

Performance analysis: Characterizing knowing in a clinical interview

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Abstract

This paper describes a nascent and developing method called *performance analysis* of characterizing “what people know” as they engage in cognitive activity, illustrated in the case of an undergraduate chemistry student answering questions during a clinical interview. The units of the analysis, called *information performances* or in-forms for short, are knowledge elements that are constituted in interaction. In-forms perform multiple functions simultaneously for the participants in interaction. These functions are both interactional, such as positioning an interviewee as a competent chemistry student, and informational, such as answering chemistry questions correctly. Performance analysis is intended to be sensitive to the situated cognition concern that knowing is tailored to suit particular purposes in particular situations, the distributed cognition concern that knowledge is distributed across people, material artifacts, and representational systems, and the conversation-analytic concern that interaction is complex and deserving of close study. The suggestion is made that clinical interviewing would benefit greatly from a frank consideration of what kinds of knowing are valued and the structuring of the interview so that it embodies those purposes.

Introduction: Knowing in a clinical interview

Clinical interviewing is a common methodology in research on science and mathematics education, especially for researchers concerned with conceptual understanding and development. In a prototypical clinical interview, the interviewer poses a series of core questions that ask the interviewee to make sense of, or explain, a phenomenon (for example, a table supporting a book, the phases of the moon, or a bird changing the color of its plumage during the winter). A series of follow-up questions are then asked in order to further probe or clarify the interviewee’s

conceptual understanding of the situation; these follow-up questions are tailored to the particular situation and are often invented on the spot in response to what the interviewee has just said. In this regard, clinical interviewing departs markedly from formal (or structured) interviewing, as employed in psychological and sociological research, in which the attempt is made to ask exactly the same questions in exactly the same way during each interview (for a critique of this practice, see Suchman & Jordan, 1990). On the other hand, because the phenomena and the questions are chosen by the researcher, clinical interviewing is likewise distinct from informal interviewing, as employed in ethnographic research, in which the interviewer has only a list of general topics to address, and the interests of the interviewee guide the specific direction of the interview (see, e.g., Burgess, 1984).

Clinical interviewing has a long tradition in educational research, dating back to Piaget, and has been used to study conceptual understanding in a wide variety of educationally-relevant domains within the physical and biological sciences and mathematics (for a representative sampling, see diSessa, 1993; Ginsburg, 1997; Southerland et al., 2001; and Vosniadou & Brewer, 1992). Given the widespread reliance upon clinical interviewing, it comes as some surprise that relatively little has been written about it as a methodology. Ginsburg's (1997) book is a notable exception, in which he concludes that, as long as the interviewer obeys a few common-sense strictures (for example, not asking "leading questions"), clinical interviewing is a powerful and appropriate tool for studying how people think.

Newman (1996), however, arguing from a situated perspective, raises the concern that "how people think" cannot be disentangled from issues of authority and accountability. Given that the situations and questions in a clinical interview are recognizably tied to a particular domain, Newman argues that the interviewee's responses cannot be divorced from the normative

standards and resources of that domain. Likewise, given that the interviewee is typically a student, recruited from a classroom, and that the interviewer is recognizably an authority in the relevant domain, the interviewee's responses must reflect an unequal distribution of authority. For both these reasons, Newman argues, responses could never meaningfully reflect "how people think" in any neutral sense, but rather how people grapple with the existing standards of a domain, in the presence of an authoritative other.

diSessa (1996) disagrees that normative standards and unequal structures of authority are necessarily relevant, arguing instead that the clinical interview shares much in common with non-school situations in which people, alone or with friends, puzzle over unusual phenomena that they encounter in their everyday lives. These type of "sense-making" activities, diSessa argues, are often entirely divorced from standards of explanation that are learned in school. Consequently, he concludes, it is plausible that some interviewees may not be attending to normative standards or the authority of the interviewer during a clinical interview, in which case it would be appropriate to talk about how the interviewee makes sense of a situation in a personally-meaningful way. diSessa (1996) suggests that an interaction analysis would help illuminate the nature of a clinical interview and allow the researcher to determine whether or not the interviewee is engaged in "sense-making." Although a detailed study of interaction like those associated with ethnomethodology, conversation analysis, interaction analysis, or sociolinguistics is not conducted, diSessa (1996) looked at occasions of talk in which the interviewee explicitly referred to school or "physics," showing that these moments decreased in frequency over the course of several interviews. This was taken as evidence that school-related standards eventually became irrelevant for the interviewee.

Theoretical commitments

The analysis described in this paper traces its roots to two bodies of research. The first is attributable to sociolinguistics and ethnomethodology, and particularly the commitments of conversation analysis (CA). A close analysis of talk-in-interaction allows the researcher to acknowledge an event's inherent complexity and dynamic quality, to understand how talk is used strategically to shape (and consequently derive its meaning from) local contexts, and to avoid giving preference to preconceived categories of activity or social relations rather than the categories that participants make relevant and attend to in-the-moment (see, e.g., Goodwin & Heritage, 1990; Jordan & Henderson, 1995; Schegloff, 1972; 1992). The complexity and inherent order that such analyses have revealed in the interactions between people suggests that diSessa's (1996) call for an interaction analysis of clinical interviewing should be taken seriously. The second body of research is attributable to theories of situated and distributed cognition. This body of research has shown that "knowledge," broadly conceived, is strategically tailored to do work in particular situations and is distributed across people and material artifacts including tools and symbolic representations (see, e.g., Cole, 1996; Hutchins, 1995; Leont'ev, 1981; Vygotsky, 1987; Wertsch, 1991).

Unfortunately, there has not been much overlap between these two bodies of research. While research that focuses on interaction has rarely taken as its primary goal the characterization of "what people know," research on situated and distributed cognition has rarely attended closely to interaction. Consequently, several questions are relevant. How is the co-construction of "knowledge" for particular purposes accomplished in interaction? What does this resulting "knowledge" look like at the local, microgenetic level? If we value some form of

the question “What does this particular interviewee know,” how can we ask that question in an intellectually honest way, and what qualifies as an answer?

Information performances

The approach taken in this paper is to identify and characterize the knowledge elements that are created, exist, and are observable (both by analysts and participants) in interaction. These knowledge elements are called *information performances* to highlight their status as segments of activity. The idea of a *performance* draws from both Goffman’s (1981) dramaturgical metaphor of interaction as a performance that is sensitive to the current audience of listeners, and the body of sociological work that speaks of performing certain social identities, such as gender or race, as a means of emphasizing that these roles are enacted in, and supported by, the ongoing interaction, rather than being fundamental aspects of a person’s nature.

