Letters to the Editor

You Can’t Do Everything at Once: Responses to the Commentaries by Amin [2017] and Gupta [2017] on diSessa [2017]

I was happy to see commentaries on my article by two people who know my work reasonably well (with some apparent exceptions I will document), so their commentaries are on-topic and illuminating for me to respond to. Although Amin’s primary allegiances are different from mine, he is a careful reader and thinker and is always worth attending to. A principle line in Gupta’s work has advanced critiques of Chi’s ontological view (OV) that I began in 1993 [diSessa, 1993; see the “Responses to Commentary”], and he has also continued the Knowledge in Pieces (KiP) tradition of developing “fragmented” and contextual views of students’ ontologies and epistemologies, which are quite distinct from those that, like the theory theory (TT), propose coherent, stable, and non-productive “naïve states.” In my attempts to keep these comments compact, I hope readers will tolerate obvious gaps.

Response to Amin

Amin appeals to root feelings of fairness, balance, and community to suggest that joining together, collaging contemporary perspectives on conceptual change, is the right thing to do. I pursue two directions in response. I make the case that science is sometimes best served by dissent; my decision to contest TT and OV is a considered choice that I believe will serve us best over the long term. Second, I analyze the specific case that he puts forward as a model for what might be achieved by adding TT and cognitive linguistics insights to the analysis I made in my “microcosm” paper. I believe that his proposal is unconvincing, and, in fact, denies things that we
already know about the relevant issues. My analysis suggests that there are deep divides here (e.g., between KiP and TT) that are more like Kuhnian “paradigm differences” than just differences of opinion about some things. I maintain that a kind of collage approach – a bit from theory X, a bit from theory Y – is likely to result in a chaotic landscape where there is no coherent center to attend to and build on.

To establish some bona fides concerning choosing between joining and contesting, let me contrast an arena where I decided differently. I recently completed a 5-year project involving a substantial group of researchers from two paradigms that are generally construed as deeply conflicting. The project resulted in a book [diSessa, Levin, & Brown, 2016] containing inquiries into possible articulation of studies of knowledge with studies of human social interaction. My contention is that there is nothing contradictory about using theories and methodologies relevant to understanding knowledge in the “domain” of human interaction. Doing so is little different from the common or universal assumption that conceptual change in, say, physics is similar enough to learning in, say, biology that we don’t need a completely different theory to handle it. While those of us in the project who advocated a substantial and positive fusion of perspectives remained a minority – this is really hard work! – there were some strong results in the book, especially in the form of new research conducted by teams from the “conflicting” perspectives.

In science, I believe one has to be thoughtful in choosing between attempting to join apparently conflicting paradigms, or, alternatively, to understand why they are deeply at odds. Historically, the phlogiston theory had to yield to the new chemical ideas of combustion as they gradually developed. The emerging theory was not a polite compromise between the phlogiston and alternative views. Similarly (although admittedly an extreme case), an attempt to reconcile creationism with evolution is, in my view, properly judged to be doomed from the start: Root epistemic orientations are flatly at odds. My microcosm paper is not only an attempt to produce a clean contrast rather than an amalgam; it is an argument that that is the right thing to do.

Now to details: My original analysis noted that one of the unusual things that happened in the microcosm learning event was that a p-prim usually associated with symmetrical spatial configuration, abstract balance, was applied to a situation where there is no spatial symmetry, the
different temperatures of two objects in contact. To explain this, Amin draws attention to the metaphorical spatial language that is used to describe states and changes of state. So, space is there, he says, and thus invoking a spatially cued idea should not be surprising. There are several problems with this.

First, this account is going in a misleading direction. The bigger issue here is the rarity of activation, not the fact that it sometimes may happen. Amin makes a case that the use of some particular knowledge can be cued merely by spatial language. But, while spatial language concerning state and state change may be nearly universal, why does that idea not get evoked in any of the more than half dozen other editions of our thermal equilibration curriculum, even if spatial language for state and process situations are almost always there (an example is to come)? Amin’s explanation does not address why no other students in any other classes evoked these balancing ideas. Why it happened in this case is interesting to pursue, but of secondary importance in the big picture of instructional difficulties.

