 5). (Ion Storm, 2000, p. 5).

> The destruction of a land surface by the combined effects of abrasion and removal of weathered material by transporting agents is called erosion. ... The production of rock waste by mechanical processes and chemical changes is called weathering. (Martin 1990, p. 93)

Based on what I said above about scenarios in the mind here is one theory about how situational meaning works: Humans have experiences (best: experience[GFL]) in the world. They store these experiences in their minds, but in an edited fashion where they foreground or highlight the aspects of the experience that were relevant to their goals (an effect of how they paid attention to elements in the experience while having it). With more and more similar experiences, humans find patterns and sub-patterns in this experience and they organize their experiences in their minds, and how they recall their experiences, in terms of these patterns and sub-patterns (associations). Patterns and sub-patterns, after a lot of experience, can rise to a fair degree of abstraction and generalization, but, for the most part, abstraction grows bottom up from specific experiences initially viewed in fairly concrete and specific ways (diSessa 2000). When humans need to act, they can run scenarios in their heads that flexibly combine and recombine elements of these patterns and sub-patterns to imagine things from the perspective of themselves and their goals or from the perspective of other actors or even objects (e.g., imagining a river flowing to the sea).

In giving situational meanings to words in context, we associate the word with a scenario or a set of them. We "see" and "act" (and "feel") in our mind's eye and can do so vicariously for others as roles in our heads. Remember that these scenarios can be at various levels of abstraction, but must remain iconic enough for patterns and sub-patterns to be apparent, rearrangable, and modifiable. So, for example, say you heard from a clerk in an ice-cream store: "The coffee spilled, so I quickly scooped it up off the floor before the boss saw me". You may well give the word "coffee" here a situated meaning based on a scenario involving coffee ice-cream and ice-cream scoops. Of course, you could imagine a comedic scene in which the person is frantically attempting to scoop coffee as liquid with an ice-cream scoop.

Learning

So now we have the pieces in place to state a theory of learning. What do situational meanings and the ability to situate meaning have to do with learning? One key thing to realize here is that comprehension is a general faculty in the mind that applies to written language, speech, and understanding things and actions in the world (Biemiller 2003; Stanovich 2000). It is not specific to language or reading (the only mental capacity specific to reading for alphabetic scripts is decoding). Humans use the same comprehension skills (and the same parts of the brain) to understand the world, oral language, and written language. We use the same capacities to understand what people say, write, and do. And the basic form of this understanding is the giving of situational meanings to words, things, and actions via scenarios.

Learning from experience, texts, or teachers means a change in our mind/brains in terms of what we know or what we can do. This change requires, in any and all cases, that we understand (comprehend) the world and language in ways that allow input of data to be intake (intake = data that we can understand and process) so that such a change can happen. We move, in learning, from experience from input to in-take based on our current capacities to comprehend or understand in a contextually appropriate way (and provided we do not block input based on emotional responses). So by its very nature situational meaning is the core basis of learning. As we have seen purely verbal learning not tied to scenarios is much less good for understanding and problem solving, at least for beginners.

But now this raises the question of what the role of language is in learning, since the capacity to understand things in their actual contexts of situations is not germane just to language itself. We use the same capacity to understand things (e.g., glasses for banging or table setting) and actions (e.g., pointing as indicating or as threatening). There are two different senses of the term "language" that are relevant here. One sense is language as a communicational device composed of tools that help listeners and readers understand and situate meaning in the right ways (the way the speaker or author "intends"). On this view of language, we view grammar as "functional", that is, grammatical constructions are viewed in terms of their communicational functions (Halliday 1978). An example would be restrictive relative clauses which function to help listeners or readers identify things in context. If I say "The woman you liked best for the job is back for her last interview", I am using the relative clause construction "the woman you liked best" to signal to you that you already know the woman and to signal, as well, what part of the context is most relevant for you to use to recall who she is and what she means in this conversation and upcoming situation. This sort of functional approach to language is essentially a way of talking about grammar as a set of tools to help listeners and readers situate meanings (and this is what functional grammarians do, Halliday & Matthiessen 2013).