Before moving to a more systematic description of the different types of information performances, or *in-forms* for short, it is worthwhile to develop a more general sense of two of their defining features: (a) in-forms do work; and (b) in-forms are constituted in interaction.

Information performances do work

The first defining feature of an in-form is that it, always and fundamentally, accomplishes some form of work. Such work may be informative (e.g., explaining a phenomenon), interactive (e.g., reorganizing the current participation framework), and/or social (e.g., invoking a set of relations or standards). Importantly, in-forms often, if not always, accomplish multiple jobs simultaneously. Goodwin (1987) has elegantly illustrated the multifunctionality of interaction in a detailed analysis of a short segment of conversation that occurred during a backyard picnic. During this segment, which opens during an ongoing discussion about censorship, Mike is attempting to initiate a story about something he saw on television:

(1) G.86:490

1 Curt: The S'preme Court really screwed up.
2 (0.8)
3 Curt: I think that's *terrible*. I really
4 do.
5 Mike: Well,
6 Pam: [[Yeah.-] I think everybody should be
7 allowed to (0.1) s:ee what they want er
8 Pam: read what they want. Bu:t,
9 Mike: I was watching *Johnny Carson*¹ one night
10 en there was a guy
11 Phyl: Yuh:, 'h if they wanna go t'see it they should.
12 Mike: [[by the na- *What* was that guy's name. = [Blake?
13 Curt: ← The Critic.
14 Mike: Blake?
15 Mike: No. **Mike Shifts Gaze To Phyllis**
16 Pam: [A no-
17 (0.6)
18 Mike: Robert Blake?
19 Pam: [Reed?
20 (0.2)
21 Mike: Er somp'n like 'at. = *He* was-
22 Pam: [Robert Reed.
23 Robert Reed.
24 Mike: No:, This guy's-
25 Curt: [No:, Rex Reed.
26 Curt: °()
27 Pam: [[*Rex Reed*. = Yuh.
28 Mike: [This guy's name was Blake,
29 (0.4) He was in the movie uh:, (0.6) In
30 Cold Blood

Although Goodwin does not attempt to characterize these participants' knowledge per se, I will assert (without justification for the moment) that the segment of activity consisting of lines 10 and 12-28 are a performance of a piece of information that could be glossed as "there was a guy named Blake." This propositional content, however, is only one aspect of the total performance, which also includes the variety of purposes the performance accomplishes in this particular interaction. Through a close analysis, Goodwin concludes that, at a minimum, the

following work is being done during this segment: (a) Phyllis is dislodged from a participation framework (established in the exchange in lines 6-8 and 11) in which she is conversing with Pam; (b) Phyllis is positioned by Mike (by his shift in gaze in line 12) as having shared knowledge of the guy's name; (c) Phyllis is (re-)established as someone who would watch late-night television with Mike; and (d) the telling of a story by Mike is initiated. All of this interactive and social work is in addition to the informative work in which (e) the man is identified as Robert Blake. In the current situation, this last is, arguably, the least consequential for the participants of all the work that is accomplished.

It should be made clear that I do not mean to necessarily imply individual intention when I say that a performance does work. It is unlikely that Mike consciously intended all of the functions that this performance ended up accomplishing. For example, the work of (re-)establishing a particular social relation between Phyllis and himself (as people who would watch late-night television together) may not have been an explicit intention of Mike's, and may have been merely a consequence of positioning Phyllis as possessing a certain kind of shared knowledge (which, in turn, may have been merely a consequence of trying to interrupt Phyllis' and Pam's conversation). Indeed, the statement that this social relation has been (re-)established is somewhat untenable; established for whom? Why this particular relation and not others, such as that they are people who know each other outside the current interaction, or that they are people who watch Johnny Carson? Consequently, it is important to distinguish between Schegloff's notions of relevance and procedural consequentiality. While any of the above social relations could potentially be relevant, only some will actually affect the ongoing course of the interaction. Thus, it is critical to not study in-forms in isolation, but to understand how they are related to what has come before and what follows in the interaction.

Information performances exist in interaction

The second defining feature of an information performance is that it is constituted in interaction. This implies two consequences. First, any in-form always involves every participant in the interaction, and is therefore not fully attributable to a single person. Second, any particular in-form that is observable in a particular stretch of interaction is distinct from, and potentially very different in form and function than, any in-the-head cognitive structure that could be attributed to a person or any physical object or tool that is present and in use.

Consider again the segment from Goodwin (1987), above. Although it may be tempting to claim that the content of this in-form (*there was a guy named Blake*) belongs, in some sense, to Mike, the performance should not be confused with any declarative cognitive structure that may or may not exist inside Mike's (or anyone else's) head. Certainly, Mike initiates the performance in line 10. And, as is often the case, one of the functions of the in-form is the attribution to Mike (and Phyllis) of the knowledge (used in the vernacular sense) that the guy's name was Blake. However, one of the main reasons for focusing on performances, rather than inferences about in-the-head mental structures, is to avoid certain analytical conclusions that might result from confounding the two. One of the major conclusions of Goodwin's analysis of this segment is that what appears to be forgetfulness in line 12 ("*What* was that guy's name. Blake?") should not be construed as a cognitive deficiency on the part of Mike. The performance that includes Mike's question has a particular form, but that form is dictated by particular functions (dismantling one participation framework and establishing a second) that should not be confused with forgetfulness. Likewise, although the fact that there was a guy named Blake appears to be solidified by line 30, this should not be taken as evidence that all of the participants now possess a stable declarative cognitive structure regarding the guy's name. There are many

possible *interactional* reasons for bringing the discussion of the guy's name to an end, including the desire to get on with the story or not wanting to continue a confrontation, that could explain the form of this performance; these possibilities must be considered before inferences are made about the cognitive structures of these participants.

Five aspects of information performances

The preceding discussion, centered around a brief example from a published study, was intended to illustrate what was meant by an information performance as a segment of activity that does work and is constituted in interaction. More specifically, in-forms have five aspects: an informational form and function, an interactional form and function, and content.

The *content* of an information performance refers simply to the propositional content of that stretch of activity. In the above example, the content of the performance was the information that "the guy's name was Blake." The content of an in-form is its defining feature; when the content shifts, a new in-form begins.