Amin is also missing a critical part of what I put forward [diSessa, 1993] as a central feature in the cuing of abstract balance: Symmetry. Even if a spatial perspective is established, where is the symmetry? Indeed, the TT’s “naïve theory of thermal equilibration” has a stark asymmetry at its core. Hot things are agents that act on (and are not reacted on by) non-hot things. So, not only are the cuing conditions for abstract balance not in place, a TT account assures us that they cannot be in place since thermal equilibration is necessarily asymmetrical. In net, conceptual metaphor does not establish a sufficient condition to evoke abstract balance, and the core of the TT account puts the nail in the coffin: The naïve way of construing thermal equilibration cannot involve symmetry, so abstract balance is ruled out.

Amin misconstrues what I say about the cuing of abstract balance. I meant to impute literal spatial symmetry, for example, a pan balance, as a positive feature in cuing. Now, here’s an important idea that is, as far as I can see, missing from the theory of conceptual metaphor, or at least what Amin is using here: Modality. Which ideas are cued is extremely sensitive to the modality of presentation. I learned the importance of modality ages ago when we presented animations of what children predicted would happen to an object (a ball) swinging around in a circle
if the string holding it broke – Piaget’s sling experiment. How subjects react to motion is often different from what they imagine and draw. Children who thought the ball would fly directly outward often reacted quickly and decisively to a simulation showing precisely that motion. “Oh! No, that isn’t what would happen. Something must have hit the ball [in the animation] to make it turn so sharply.” In contrast, a sharp corner in a drawing of the ball’s path is not at all disturbing.

Modality is powerful, and by this time many researchers have documented its influence. Studies of children learning the idea of horizontality from Piaget’s lab showed that when subjects gestured, they often gave discrepant answers compared to drawing. Susan Goldin-Meadow, for example, has built observations of the effects of modality into an expansive multi-year research program on its effects in learning.

Amin does not consider the influence of modality in knowledge cuing. He does not take seriously and carefully the existing descriptions of cuing conditions for p-prims (e.g., he seems to think that a linguistic spatial metaphor is sufficient to replace a spatial display, and he appears to ignore symmetry and its relation to TT theories of thermal equilibration). He, thus, picks and chooses elements of theories that are useful on the spot, but which cause problems on other occasions: He invokes childhood resources that attend to agency from the TT (see later discussion), but does not mention that the only on-the-record TT account of naïve student ideas about thermal equilibration rules out symmetry.

The next steps in Amin’s narrative are as follows: Goals are construed as destinations, and then, since the hot and cold water are already construed as objects, they easily “attract” agency, which is characterized as a universal “component of innate core cognition.” I agree that agency is powerful or even defining in many aspects of physics thinking. But agency is construed very differently in KIP than in Carey’s views; it is highly contextual and not an undifferentiated universal resource. The consequences of this difference are catastrophic for Amin’s attempt to explain how agency gets into the picture. I will get to that, but first I want to address other issues that frame the bigger picture.

Let me recount what turned out to be a serious and nearly pervasive block to getting other classes to take up something like W’s explanation. In several of our classes, students settled on
the phenomenon of slowing down to equilibrium as a destination phenomenon. They said to us essentially that "things always slow down as they reach their destination," like a train pulling into a station. Our interpretation of this is that it represents a kinematic (not agentive) p-prim, similar to (non-agentive) equilibration p-prims, but one that was not documented in earlier work.

In terms of agency, this is very different from W's final ideas. It is not obviously agentive at all, and the destination is the direct cause of slowing down, rather than a gap between temperatures. We never succeeded regularly in "nudging" this conceptualization into W's. It appeared to be a block, not a stepping-stone.