A second sense in which the term "language" can be used is language as a system, as grammar composed of morphological, lexical, syntactic, and semantic systems (semantics here narrowly meaning basic meanings or type meanings and logical form). In the system sense of "language" we care about how grammatical constructions and words create meaning systems that are not specific to context (Saussure 1916; Vygotsky 1987). For example, imperfective aspect (signaled by "-ing" as in "washing") means an action is viewed as ongoing, continuous, or repeated ("John is/was washing his car"). Perfective aspect (signaled by the simple present or past tense as in "washes" or "washed") means an action is viewed as a point in time ("John washes/washed his car"). There are other aspects and they make up a system of related variables. So, too, words make up systems of contrast, such as cow/beef; pig/pork; sheep/mutton; deer/venison; lamb/lamb; chicken/chicken; fish/fish. Here we see a system in which some terms have different words for a live animal and the animal as food, but some do not. However, the words that do (e.g., cow/beef) indicate to us that the words that don't (e.g., chicken/chicken) have two different basic meanings. This lexical system organizes one aspect of reality. Another example: the words "heat" and "temperature" relate to each other differently in vernacular everyday language and thought than they do in chemistry. Everyday language equates "high temperature" with "hot", but these terms are tied to quite different concepts in chemistry.

Language as system is a way of organizing experience in relational and categorical ways via grammatical constructions and labels, and everyday language works differently in many respects than does the language of chemistry. An example of how grammatical constructions can categorize experience is nominalization in English. English has a near mania for treating processes as if they were abstract things, for example: grow → growth; vary → variation; destroy → destruction. This tendency is taken even further in many branches of science (Gee 2015b) where nominalizations are very frequent because something like "growth" seems more quantifiable than a process like growing (e.g., consider "Hornworm growth exhibits a significant amount of statistical variation", note here: "growth" rather than "grow" and "variation" rather than "vary" in comparison to something like: "Hornworms vary a lot in how well they grow").

Language as system raises a chicken-and-egg paradox when we consider language as system side by side with situational (contextually-derived) meaning. As Vygotsky (1987) argued long ago, language as system regiments experience. Language as system places things in categories and relationships. Different registers (different varieties of language) regiment experience differently. The language of physics cuts up and relates things and processes in the world quite differently than do any vernacular varieties of language and differently again than, say, the language of chemistry or biology does. The language of traditional grammar cuts up English much as if it were Latin (which is where traditional grammar came from), while the language of Systemic Functional Grammar (to take a more formal academic approach) cuts up English in terms of forms married to functions (Halliday & Matthiessen 2013) and the language of generative grammar (to take another more formal academic approach) cuts up English into abstract structures that are, in part, universal across all languages (Chomsky 1995). Languages and registers tell us where to cut at the joints in naming and thinking about experience in different domains (e.g., animals, biology, birding, chemistry, basic shapes and colors, plants, botany and a nearly endless number of other domains). Different languages and registers cut reality at different joints.

But now we reach a paradox. I have argue that scenarios give words and phrases situational meanings based on our experiences in the world. But I have also argued that language regiments (organizes) experience. So, if experience gives meaning to language and language tells us how to regiment and cut up experience, which comes first: language or experience? The answer is that they bootstrap each other. The literature on the acquisition of language and the learning of registers is clear here (diSessa 2000; Hoff 2013; Gee 2004). Humans start by giving things concrete, contextually-specific meanings (represented by scenarios in our heads). For example, children may first assume that only four-legged animals with fur are animals and only later generalize the term to fish, bird, and insects (and maybe never to humans). With more experience we find patterns and sub-patterns in our related experiences and move towards more abstraction and generality, but always ready to go concrete again in new experiences.

The way language learning works in moving from specific and concrete meanings to more general and abstract ones is true of other domains as well. Andy diSessa (2000) points out that algebra does not distinguish effectively "among motion ($d = rt$), converting meters to inches ($i = 39.37 \times m$), defining coordinates of a straight line ($y = mx$), or a host of other conceptually varied situations." They all just look alike. He goes on to point out that "[d]istinguishing these *contexts* is critical in learning, although it is probably nearly irrelevant in fluid, routine work for experts," who, of course, have already had many embodied experiences in using algebra for a variety of different purposes and applied to different sorts of specific contexts.