Informational form describes the relationship of the content to the content of the in-forms that occur immediately before and after the performance (and, to a lesser extent, further up- and downstream). An example of a content relationship might be that of a warrant or backing.

Informational function characterizes the in-form's role in furthering the ongoing goal-oriented cognitive activity (e.g., explaining a phenomenon). Not to be confused with any (putative) intentions possessed by the participants, the informational function must be established by looking upstream and downstream to determine how the performance actually is responsive to previous performances and how it affects subsequent activity.

While drawing heavily upon Goffman's (1981) performance metaphor for human activity, performance analysis acknowledges that any performance involving a live audience is

necessarily a group performance, structured by varying forms of verbal and nonverbal feedback from other individuals (Goodwin, 1981; 1987). *Interactional form* therefore characterizes how each participant contributes to the construction of the performance, both verbally (e.g., through feedback such as ‘mm-hm’) and non-verbally (e.g., through gaze, gesture, or body positioning). Interactional form also characterizes how the participants position themselves with respect to the performance’s truth and believability. This latter aspect is an extension of Goffman’s (1981) construct of *footing* to include the hearers in addition to the speaker. Finally, as an in-form is a stretch of activity, it is necessarily mediated by a set of available sociocultural resources (Cole, 1996; Hutchins, 1995; Leont’ev, 1981; Vygotsky, 1987; Wertsch, 1991), which also structure the interactional form of the performance.

A single in-form may have multiple *interactional functions*, including the establishing, invoking, maintaining, or restructuring of participation frameworks, social identities, and/or structures of accountability. As in the case of the informational function, interactional functions must be established post-hoc, in reference to how the performance is responsive to, and helps construct, the ongoing activity.

In summary, in-forms are intended to be the extramental, co-constructed counterparts of conceptions. Existing and observable in activity, they are meant to provide a useful intermediate role between records of activity (e.g., video recordings of interviews or written responses to tests) and inferences regarding particular cognitive structures. Their five characteristics, described above, are an attempt to disentangle the informational and interactional aspects of cognitive activity while simultaneously keeping both in view.

Example analysis

I will now attempt to characterize some of the information performances that are constituted during a five-minute segment of a clinical interview in order to illustrate how a performance analysis could help answer the question, “What does this interviewee know?”

This segment, which appears in Appendix C, was taken from an existing corpus of video recordings of clinical interviews conducted with undergraduate student volunteers taking a high-enrollment general chemistry course for non-majors at a large public university in the San Francisco Bay Area. Eight one-on-one interviews were conducted midway through the semester. The interview questions dealt with the topic of chemical equilibrium, on which the students had taken a midterm examination during the prior week.

The student in this segment is a Caucasian female in her late teens and a freshman in her second semester. The interviewer (the author), is a Caucasian male in his mid-20s. He had been a graduate student teaching assistant for the course twice before, but not for the semester during which the interviews were held. The interviewer had no prior relationship with the interviewees beyond recruiting them during their laboratory section and over e-mail. The interviewer was moderately experienced, having conducted a series of similar clinical interviews on two prior occasions. The interviewer introduced himself to this particular interviewee as a graduate student conducting research in chemistry education with an interest in learning how the interviewee thought about the material she had learned for the previous week’s midterm.

The segment under study, which occurs 23 minutes into the interview, begins as the interviewer positions the interviewee’s response to the previous question as complete and asks a question about a new hypothetical situation. This situation, the fifth (and last) of the interview, was also depicted on a sheet of paper made available to the interviewee (Appendix B). The

situation involves a chemical substance called hypochlorous acid (also called HClO, pronounced “H-C-L-O”). When this acid is dissolved in water (also called H₂O, pronounced “H-two-O”), some of the acid disappears and two new chemical substances appear: ClO⁻ (pronounced “C-L-O-minus”) and H₃O⁺ (pronounced “H-three-O-plus”). Using chemical terminology, the acid has *reacted* with the water to form ClO⁻ and H₃O⁺; HClO and H₂O are called *reactants* and ClO⁻ and H₃O⁺ are called *products*. The phenomenon to be explained is that this reaction does not appear to go to completion. That is to say, when things stop changing, some products (ClO⁻ and H₃O⁺) have been formed, but some of the original acid (HClO) is left over as well. After a somewhat lengthy description of the situation (units 3–15), the interviewer asks for an explanation of this phenomenon in unit 16.

In the analysis that follows, please refer to the transcript in Appendix C. A discussion of transcript conventions appears in Appendix A.

In-form: H₂O is a limiting reagent

Even before the interviewer begins to ask the question in unit 16, the interviewee has begun to display confidence in answering. In the middle of unit 15, at a place that could be construed as the end of the interviewer’s description, the interviewee begins to nod slowly, continuously, and exaggeratedly. This continues through to the middle of 16, when, taking advantage of a brief pause in the interviewer’s talk, the interviewee makes a bid to start speaking. The interviewer continues, however, and the interviewee fidgets, eventually taking advantage of another brief pause to begin talking over the interviewer.

The emphasis in the interviewee’s first statement, “I think I can **answer this** one,” positions her explanations of the four previous situations as being relatively unsatisfactory (this is consistent with how those explanations were positioned at the time they were given). In

making this contrastive statement, the interviewee both displays her relative confidence in producing an answer to this question, and displays her orientation to the ongoing activity as one of “answering chemistry questions correctly.” These displays are ratified by the interviewer in unit 18, although in a way that attempts to lessen the stakes of getting the answer wrong (compare “cool” with “good” or “finally”).

Beginning in unit 19, the interviewee immediately begins to constitute an in-form for the purpose of answering the question (note the use of the discourse marker *because*). This constitution begins with the use of the scientific term *limiting reagent*. The use of this term connects this in-form to her chemistry course, where this term was most likely learned, and makes what is taught in that course relevant for answering the question.