Even agentive interpretations are contextual and diverse. Note that, in Precursor 5 in my article, student R "agentified" one of the two partners in equilibration (possibly consistent with Wiser and Carey's TT account) and the other partner was not acting, but being acted upon. R is, however, stymied with this construal, needing W's innovation to advance: The objects in equilibration are each acting on themselves. They are not acting on the other object. The ultimate symmetry, i.e., each object acts on itself, is hardly salient in the mere fact that things might be regarded as agents.

The issue here is two-fold. First, there are a plethora of agentive and other construals, and most of them are not helpful. Bindings also are demonstrably fluid and potentially scientifically inappropriate. For example, R's agency had "external" patients, so she never got to W's acts-on-self version on her own. Some objects are simply not regarded as agents, but mere blocks to another object's motion [Kapon & diSessa, 2012]. In a different direction, a destination might also be present, but might invoke other p-prims (the "train station" p-prim), not Ohm's p-prim. Amin's account acts as if W's construals were the only ones that agency, object, and destination construals make available, as if nonagentive and other construals and bindings were not available. So, Amin's account seems to be disregarding richness and contextuality, two of KiP's foundational concerns. He talks as if the only issue is how W could have gotten to his final interpretation, the path of which, I think, is better handled by KiP in any case. But, critically, he also does not consider how W avoided the massive number of alternative, "attractive" interpretations that we saw in other classes.
Amin is walking into a minefield. KiP has been working on richness and contextuality for decades. We know there is a huge range of possibilities (both schemata and bindings), and we have been “bit” in our instructional attempts by the fact of richness, and by some particularly prevalent and persistent ones; we call the general phenomenon “hyper-richness.” The microcosm learning event, as I made clear, was a rare occurrence and is useful mainly because it did happen, it is unusually clear what happened, and it directly challenges core tenets of TT and OV.

Within KiP, contextuality is an idea that has a technical realization in parameters (“priorities”) that we have empirically determined and validated in certain circumstances. Kapon and diSessa [2012] follow three students during an instructional sequence, identify the p-prims they have and their priorities, and use those to explain very substantial differences in learning trajectory. We even identify episodes of learning that show thoughtful shifts in priorities. What is particularly relevant about this work is that it concerns a well-recognized problem in physics instruction, which turns out to be, essentially, that agentive interpretations are ordinarily not applied in the relevant context. More than that, we analyze one student who could not be brought to an agentive interpretation, while another followed a long and interesting path to get there. Agency, construed as a fixed and contextually undifferentiated resource, a “component of innate core cognition,” simply cannot get to this critical level of detail.

TT, as Amin admits, does not usually follow individual students and their intermediate states. So, the minefield is trying to do that as a newcomer to richness and contextuality. The connections he is trying to make might work in some respects, but it will take hard work to show that, against the backdrop of those who have made those concerns, theoretically and empirically, a backbone of their work. To bring TT (and likely conceptual metaphor) together with KiP, we need paradigm shift level changes in, for example, how TT advocates do their work on conceptual change, specifically regarding handling richness and contextuality. “Cutting and pasting” elements of very different scientific programs won’t work.
Response to Gupta

I also have to be frugal with Gupta; my sincere apologies. In particular, I compact a long list of references largely into “meta-references” that contain a fuller list of specifics. The most extensive meta-reference is diSessa et al. [2016], which I refer to as KAIA. My original microcosm article is also useful in this regard. Contact me if you want any particular references, or a full list.

Gupta’s commentary is deeply puzzling to me. This reply mostly elaborates this puzzlement. I begin in an unusual way. I describe what I think the commentary should be about, given the things it discusses. The puzzle is why it is not about what I think it should be about.

Science, related to education in particular, is an essentially multifaceted enterprise. We are a long way from a unified theory of all aspects, so we must pursue multiple avenues. The problem is that one simply cannot do all things at once. One has to pick pockets of inquiry that are independent enough from others so that one can reach the degree of depth and precision concerning meaning and empirical support that science requires. This is not easy. One needs to (a) make good judgments about dependence and independence; (b) be alert to impingements of other facets; (c) craft empirical and theoretical avenues of work that do not deny other facets, but minimize their threat to results; and (d) learn to actively manage non-focal issues so they don’t unreasonably interfere with our focal claims and empirical grounding. I have written about this in several places: (a) concerning design-based research, where I consider some key issues as “managing the gap” between our focal concerns and all other concerns that might impinge; (b) concerning how one can partition concerns, for example, into levels, that are more independent than strongly inter-constraining. My most recent thoughts about this are in an essay on “approximate modularity in science” in KAIA.