The problem for human learning, viewed as a form of pattern recognition, is how to know out of all the myriad of patterns and sub-patterns the ever-ready pattern-recognizing human mind can find (many of them spurious), which patterns and sub-patterns are "right" or useful. We need help knowing which patterns and sub-patterns to look for, pay attention to, retain, and use (Gee 1992; Kirschner, Sweller, & Clark 2006). Where does this help come from? Some such help comes from our genes, undoubtedly. But, mostly it comes from parents, teachers, mentors, and social and cultural groups that help us to monitor and focus our attention and help us to learn new forms of language as a guide to the appropriate patterns and sub-patterns to be found and used in a given domain (Gee 1992, 2015b; Tomasello 2014). The new language is not general and abstract initially for us learners, but it is more so for the mentors who can inscribe instances of that language in and on our experiences of the world and media. Mentors can point the way along the path from situational meanings to meanings as system and back again as a way to organize experience in more and more general ways (when we need to).

The basic categories and relations of a language as system (ones that mentors already know) serve as attractors for learners to gradually organize their growing experiences and scenarios around. A good example of this process is birding. New birders need to see all sorts of birds in all sorts of different contexts (ecologies). They need to come to be able replay all sorts of bird scenarios in their heads (from the perspective of themselves, other birders, or birds themselves). The experiences they have had and the ways then can use these experiences in their heads allows them to give situational meanings (contextually appropriate meanings) to the bird talk they hear and the bird texts they read, as well as to the bird shapes, colors, and behaviors they see (e.g., quick sight of a white rump in a field of grass = Bobolink; quick flash of white rump in forest = Flicker, a type of woodpecker; begging behavior in one setting = request to be fed from juvenal bird; begging behavior in another setting = part of sexual foreplay and social bonding).

At same time, bird books and guides and bird talk—in the guise of "bird language" or birders' "ways with words"—help new birders organize and regiment their experience in terms of what patterns and sub-patterns they begin to recognize and use, patterns and sub-patterns that come, more or less, to match the system inherent in the books, guides, and talk. Of course, learners can sometimes come to see things in their experience that make them question or attempt to change the language as system they are learning as part and parcel of their education.

Mentors (more advanced birders) and social groups (clubs) of birders serve as the intermediators between situated meanings (birding in environments in the world, in the field) and language as system, abstraction, and generality. Mentors see that situated meaning and systemic abstraction bootstrap each other. Language as function and language as system come together.

I am using the terms mentors and mentoring broadly here for the ways in which parents, teachers, more advanced peers, or different technologies can engage in the core aspects of instruction or teaching: telling, showing, modelling, resourcing, constraining experience, and designing interactional and participatory frameworks. A key to any such teaching—in or out of school; in social groups, cultures or institutions; in workplaces or popular culture—is to deftly relate both language as function and language as system, on the one hand, to action in the world and scenarios in the mind, on the other.

Words and symbols need to be supplied "just in time" (small amounts that can be applied in context right away) or "on demand" (larger blocks of talk or texts when learners need them and are ready for them and know they are or ask for them) (Gee 2003, 2013b). How to situate meanings for words and symbols in different contexts needs to modelled, as does assessing whether an action in a given context has worked "right" or not (Bereiter & Scardamalia 1993; Schon 1983).

Words as systems for organizing experience and finding the "right" patterns and sub-patterns in that experience need to be inscribed on experience and representations of experience (and graphs and diagrams can be representations of experience) (Wellington & Osborne 2001; Zwiers 2014). One powerful new technology for inscribing language on experience is augmented reality (Klopfer 2008). Augmented reality uses mobile devices to lay images, graphs, and words over real environments that learners can navigate and see in real time both on a screen and in the real world. With or without technological support, deep learning is a mediated process among experience, scenario building, language as function, and language as system, serving (and changing) the interests and needs of different domains, groups, cultures, and institutions.

Education

The view of the mind, understanding, language, and learning I have sketched here has important conceptual and ethical implications for learning, teaching, and education. Think a minute about maps. Maps are fairly abstract representations (much like a video game with 8-bit graphics). Concrete experiences of the terrain the map maps allows us to better understand and more effectively use the map. Handing a map of a city (system) to sometime who has had lots of experience with that city (situation) and asking them to find locations efficiently and effectively is easier than handing the same map to someone who has little experience of the city. It is even worse for people who have had little experience of cities at all. When we have had experiences with the terrain a map maps we can then use the map for our purposes and we can use it to supplement, deepen, and extend our own abilities as we enter new experiences.