As a contrastive example, consider this excerpt from a clinical interview with a different student. It begins with the equivalent of unit 16, the asking of the core question.

```
(2) [3/21:2p]
1 IR: so the question is ()
           how come there's still some ()
                                           HCLO
           left ()
           when this ()
                   reaction ()
                           stops ()

2 IE: mm ()
           how come there's still some HCLO left ()

3           um ()
           let's see ()
           I mean ()
                   they have ways of explaining it in chemistry =

4           where they tell you ()
                           um =
                           about KAs and KBs =

5           where things disassociate =

6           and =
                   like ()
                   d- ()
           it's dependent on PH and stuff like that =
```

7 but I'm trying to formulate a way where ()
it won't
get ()
like =
convoluted in numbers ()

IR: okay ()

:

8 IE: um ()
as for ()
pure explanations of that they really never nailed
that ()

As in the segment under study, in the above excerpt the interviewee introduces several scientific terms (*KAs and KBs, disassociate, PH*) that are connected to his chemistry course. In contrast with the segment under study, however, this interviewee explicitly rejects the use of these terms, positioning what was taught in the course as not relevant. He continues this positioning throughout his interview; a later example is given in unit 8, in which he also orients to the ongoing activity as “giving a pure explanation.” Importantly, this interviewee does not explicitly deny the possibility that a “pure explanation” could be given in his course. Indeed, the way that unit 8 is designed seems to imply that “they” *should have* “really nailed that.” So a “pure” explanation is likely to still be connected to what *could* be learned in a chemistry course, but not, apparently, to what he *did* learn in *his* chemistry course.

Returning to the interviewee in the segment under study, she appears to wield the term *limiting reagent* confidently; although the use of questioning pitch in unit 19 creates a space for the interviewer to pass comment, this space is designed to be very small. Immediately upon finishing unit 19, the interviewee shifts her gaze away from the interviewer and towards the paper, leaning in to pick up a pencil. Although the interviewer is given an opportunity to comment, the interviewee does not apparently expect him to do so; this behavior is consistent with her expression of confidence in unit 17.

Goodwin (1987) has shown that the design of utterances in this manner – as statements delivered with questioning pitch at the end – is a strategy for communicating information in the presence of a party who already possesses that information. The questioning pitch, accompanied by a shift in gaze to a particular person, acknowledges that person as already possessing the information. By not designing the statement as a true question, however, the speaker simultaneously asserts that they possess the information also, maintaining their position as a competent story-teller. The use of this utterance design in this interview positions the interviewee as a competent explanation-giver, while simultaneously acknowledging that the interviewer already knows the answer to the question. The expected response from the interviewer is a minimal expression of agreement; for example, a head nod or a verbalization using pitch that acknowledges the interviewee is going to continue (e.g. *mm hm*, or *okay*,). Nearly every unit throughout this interview is designed in this way (e.g. 19, 20, 21, 22, 24, 25, 26, 28...). Most exceptions occur when no new information is presented (compare 23 with 22, 27 with 26, etc.).

At this point, it is important to remember the dangers of confounding in-forms, which are constituted in interaction, with mental structures. While it is true that the interviewee introduces each piece of information used to constitute this in-form, it is equally true that the interviewer ratifies each of these pieces as shared knowledge. That is, by giving the expected response to the interviewee's designed utterances (as discussed above), the interviewer helps to constitute the in-form as agreed on by both participants. As it turns out, this in-form is incorrect: according to the standards of chemistry (including the local standards of this interviewee's chemistry course), water is not a limiting reagent in this situation. There is not "less H₂O to start off with than there is HClO" (unit 24); there is, in fact, several thousand times as much H₂O. However, the full constitution of this in-form and its extended use over the course of this five-minute segment

4b IE: yeah =
for certain =
um (1.5)
for certain acids and bases? =
like (.)
they have (.)

6 well all of them =

4c they have KA values =
all acids have KA values (0.5)

7 and they can only take in a certain amount? (1.0)
of (15.0)

8 yeah =
to be in equilibrium =

9 they have to =
um (3.0)
be in proportion? (0.5)

10 um (0.5)
so that (.)
it's (3.0)
mm (1.5)
the proportion of products? (1.0)
and
reactants? (0.5)
equals the KA value? =

11 and that's the equilibrium (1.5)
value (1.0)

12 IE: [and]

13 IR: [okay,] (3.5)

14 IE: yeah =
that's the only way I know how to say it (1.5)
IR: all right, (4.0)
IE: yeah. (2.5)

The overall impression one gets from this interviewee is that she is unsure of herself. She begins her response with an explicit statement to this effect (unit 2), her response is filled with long, uncomfortable pauses (especially following unit 7), and she ends with a qualification in unit 14. As it turns out, everything she is saying is correct from the perspective of her chemistry course, but this is overshadowed by what is tempting to interpret as a lack of confidence in her knowledge. Once again, however, the lack of confidence she is exhibiting is foremost with respect to the in-form that is being constituted in interaction. Note that, despite a steady stream of

utterances designed to elicit confirmation of shared knowledge (units 4b, 7, 9, and three in 10), the interviewer does not respond, not even with a head nod. When the interviewer *does* respond (unit 13), the interviewee appears to interpret this to mean that she has said enough; she immediately halts her elaboration (unit 12) and, when the interviewer fails to continue speaking, the interviewee's next utterance positions her answer as finished. Rather than indicating a lack of confidence in her knowledge, this interviewee's hesitancy and prolonged "dragging on" could also be attributed to the interviewer's complete lack of feedback. Given the interviewee's repeated bids for feedback, the lack thereof can reasonably be taken to mean both that the interviewee has incorrectly positioned the in-form as shared (and hence correct) knowledge, and that the in-form has not yet been constituted to the satisfaction of the interviewer.

Returning once again to the segment under study, one more feature of the in-form *H₂O is a limiting reagent* is worth pointing out. Its constitution, over units 19 to 24, includes two observations: (a) both HClO and H₂O are initially present (unit 20); and (b) HClO still remains after the reaction (unit 21). These two observations are both knowledge elements, constituted in interaction for a purpose (at the very least, to support the constitution of *H₂O is a limiting reagent*). As such, these two observations can also be considered in-forms. This illustrates two points. First, one of the purposes of a in-form can be to support the constitution of other in-forms. That is to say, in-forms need not exist sequentially in time, but can overlap and exist in hierarchical structures. Second, it is unlikely that a full characterization of all the in-forms constituted in interaction would ever be analytically useful, let alone feasible. The choice of which in-forms to focus on is an analytical choice and would depend on what types of in-forms (and purposes) a researcher is interested in. For the current analysis, I will focus on what might be called the *top-level in-forms* in the segment. By that, I mean those in-forms that are

constituted, in part, for the purpose of directly furthering the ongoing goal-directed activity (in this case, answering questions).

As mentioned above, the interviewee first indicates the goal-oriented purpose of the H_2O *is a limiting reagent* in-form in unit 19; the use of *because* positions this in-form as answering the question posed in 16. In unit 25, the interviewee uses this in-form as the *if* clause in an *if-then* sequence. The completion of this sequence does not occur, however, until unit 75, fifty units later (note that the *if* clause from unit 25 is repeated in unit 74). In the intervening time, a second in-form is constituted, beginning in unit 26.