Even if we could in principle employ all relevant perspectives at once, the academic world would not allow it. Most of my papers are already at journals’ size limits, and editors mostly also weed out papers that involve substantial work from specialties to which they do not cater. Of course: You want to engage an audience that is most knowledgeable about the focal issues. Specialties exist and serve important purposes. My guess is that most of the readers of my microcosm paper do not know much nor care about representational design or interactional
structures. Even if they did, in most instances, it would be better for me to write separate papers for them (and I have).

Here is a rough-and-ready partial list of perspectives that are likely relevant to every study of real-world learning (Gupta acknowledges that I do the first, but, as developed later, he complains about the lack of attention to topics 2–4):

1. The development of topic-specific knowledge (the core focus of my microcosm article)
2. Students’ meta-knowledge and, in particular, their epistemological stances and strategies
3. Mediation: How external artifacts (like representations) affect thinking and learning
4. Social interaction, specifically: (a) Small-scale interactive practices, such as patterns in turn-taking; (b) mid-level-scale phenomena, such as classroom norms and time-extended interactional forms; (c) large-scale human-interactional issues, such as culture, ideology (e.g., racism), and things like literacies
5. Emotion, affect, and engagement

One can view these perspectives as projections from learning situations. They are all valuable, if still partial. But, like geometric projections, happenings viewed from one perspective can rule things out. A shadow of an object may not be able to tell you what the object is. But, for example, if the shadow is perfectly circular, the object is not a cube. I believe the domain-specific knowledge projection of the microcosm learning event rules out TT and OV interpretations.

I don’t think any sensible person could deny that these five perspectives are all relevant to any real-world, substantially scaled educational experiment. (Of course, I must admit that people who are not very sensible exist.) Nor do I imagine anyone could deny that these are all dimensions along which any such experiment might collapse, or, on the other hand, it might succeed largely on the basis of innovation along one of these dimensions.

I have done professional work in all of these categories, and I think it is important to document this in reply to Gupta. I don’t feel I need to document here my contributions to what’s primarily at issue in the microcosm article, content-specific conceptual development, perspective 1. But, I’ve devoted approximately the same amount of effort with about the same scholarly output to 3, mediation. My first book [Abelson & diSessa, 1981] was an engineering approach to changing
the entire epistemological and activity-structural (part of item 5) relationship between students and subject matter. diSessa [2000] elaborates the large-scale intent and scientific bases for this kind of innovation. This book includes discussion of conceptual change, but also how new mediation – new representations – can change the very conceptual grounds for learning mathematics and physics. The central concept of this work is “computational literacies,” which I describe as a “fundamentally social and cultural phenomenon” (4c). A significant part of the book is devoted to the concept of committed learning, which is deeply cultural and “affect-inclusive” (Gupta’s term). I just finished writing an update on the contemporary state of the art concerning “big picture” views of technology and education, most specifically the broad contemporary cultural scene and how it is facilitating or impeding the development of such literacies (4c).

My students and I have done KiP-based studies at the microscale on how representations facilitate learning. Parnafes’ dissertation concerned how, in detail, specific representations facilitate conceptual change concerning the concept of speed. She and I also looked at how different representations in a computer learning environment seeded and differentially supported distinctive conceptual strategies for solving problems. Sherin did an exhaustive KiP microanalysis of how programming representations differ from algebraic representations in terms of conceptual advancement in physics.