So, too, when learners have had lots of experience with the contexts, images, actions, and interactions that a type of talk or text is about, for example, a lecture on molecules or a text on geology, they can use the talk or text as a reference, guide, or tool to obtain their own goals, supplement and extend their understanding and problem solving abilities, and learn new things. Minus experience, though, the words are only language as system that seeks to regiment and organize experiences the learner has not yet had. The learner can only gain a relatively abstract understanding of the talk or text as a system of relationships of words to words and grammatical constructions to grammatical constructions, systems unhinged from scenarios that could exemplify them and show how the system is a guide for finding and using normative patterns and sub-patterns in actual practice, action, and goal accomplishment.

Situational meaning and language as system cannot bootstrap each other if either one is missing. Situational meaning without language as system means that learners cannot see the forest for the trees and language as system without situational meaning means that learners would not know a forest if it bit them.

Learners who do not have good mentorship, social guidance, and instruction to ensure that they have the right sorts of experiences in the right order and have experiences that are well designed to focus their attention and help them find and use the right patterns and sub-patterns are asocial. They may be very creative, but they may well have learned and applied many a spurious generalization or been overwhelmed by the wonder and myriad features present in any rich experience in the world or in media.

Let me make clear that the theory of learning I have sketched here, when it is seen as a theory of education, is not progressive in the sense that learning and education are all about learners' own goals and immersion in experience, nor is it traditional in the sense that learning and education are all about overt instruction, teachers' goals, and lots of overt telling out of contexts of application. The theory developed here says that learning involves both immersion in experiences where learners have goals they care about *and* instruction, talk, and texts that regiment that experience and socialize it towards the relevant patterns and sub-patterns of a domain or social group (e.g., biologists). Done the right way this dance between immersion and instruction can lead to creativity and innovation as well, because each of us brings something unique to our experiences in the world and because knowing the norms of a domain or social group is necessary for each of us to be able to contribute our unique perspectives to those domains or groups.

The theory of learning I have given in this paper suggests several core principles of deep teaching and learning (Gee 2008):

1. Learners must learn how to situate meaning for things, words, and actions for any new domain they need to learn. This requires lots of experience (especially experience^{GFL}) in specific contexts. They also need feedback about how appropriate their situational meanings are.

2. Learners must have an action (or actions) in their learning experiences whose outcome they care about and they must have clear goals.

3. Learners must get well-designed and well-mentored experiences (experience^{GFL}) that constrain complexity and help them to know how to manage attention in the experience.

4. Learners must have mentorship to help them develop an appreciative capacity in terms of which they can make good judgments in assessing the outcomes of their actions toward goals and in deciding what to do next.

5. Learners need mentors who use and help learners recruit language as system to label, guide, and organize their experiences and to recognize and use fruitful patterns and sub-patterns in a domain (i.e., help then grow generality and abstraction).

6. All learners, given their different backgrounds and life trajectories, have different bodies of experience^{GFL} that prepare them for future learning, problem solving, growth, and collaborative contributions to collective intelligence. These bodies of experience^{GFL} need to be honored, recruited, used, and extended by teaching and learning systems and institutions.

7. All learners, regardless of their backgrounds and life trajectories, lack crucial bodies of experience^{GFL} important for learning, problem solving, growth, and collaboration for collective intelligence in our global, high-risk, 21st Century world. These bodies of experience^{GFL} need to be supplied by teaching systems and institutions and often require a diverse array of backgrounds and life trajectories as part and parcel of good distributed teaching and learning systems (Gee 2013a, 2015b) in our out of school.

The term "mentors" here means parents, teachers, more advanced peers, technologies, social groups, and institutions. Teaching and learning is a coordinated and well-timed dance among experience, language as function, language as system, and mentors. One of the key capacities of new technologies like simulations, augmented reality, video games, and various forms of social media is their capacity to allow us to design well-structured, well-constrained, and well-mentored experiences for learners.

Giving learners tests or assessment when they lack the capacity to give situational meanings to words and phrases and have only verbal meanings (because they have too little experience[GFL] in the domain) is unfair, especially when others have had such situational meanings based on rich, well-mentored experiences. Giving learners experience but with too little mentorship and language as system can make them peripheral participants who do not share enough norms and systematic thinking with others to make real progress and gain standing in a domain.

Human capacities grow from experience, especially experience[GFL]. The only way to grow or assess such capacities is to know how much experience (especially experience[GFL]) a person has had in a domain and to ensure the person gets such experience if he or she has not had any or not had enough. Teaching, learning, and testing are unethical if they are not based on experience[GFL] for all.