In-form: *stoichiometry relations*

This second in-form takes over 40 units to be fully constituted, beginning in unit 26 and continuing until unit 72. The constitution of this in-form involves a series of simple calculations (subtractions) that result in the production of an inscribed chemical representation called a *stoichiometry table*, although the interviewee does not use that name (nor any name, for that matter; she only uses pronouns, as in units 37, “I’ll do it with molecules,” and unit 60, “let me do this cleaner”). The in-form that is constituted in interaction, however, is distinct from this material artifact. Constituted with the help, once again, of interviewer responses like *mm hm*, and embodied with a great deal of pointing, this in-form is a set of mathematical relations, called *stoichiometry relations*, between the four chemical substances involved in the reaction at different points in time.

These relations take a particular form, in part, because one of the chemical substances is identified as the *limiting reagent*. Consequently, there is a logical relationship between the H_2O *is a limiting reagent* in-form and the *stoichiometry relations* in-form. This relationship is implied by the hanging *if* clause of unit 25 and explicitly indicated by the linking of units 41 and 42

(using *so*) and units 73, 74, and 75 (using *because* and *so*). Together, these two in-forms are positioned as satisfying the top-level purpose of answering the question posed in unit 16. This positioning is collectively accomplished by the interviewee (who leans back in her chair, shifts her gaze to the interviewer, and positions her utterances as a summary, all beginning in unit 73) and the interviewer (who upgrades his response to *all right* in unit 75).

Once again, however, the *stoichiometry relations* in-form does more work than just satisfying this top-level goal. As was the case for the *H₂O is a limiting reagent* in-form, by using knowledge associated with her chemistry course (in this case, a chemical representation), this interviewee makes relevant what she has learned in that course. (One wonders if the interviewee from excerpt 3 above would have initiated the constitution of a similar in-form, given that it would be “convoluted in numbers.”)

This in-form also positions the interviewee as a competent chemistry student. To see how this is accomplished, note that the entire table of relations embodied in this in-form is not necessary. In order to explain why having less H₂O than HClO would result in having leftover HClO, only the first two columns of the table (those pertaining to the HClO and the H₂O) are strictly necessary. Indeed, it would even be possible to explain the relevant relations without producing a table at all. By constituting all of the possible relations in this in-form, the interviewee is positioned as being able to competently produce the entire table, a valued skill in her chemistry course.

Once again, it is important to point out that the accomplishment of this work does not necessarily imply individual intention. Another possible reason for constituting all of the possible relations in the in-form may have been that the interviewee interpreted the question as belonging to a common class of questions from her chemistry course, a type of question known

as a *stoichiometry problem*. A table like the one she produced is an expected and valued component of a correct answer to these questions. Consequently, the constituted form of the *stoichiometry relations* in-form may have been directly serving the top-level purpose of getting the answer right, while the positioning of the interviewee as competent was an unintended side benefit. Whether or not a particular purpose is intentional is a separate question from what purposes are accomplished by the in-form (and, arguably, much more difficult to answer).

The five units from 34 to 38 are particularly interesting, because they position the *stoichiometry relations* in-form as being constituted in an unusual situation. The concern is raised that the numbers in the table should have units of moles, not molecules. The current situation involving molecules, however, is apparently close enough to the preferred situation involving moles that the constitution of the in-form is continued. It's not clear why, if "it has to be a mole relationship," it would be okay to "do it with molecules." The excuse given in unit 38, that "it's just an example," is probably a way of naturalizing the ignoring of the difference without having to make further comment. After all, there is evidence discussed above that the stoichiometry table is an expected part of the solution, so there is reason to continue on regardless of the existence of a problem. Unit 34 ("it doesn't exactly work the same way with molecules") could then be seen as a hedging move, allowing the continued constitution of the in-form while accounting for any problem that may occur down the line (in the unlikely event the in-form turns out to fail). That the in-form is expected not to fail is supported by the fact that the problem raised in units 34 to 38 is never addressed again, even when the in-form turns out to work successfully. (It happens to be the case that a stoichiometry table can be used for either moles *or* molecules, a fact that the interviewer was aware of at the time, but this is of limited

relevance. Once again, the interviewer has helped the interviewee position the difference between moles and molecules as a problem, through his responses like *mm hm.*)

Even more so than for *H₂O is a limiting reagent*, this top-level in-form is supported by many other in-forms. Two of these are worth noting because of the type of work they perform. In-forms based on the scientific terms *neutralized* and *stoichiometry* are constituted in units 44-45 and 49, respectively. These in-forms are notable because they, in a sense, allow the interviewee to avoid work. That is to say, the work they perform is to allow the interviewee to continue the constitution of the *stoichiometry relations* in-form without having to pause to explain anything further. The *neutralized* in-form does the work of (not) explaining why the H₂O molecules “disappear” (unit 43), and the *stoichiometry* in-form does the work of (not) explaining why 72 trillion H₂O molecules would neutralize 72 trillion HClO molecules rather than some other number of molecules (units 48, 50, and 51). These in-forms continue to be used throughout this segment (see, for example, units 65-67, 75, and 78 – the last of which is an example of the interviewer using the in-form). Of course, not all scientific terms are used to avoid work; compare these examples with how the scientific term *limiting reagent* was used earlier. And, of course, avoiding work is not the sole purpose of these in-forms; once again, note how “I know the word” in unit 44 positions *neutralized* as being a preferred scientific term and, consequently, positions the interviewee as a competent chemistry student when she is able to successfully remember the term.

Discussion

What does this interviewee know?

Based on this short segment of a clinical interview, what can justifiably be said about this interviewee? How can we characterize what this interviewee knows? The full answer is given in

the analysis above, through a rich description of what particular in-forms were constituted for what particular purposes in that particular interaction. The analysis, however, may be crudely summarized as follows: in the presence of someone who is recognized as possessing authoritative knowledge of chemistry, and to satisfy the top-level goal of answering a chemistry question correctly (specifically, a stoichiometry problem), this interviewee confidently introduces the idea of a limiting reagent. With the help of the interviewer, this idea is developed into an in-form. Following the joint constitution of this in-form, the interviewee again confidently introduces the idea of stoichiometry relations. Again with the help of the interviewer, this idea is developed into an in-form. Together, these two in-forms are used to correctly answer a stoichiometry problem, make relevant knowledge that was learned in her chemistry course, and position her as a competent chemistry student.