I wrote my first published paper on student epistemologies, perspective 2, in 1985. Years later, I collaborated with two of Gupta’s close colleagues and mentors, David Hammer and Andy Elby, on a paper on KiP’s bread and butter: micro-analytical, bottom-up development of the form and content of student epistemologies. I don’t claim to have done major work in this area partly because I was happy to rely on the KiP-oriented work by my students, notably Hammer and Elby. However, that does not mean that I don’t know about the area and don’t think about it in every design of educational intervention.

Category 4 (interaction) at the smaller-scale end (4a, 4b) is interesting. It has become more central to my research in recent years, whereas mediation (3) and conceptual change (1) were prominent from the beginning. For example, I wrote a paper on how clinical interviewers set the proper epistemic stance (Gupta would say “framing”) so as to authentically probe student ideas.
Not incidentally, this is essentially the same stance we cultivate in classrooms. In a recent paper, I revisited the analysis of clinical interviewing (with colleagues who are specialists in linguistics and interactional approaches to studying learning) specifically with respect to a small-scaled interactive form called “revoicing” (4a). But then we went on to compare how higher-level goals of interviewing compared to classroom goals very substantially change the form and function of revoicing (4b).

As I mentioned in my reply to Amin, I recently finished an edited volume (KAIA) that came out of a 5-year collaborative project investigating how one might articulate, rather than contrast, knowledge-oriented and interactional approaches to learning (bridging items 1 and 4). I wrote several chapters and commentaries developing my views on this.

Every project I have ever done involves several or most of the listed perspectives. Most projects have independent papers dealing with several of them. Some projects have produced papers that deal with several of these issues at once. Every project involving educational design probably involves all these issues, even if some perspectives are handled informally or may not reach a level that warrants publishing.

So, we have firm ground for a good discussion. Gupta could say, “You have not ‘managed the gap’ [dealt with non-focal perspectives] well enough, in this particular way.” He could say, “There is something faulty in your general strategies for creating ‘approximate modularity’ in your scientific program, or in how you present your results.” He could differ with how I’ve dealt with any of the particular dimensions, or even propose some new dimensions that I have ignored in my work. But, he didn’t do any of that. Instead he believes I am ignoring things that have been life-long concerns, and are definitively in the project – though not salient in this paper. He calls me out on the role of external representation, a decade-long and intense focus of my research. He calls me out on epistemology, which has been a lively interest since near the beginning of my career. He calls me out on social interaction, after I just spent five years working on a project to engage my knowledge-based approaches with the analysis of interaction. To boot, he illustrates my lack of attention by using what seem to me casual suggestions about how these issues might play out in my data (see below).
It’s also ironic that Gupta seems to be “picking on” KiP as not doing some things he thinks we should be doing. Yet he doesn’t seem to know about the breadth of foci that KiP encompasses. KiP has encompassed many subject areas, including physics, mathematics, biology, ecology, and chemistry. More to the point of his criticism, I mentioned KiP analyses of how representations work. As far as social interaction goes, KiP work by Thomas Philip addresses “ideological transformation” – specifically, learning about race and racism. One of my papers in KAIA makes some suggestions about how to develop a better understanding of interactional patterns than currently exists, using KiP-styled analysis and general principles. An in-press paper of mine develops a knowledge-oriented, KiP inspired view of the classic “sociocultural” issue of “identity.”

The core of Gupta’s complaints is contained in one sentence. He says we need to “move from a cold clinical position,” by which he must mean a knowledge-oriented position – or my knowledge-oriented position – to an array of other views, which he characterizes as entangled with values. He exemplifies other positions as epistemological (2), and material (3) and social organization (4), all of which I have pursued.

What might this core sentence mean? It might mean that there is no value in perspective 1, since he states that we must “move from” it to other things. If so, it seems to me he should explain why it is useless. Alternatively, perhaps he believes that aspect is done, and thus “move from” it just means to move our attention elsewhere. This seems equally strange, given the starkly contrasting views of conceptual change at issue in my microcosm paper. I would expect him to explain. But he doesn’t.