REFERENCES

Baddeley, A., Eysenck, M. W., & Anderson, M. C. (2009). *Memory*. London: Psychology Press.

Barsalou, L. W. (1999a). Language comprehension: Archival memory or preparation for situated action. *Discourse Processes* 28: 61–80.

Barsalou, L. W. (1999b). Perceptual symbol systems. *Behavioral and Brain Sciences* 22: 57–660.

Barwise, J. (1981). Scenes and other situations. *The Journal of Philosophy*, 78: 369–97.

Barwise, J. (1988). *The situation in logic*. Stanford: CSLI.

Barwise, J. & Perry, J. (1983). *Situations and attitudes*. Cambridge, MA: MIT Press.

Bergen, B. K. (2012). *Louder than words: The new science of how the mind makes meaning*. New York: Basic Books.

Bereiter, C. & Scardamalia, M. (1993). *Surpassing ourselves: An inquiry into the nature and implications of expertise.* Chicago: Open Court.

Biemiller, A. (2003). Oral comprehension sets the ceiling on reading comprehension. *American Educator* 27.1: 23, 44.

Chomsky, N. (1995). *The minimalist program*. Cambridge, MA: MIT Press.

Clark, A. (1989). *Microcognition: Philosophy, cognitive science, and parallel distributed processing*. Cambridge: MIT Press.

Cosmides, L. (1989). The logic of social exchange: Has natural selection shaped how humans reason? Studies with the Wasson Selection task. *Cognition* 31:187-276.

Cruse, D. A. (1986). *Lexical semantics*. Cambridge: Cambridge University Press.

Damasio, A. R. (1995). *Descartes' error: Emotion, reason, and the human brain*. New York: Quill.

Damasio, A. (1999). *The feeling of what happens: Body and emotion in the making of consciousness*. Orlando, FL: Harvest Books.

diSessa, A. A. (2000). *Changing minds: Computers, learning, and literacy*. Cambridge: MIT Press.

Gazzaniga, M. S. (1988). *Mind matters: How mind and brain interact to create our conscious lives*. Boston: Houghton Mifflin.

Gazzaniga, M. S. (2011). *Who's in charge: Free will and the science of the brain*. New York: HarperCollins.

Gee, J. P. (1992). *The social mind: Language, ideology, and social practice*. New York: Bergin & Garvey.

Gee, J. P. (2003). *What video games have to teach us about learning and literacy*. Second Edition, 2007. New York: Palgrave/Macmillan.

Gee, J. P. (2004). *Situated language and learning: A critique of traditional schooling*. London: Routledge.

Gee, J. P. (2008). A sociocultural perspective on opportunity to learn. In P. A. Moss, D. C. Pullin, J. P. Gee, E. H. Haertel, L. J. Young, Eds., *Assessment, equity, and opportunity to learn*. Cambridge: Cambridge University Press, pp. 76-108.

Gee, J.P. (2013a). *The anti-education era: Creating smarter students through digital learning*. New York: Palgrave/Macmillan.

Gee, J. P. (2013b). *Good video games + good learning: Collected essays on video games, learning, and literacy*. Second Edition. New York: Lang.

Gee, J. P. (2014). *An introduction to discourse analysis: Theory and method*. Fourth Edition. London: Routledge.

Gee, J. P. (2015a). *Unified discourse analysis: Language, reality, virtual worlds, and video games*. London: Routledge.

Gee, J. P. (2015b). *Literacy and education*. New York: Routledge.

Givon, T. (1992). The grammar of referential coherence as mental processing instructions, *Linguistics* 30.1: 5-55.

Glenberg, A. M. (1997). What is memory for? *Behavioral and Brain Sciences*, 20: 1–55.

Glenberg, A. M., & Gallese, V. (2012). Action-based Language: A theory of language acquisition, comprehension, and production. *Cortex*, 48: 905-922.

Halliday, M.A.K. (1978). *Language as a social semiotic*. London: Edward Arnold.

Halliday, M.A.K. & Matthiessen, C. (2013). *Halliday's introduction to functional grammar*. Fifth Edition. London: Hodder Arnold.

Hartmann, T. (2010). *Unequal protection: How corporations became "people"—and how you can fight back*. Second Edition. San Francisco, CA: Berrett-Koehler.