A related question that is likely to be of interest to many researchers is, “What does this interviewee *not* know?” What is usually meant by this question is, “What *should* this interviewee have known?” and we should be as careful and honest in defining this question as we were for defining its opposite. For example, given the presence of an authoritative other and the co-orientation towards the activity of “correctly answering a chemistry question,” it would be unreasonable to suggest that this interviewee should have avoided the use of scientific terms. As a further example, one might suggest that the in-form *H₂O is a limiting reagent* should not have been used, as the content of this in-form is incorrect. This is likewise unreasonable, for the following two reasons. First, the idea of a limiting reagent was introduced in an interaction that highlighted similarities of the question to stoichiometry problems in which limiting reagents are relevant (e.g. phrases like “left over” and “end of the reaction,” lists of numbers corresponding to amounts of chemical substances) and backgrounded differences (e.g. the small label “Water” off

to the side of the right glass, indicating that some water is still present). Second, once the idea was introduced, the interviewer helped position the idea as correct through his verbal and non-verbal feedback, even though the intention of such feedback may have only been to support the interviewee in articulating her “own” ideas. Consequently, it is not fair to say that this interviewee should have constituted a different in-form. The most that could be claimed is that this interviewee should have introduced a different idea in an interaction that strongly suggested introducing the idea of a limiting reagent, which is asking for something considerably different (and considerably more difficult, which in turn creates a more favorable characterization of this interviewee’s knowledge).

A suggestion for improving clinical interviewing

Hopefully, the example analysis has illustrated one way of answering the question, “What does this interviewee know?” However, a more fundamental question is, “Why does one care?” This, of course, is an analyst’s concern and different researchers will care about different situations (and, consequently, will value different purposes for constituting in-forms). Some researchers may value the constitution of in-forms for the purpose of answering chemistry questions in the presence of a knowledgeable other using the standards of chemistry, because doing so is similar to taking a chemistry test, a practice that has important consequences for students. Other researchers may be more interested in how students explain certain phenomena outside of school, using in-forms that are not as connected to school knowledge (this may be closer to what diSessa calls “sense-making”). Still other researchers may value different purposes.

Unfortunately, in most clinical interviews, purposes are often concealed. Questions are designed by the interviewer using discourse markers like *so* to create a direct link to what has

come before, thus naturalizing the asking of a question without commenting directly on why it is being asked. See, for example, unit 16 (“so the question is”) in the segment in Appendix C. This strategy, which is used frequently in this segment (see units 76, 79, 81, 94, 118, and 146), has been described by Antaki & Rapley (1996) in their analysis of psychological interviews carried out to assess the quality of life of clients. In those interviews, as well as in the clinical interviews analyzed in this paper, direct linkage is used to avoid drawing attention to the fact that the questions are conceived of by and have particular purposes for those conducting the interview.

Likewise, as the analysis above has illustrated, answers are often designed by the interviewee in ways that obscure why they are constituting the in-forms. Excerpt 3 is a particularly good example of this; note how the interviewee uses *yeah* as a direct linker (e.g. units 4b, 8, 14) in a manner similar to how *so* is used by the interviewer. In general, as has been pointed out elsewhere, explicit displays of footing with respect to utterances are the exception rather than the rule (Goffman, 1979), even in settings where the footing is complex or exhibits leakage, as in the case of news anchors displaying neutrality while making controversial claims during news interviews (Clayman, 1992).

Consequently, it is my opinion that clinical interviewing would benefit greatly from a frank consideration of what particular purposes for constituting in-forms are valued, and the structuring of the interview so that it embodies those purposes. If researchers value the constitution of in-forms for the purposes of displaying knowledge learned in class, an interview with an authoritative other, such as was the case here, may be appropriate. If researchers value the constitution of in-forms for teaching a less-knowledgeable peer, a better format might involve, rather than an interviewer, the presence of a less-knowledgeable peer and a mediator who is not familiar with the content. If researchers value explaining a phenomenon to a non-

scientific audience, different people with different backgrounds would be appropriate. In these latter cases, if the presence of an authoritative interviewer is required for some reason, at the very least, the specific purposes for constituting in-forms should be made explicit throughout the interview.

Making purposes explicit or, better yet, reorganizing the structure of the interview so that it embodies those purposes would, in my opinion, greatly aid the researcher in establishing for what purposes different in-forms are constituted. Of course, the analyst should be always be sensitive to the fact that the interviewee may not take up intended purposes, or that they will also take up additional purposes that may be in conflict. Being explicit about purposes from the start, however, will likely mean that whatever purposes are actually taken up will also be explicit. This, in turn, will greatly aid the analysis.

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Appendix A. Transcript conventions.

Transcript conventions

The transcript below contains four columns. The first column is a sequential numbering of clause units. A clause unit is a stretch of interaction that expresses a single noun-verb clause. In the present analysis, clause units are preferable to turns-at-talk (Sacks, Schegloff, & Jefferson, 1974) for several reasons. First, a single speaker may talk for an extended length of time. In cases like these, which include interviewees responding to questions, it is desirable to have a smaller division than speaker changes. Second, multiple participants often contribute to constructing a single clause unit through several turns-at-talk (e.g., by talking in unison, by finishing a hanging sentence, or by simply providing back-channel feedback like *mm hm*). Third, speakers are sometimes interrupted in the middle of an utterance, by themselves or by others; in cases where the original utterance is completed following the interruption, discontinuous turns-at-talk can constitute a single clause unit. (In the transcript below, discontinuous parts of a single clause unit are labeled with letters, e.g. 29a and 29b).

Of course, the dividing up of a transcript into any units is somewhat subjective, and clause units are no different. This is especially the case for back-channel feedback like *okay* or *all right*, which could be construed as either a continuation of the previous unit or an entirely new unit (with the noun left implicit). As a continuum exists between feedback that is hearably a continuation and feedback that is hearably a new unit, any particular choice is necessarily subjective.

The second column contains a speaker identifier (IR: interviewer; IE: interviewee) printed whenever the current speaker changes.

The third column contains the talk. Bucholtz (2000) has highlighted the problem that particular pronunciations that are unmarked in speech become marked as deficient when

Appendix A. Transcript conventions.