I want to consider at least a few specifics that Gupta offers as counterparts or complements to what I did. In this, Gupta is in a similar position to Amin in thinking we have not thought about the things he talks about, don’t have definite positions about them, nor data to support our own positions, and possibly contest his self-described “speculations.”

To start, Gupta appears to have misframed the article. He appears to think it is about every detail of what happened in this learning event, not just the content-specific knowledge projection. But, the logic of the paper is “this conceptual development happened!” however it happened. Now, what would different theories of conceptual change say about that? So, he thinks he can add detail
in how it happened in other perspectives. I could too (and will, just a bit, below), but almost none of this is to the main point.

Gupta starts his “details” section by positively describing the attitude he sees in some of W’s contributions. But he seems not to consider that W’s attitudes and stance are exactly what we aim for and seek to instantiate. In fact, I would say, these are minimal preconditions for our work. If we could not instantiate those attitudes, we would halt the experiment. In one instance of our patterns class, we did fail (owing to adverse cultural conditions in the school), and we moved to a different site.

Gupta wants to know more about how the teacher created a positive epistemic frame. In this, he misinterprets my explanation of how we decided on this site, which was on the basis of links with a teacher working there, a teacher with whom I have worked for about 30 years in very many ways. So, we knew that his students would be well-prepared to take the epistemic stance we wanted. And, they were; there is no mystery. Furthermore, graduate students in my group (named in the paper’s acknowledgements) were the actual instructors of the unit. So, the group as a whole would have taken responsibility for fostering productive student attitudes, were they not in place. We had to do that in other contexts.

With regard to representations, Gupta seems to think these were not in our minds. This is profoundly incorrect. For example, the decision to have the second phase of instruction mediated by graphs was an empirically and theoretically motivated (and successful) attempt to channel the richness of students’ prior ideas, moving them toward some more productive intuitions (e.g., toward equilibration p-prims). Furthermore, the phase involving a scaffolded reconstruction of a computer model (nearly irrelevant to the microcosm paper, since essentially everything in the microcosm learning event happened before that stage) attempted to reproduce prior work on scaffolding student understanding of physics using computational representations. For reasons we do not completely understand, this move was less successful in the case of equilibration than for prior topics. Discussion appears in another paper.

Gupta says he believes he can see why our microcosm students settled on the bindings they did. But in no other instantiation (of more than half a dozen) did any class settle, without very
substantial scaffolding, on anything like what W and his colleagues spontaneously did. Like Amin, he does not know how difficult-to-achieve and exceptional the microcosm case is. And he doesn’t seem to anticipate that we have thought long and hard about this, so can bring data to undermine casual speculations.

Finally, with respect to interaction, Gupta misinterprets a disclaimer about a teacher’s turn in the class. Gupta says I framed the turn in terms of helping social uptake. Social uptake was the topic, but in the quote Gupta provides I was trying, briefly, to warn readers that while they might interpret the teacher turn as strongly sanctioning a student idea, in fact it is a “mere” revoicing (typical in our instruction), which asks students to agree or not with her rendering of their ideas. Why is Gupta both championing more detailed attention to interaction and also insensitive to this interactional issue?

In sum, Gupta is making several mistaken assumptions in his commentary. Perhaps the most personally frustrating is that he does not seem to know anything about the larger frame of my life’s work. He does not expect that we have considered the epistemic stance we want and need to do our work. He does not expect that the material infrastructure of this learning environment was both carefully designed and its effects monitored. He appears to think that we do not attend to interaction in instructional design and evaluation of “what happened.” Perhaps the deepest mistake is to regard KiP as a framework only for subject-specific conceptual growth, and not also (a) a perspective on interaction (e.g., student and teacher “knowledge of interaction”; or, at larger scales, a way of thinking about ideologies and culture); (b) a perspective on student epistemologies (knowledge about knowing); and (c) a way of considering the material infrastructure for thinking (e.g., KiP-based analysis of the effect of representations). His essay frames my colleagues and I as negligent opponents, whereas we are actually friends who regard all of the dimensions he mentions – and more – as important. Indeed, we have busily been working on at least some of those things for decades.

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References