Hattie, J. & Yates, G. (2013). *Visible learning and the science of how we learn*. London: Routledge.

Hoff, E. (2013). *Language development*. Fifth Edition. Belmont, CA: Cengage Learning.

Ion Storm (2000). *Deus Ex Manual*. London: Eidos Interactive. Retrieved from http://gamecontentgreen.yummy.net/deusexdemo/doc/Deusexmanual.pdf.

Kelleher, J., Costello, F., & van Genabith, J. (2005). Dynamically structuring, updating and interrelating representations of visual and linguistic discourse context. *Artificial Intelligence* 167.1-2: 62-102.

Kintsch, W., & van Dijk, T. A. (1978). Toward a model of text comprehension and production, *Psychological Review* 85.5: 363-394.

Kirschner, P., Sweller, J., & Clark, R. E. (2006). Why minimally guided learning does not work: An analysis of the failure of discovery learning, problem-based learning, experiential learning, and inquiry-based learning. *Educational Psychologist,* 41: 75-86.

Klein, N. (2007). *The shock doctrine: The rise of disaster capitalism*. New York: Henry Holt.

Klopfer, E. (2008). *Augmented learning: Design and research of mobile educational games*. Cambridge, MA: MIT Press.

Loftus, E. F. (1976). *Memory: Surprising new insights into how we remember and how we forget.* Lanham, MD: Rowman & Littlefield.

Loftus, E., & Ketcham, K. (1991). *Witness for the defense: The accused, the eyewitness and the expert who puts memory on trial*. New York: St. Martin's Press.

Marcus, G. (2008). *Kluge: The haphazard evolution of the human mind*. New York: Houghton Mifflin.

Martin, J. R. (1990). Literacy in science: Learning to handle text as technology. In F. Christe, Ed., *Literacy for a changing world*. Melbourne: Australian Council for Educational Research, pp. 79-117.

Murphy, M. L. (2010). *Lexical meaning*. Cambridge: Cambridge University Press.

Pinker, S. (1994). *The language instinct: How the mind creates language*. New York: William Marrow.

Renfrew, C. (2009). *Prehistory: The making of the human mind*. New York: Random House.

Reeves, B. and Nass, C. (1999). *The media equation: How people treat computers, television, and new media like real people and places*. New York: Cambridge University Press.

Saussure, F. de (1916). *Cours de linguistique generale*. Paris: Payot. English translation published as *A course in general linguistics* (trans. by Wade Baskin). New York: McGraw-Hill, 1959.

Schacter, D. L. (2002). *The seven sins of memory: How the mind forgets and remembers*. New York: Houghton Mifflin.

Schön, D.A. (1983). *The reflective practitioner: how professionals think in action.* New York: Basic Books.

Simons D. J., & Chabris C. F. (2011) *What people believe about how memory works: A representative survey of the U.S. population*. PLoS ONE 6(8): e22757. doi:10.1371/journal.pone.0022757

Smith, E. E. & Medin, D. L. (1981). *Categories and concepts*. Cambridge, MA: Harvard University Press.

Stanovich, Keith E. (2000). *Progress in understanding reading: Scientific foundations and new frontiers*. New York: Guilford Press.

Suddendorf, T. (2013). *The gap: The science of what separates us from other animals*. New York: Basic Books.

Tomasello, M. (2014). *A natural history of human thinking*. Cambridge, MA: Harvard University Press.

Vygotsky, (1987). *The collected works of L.S. Vygotsky, Volume 1: Problems of general psychology. Including the volume Thinking and speech*. Ed. by R. W. Rieber & A. S. Carton. New York: Plenum.

Wellington, J. & Osborne, J. (2001). *Language and literacy in science education*. Buckingham, England: Open University Press.

Wason, P. (1966). Reasoning. In B. M. Foss, Ed., *New horizons in psychology*. Harmondsworth: Penguin, pp. 135-151.

Wason, P. (1968). Reasoning about a rule. *Quarterly Journal of Experimental Psychology* 20: 273-281.

Wittgenstein, L. (1953). *Philosophical investigations*. Oxford: Blackwell Publishing.

Zwaan, R. A. & Radvansky, G. A. (1998). Situation models in language comprehension and memory. *Psychological Bulletin* 123.2: 162-185.

Zwiers, J. (2014). *Building academic language: Meeting common core standards across disciplines*. San Francisco, CA: Jossey-Bass.