“captured” in written form (e.g. now you got, I’m gonna say). Because unusual pronunciations or differences in dialect do not appear to be relevant in this interaction, no attempt has been made to represent the phonetic aspect of speech. Instead, I have represented all speech using the unmarked written forms associated with competently-produced mainstream American talk (e.g. now you’ve got, I’m going to say).

Any talk that interrupts the flow of the unit (a place-holding sound like *uh* or *um*, or a restart) is represented by a line break. Since place-holders and restarts are stacked vertically, the uninterrupted unit can be read easily by reading from left to right along the bottom of each stack. Likewise, the vertical height of a unit gives a visual indication of the number of internal pauses and restarts that characterize that unit. The end of each line is marked by either a pause () or the lack of a pause =. Pause lengths are reported to the nearest half-second; e.g. (2.5) indicates two-and-a-half seconds. A pause of less than 0.5 seconds is indicated by (.).

The onset and end of overlapping speech are marked with square brackets []. Overlapping speech is vertically aligned for better visual clarity. A word that is cut off before its natural ending is marked by a terminal hyphen. The placement of the hyphen roughly corresponds to when the word was cut off, but some words that are cut off very early are expanded in length to avoid ambiguity. Sounds such as coughing or tongue clicking are described within triangle brackets < >.

Pitch is represented in the following ways. An emphasized word or syllable is marked with boldface type. Pitch that indicates the end of an idea (often by returning to a normal level) is represented by a period. Pitch that indicates a continuation is expected (often by a dip within a single syllable) is represented by a comma. Pitch that indicates a request (often by rising on the last syllable) is represented by a question mark.

Appendix A. Transcript conventions.

The fourth column contains descriptions of non-verbal aspects of the interaction, including gaze, body position, and gesture. Each description is underlined; the talk that occurs simultaneously is likewise marked with an underline. In cases where confusion is likely, different styles of underlining (e.g. single vs. double lines) are used.

The following table summarizes the symbols used in the transcript and their meaning:

Symbol	Meaning
(.)	Pause of less than 0.5 seconds
(2.5)	Pause of approximately 2.5 seconds
=	No pause; next line continues immediately
-	Word is cut off before its end
<text>	Text describes a sound
[text a] [text b]	Overlapping speech; texts a and b are spoken simultaneously
text	Pitch and/or volume indicates emphasis
text.	Pitch indicates an end has been reached
text,	Pitch indicates more is to come
text?	Pitch indicates something is requested of another speaker

Appendix B. Printed version of the core question available during the interview segment.

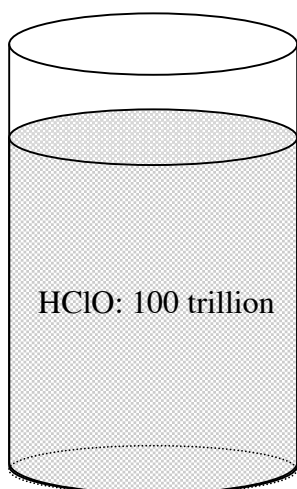
Experiment 5

Hypochlorous acid (HClO) reacts with water (H₂O) to form hydronium ion (H₃O⁺) and hypochlorite ion (ClO⁻): $\text{HClO} + \text{H}_2\text{O} \rightarrow \text{H}_3\text{O}^+ + \text{ClO}^-$

You take a glass of water and put 100 trillion molecules of HClO in it. After a few seconds, the water contains 28 trillion molecules of HClO, 72 trillion molecules of H₃O⁺, and 72 trillion molecules of ClO⁻. After that, the water always contains the same number of each molecule, no matter how long you wait.

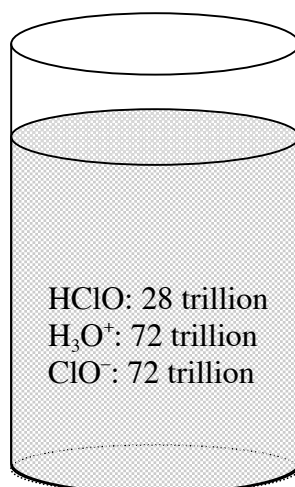
Why is there still some HClO at the end of the reaction?

Beginning of the reaction



← Water

End of the reaction



← Water

Appendix C. Transcript of the segment analyzed in the text.

1	IE:	and the rest has to remain water ()	under the liquid form ()
2	IR:	okay ()	
		cool ()	
3		um ()	
		one more then ()	
		<u>all right? ()</u>	
4		<u>this ()</u>	
		is ()	
		<u>slightly different ()</u>	
5		um ()	
		once more you have a glass of water? ()	
6		um ()	
		but now into the water you put ()	
		not salt but ()	
		um ()	
		uh =	
		something called hypochlorous acid? ()	
7		<u>I don't know if you've ever heard of that particular acid =</u>	
8		<u>but ()</u>	
		it's an acid ()	
		<u>mm hm =</u>	
9	IE:	<u>um ()</u>	
	IR:	<u>and ()</u>	
		<cough> ()	
	IE:	it reacts with the water in the glass ()	mm hm ()
10	IR:	uh ()	
		to form H3O plus and =	
		<u>um =</u>	
		<u>ClO minus? ()</u>	<u>mm hm ()</u>
	IE:		

IR positions paper between IR and IE, facing IE

IE leans in towards paper, arms folded in lap, gaze on paper

IE nods

IE leans back in chair, hands clasped in lap, gaze on paper

IE nods

Appendix C. Transcript of the segment analyzed in the text.

11	IR:	<u>um</u> () and so <u>in this particular situation</u> you've got () a glass of water =	<u>IE nods</u>
12	IE:	you put in () a <u>hundred trillion</u> () <u>molecules</u> of HClO () mm hm ()	<u>IE nods</u>
13	IR:	and after a couple seconds () <u>um</u> () you have () uh = only twenty-eight trillion () molecules () mm hm () of <u>HClO</u> =	<u>IE nods</u> <u>IE nods</u>
14	IE:	and then you've got seventy-two trillion <u>of =</u>	<u>IE nods slowly and exaggeratedly</u>
15	IR:	it stays like that () <u>forever</u> () and that's = that = it stays like that () <u>forever</u> ()	<u>IE nods slowly and exaggeratedly</u> <u>IE opens mouth to speak, shifts gaze to IE</u>
16	IR:	<u>so</u> () <u>the question is</u> () <u>um</u> () how come () <u>you've still got some</u> () of () what's basically the reactant left over at the () [end of the reaction] ()	<u>IE fidgets with hands</u>
17	IE:	[I I] = I think I can answer this one ()	
18	IR:	cool ()	
19	IE:	<u>um</u> = because of the limiting reagent? ()	

Appendix C. Transcript of the segment analyzed in the text.

IE shifts gaze to paper,
leans in, picks up pencil

IE writes "100" on
paper

20 um ()
we have in the reaction here? ()
we have HClO and H₂O? ()
mm hm =

21 IR:
IE: and =
um =
I guess in this case since there's still HClO remaining? ()
mm hm ()

22 IR:
IE: that means that H₂O is the limiting reagent? ()

23 um ()
wait =
wait one second =
um ()
yeah ()
H₂O is the limiting reagent =

24 IR:
IE: means there's less H₂O to start off with than there is HClO? ()
mm hm ()

25 IR:
IE: so that means if ()
if there's less to start with? =

26 let's say we have =
um ()
let's see =
uh =
oh =
wait =
a hundred =
uh =
trillion? =
mm hm =

27 IR:
IE: this is to start off with ()

28 um =
and there's twenty-eight left? =
[mm hm]

29a IR:
IE: [uh] =
so ()

Appendix C. Transcript of the segment analyzed in the text.

30	okay = let's see = there's twenty-eight left = that's seventy-two ()	
31		
29b		so () <u>there's seventy-two ()</u>
32	wait- = trillion is what moles? = or () mol- = molecules = okay =	
33	IR: trillion molecules [right] IE: [mm hm] ()	
34	it doesn't exactly work the same way with molecules =	
35	because it's a mole () um () it's = it's moles? ()	
36	<u>in the equation?</u> of the equilibrium? it has to be () a mole () um = relationship () okay =	
37	IR: but () IE: I'll do it with molecules? ()	
38	because it's just an example =	
39	like () okay = <u>let's say there's a hundred trillion =</u> um = molecules of HClO () okay = <u>and only seventy-two? ()</u>	
IR:		
IE:		

IE writes "72" to the right of the 100

IE draws a right-pointing arrow to the right of the 72

IE writes "H₃O" to the right of the arrow

IE taps the 100 with pencil

IE points to the 72 with pencil

Appendix C. Transcript of the segment analyzed in the text.

40	then all the H ₂ O molecules? are = um () uh () how can I explain this ()	IE points to the 72 with pencil
41	um = so- the limiting reagent would be- meaning there's less = um = H ₂ O molecules than	IE taps the 72 with pencil
IR:	there are () HClO molecules? = okay =	IE taps the 100 with pencil
42	so all the = um () all the H ₂ O molecules () are transferred into the = the reaction? =	IE draws a circle around the 72
43	I mean they = they all disappear =	IE taps the 72 with pencil
44	because they're all () um () the word is () uh = they're all () h () I know the word () they're all () neutralized ()	IE draws an arrow from the 72 to the H ₃ O ⁺
45	okay they're all neutralized = okay =	IE moves pencil point along the path of the arrow
IR:		
46	so the seventy-two from here =	IE points to 72 with pencil
47	since there's less than the hu- = than the hundred? ()	
48	there would only be seventy-two used here? = [okay]	IE writes "72" below the 100
IR:		IE taps new 72 with pencil
49	[because] it's a = it's a () it's stoichiometry =	

Appendix C. Transcript of the segment analyzed in the text.

50	so you would have () uh = 1 to 1 to 1 to 1 usually in stoichiometry? =	
51	so the <u>seventy-two</u> would be used ()	IE draws a line below the new 72
52	and you'd <u>only</u> get the <u>twenty-eight</u> ()	IE writes "28" below the line
53	and so there'd be twenty-eight = um = <u>trillion molecules</u> <u>left of the HClO?</u> = okay ()	IE taps 28 with pencil IE points to the 100 with pencil IE taps 28 with pencil
IR:		
54	versus <u>there'd be no more of the H2O</u> ()	IE taps the old 72 with pencil
55a	and since there'd be twenty-eight and it's stoichiometry? ()	
56	there would be ()	
57	um = how much does this say? ()	
58	seventy-two = yeah ()	
55b	since- ()	
59	okay <u>what we did here-</u> =	IE writes "100" in a new place
60	sorry let me do this () um = cleaner ()	
61	okay we'd have () uh = hundred <u>seventy-two</u> ()	IE writes "72" to the right of the 100
62	and then at the <u>beginning</u> we'd have zero of the H3O plus = okay =	IE writes "0" to the right of the 72
IR:		
63	which is the products ()	
64	um = and we'd have <u>zero</u> of the = um () ClO minus? = mm hm =	IE writes "0" to the right of the 0
IR:		

Appendix C. Transcript of the segment analyzed in the text.

65	IE:	so <u>seventy-two</u> would be used here? =	IE writes " <u>72</u> " below the <u>100</u> , beginning a second row
66	IR:	would be neutralized? =	
67	IE:	[mm hm]	IE writes " <u>72</u> " in column two
68		[seventy]-two would be neutralized =	IE writes "+ <u>72</u> " in column three
		and since these are neutralized =	IE writes "+ <u>72</u> " in column four
		we need to ()	
		have <u>seventy-two</u> ()	
		um ()	
		that appear in the ()	
		as =	
		as the =	
		um ()	
		as the products ()	
		[okay]	
		[wait] =	
		um =	
		products ()	
		reactants =	
		yeah as- =	
		as the products ()	
69		so we'd have =	IE draws a line below column one and writes "28" below it
		here <u>we'd only have twenty-eight left?</u> =	IE draws a line below column two and writes "0" below it
70		here we'd have <u>zero left</u> ()	IE draws a line below column three and writes "7" below it
71		here we'd have <u>seventy-two left</u> =	IE draws a line below column four and writes "7" below it
72		and here we'd have <u>seventy-two left</u> ()	IE points to numbers inside second place on problem sheet
73	IR:	so I <u>guess that's</u> where the numbers come from ()	IE leans back in chair and shifts gaze to IR
74	IE:	because <u>this is a limiting reagent</u> =	IE taps top <u>72</u> in column two

Appendix C. Transcript of the segment analyzed in the text.

IE taps middle 72 in column
one

75 so () only seventy-two can be neutralized of the ()
HClO () one hundred trillion of the
IR: all right ()

76 so ()
um ()
so () you're saying that the water's the limiting reagent? =

77 IE: yes =

78 IR: um ()
and that it's ()
it's being ()
being completely neutralized ()
