## Cognitive Apprenticeship: An Analysis of Classroom Interactions

Throughout the students' inquiry, I conceptualized my role as that of an advisor and resource person. The role of an expert who scaffolds student performance was most apparent during the interpretation of data and construction of knowledge claims. Here, I had provided the scaffolding support students needed to coordinate isolated items of their prior knowledge and construct new, more integrated frameworks (to students I had become "the physics coach"). This construction occurred first in the collaborative effort between students and teacher, from where each individual could appropriate, that is individually construct, his own representation. I monitored students' emergent meanings throughout each lesson.

Interacting with the students throughout the focus finding sessions, I suggested alternative research questions, coached students as they evaluated their ideas in terms of instruments and materials, encouraged students to frame new experiments in terms of the findings of previous ones, and encouraged students to focus on details of their plans. These interactions can be understood as instantiations of the *scaffolding* metaphor. However, I also emphasized that it was the students' responsibility and privilege to make decisions with regard to both the focus question and the plan for the experiment ("If **you** think that this is worthwhile investigating, I would like for you to look into that" or "I want to leave it to **you** to decide what question you will investigate"). Such a shift in responsibility to the students corresponds to the process of *fading*, and thus overlaps with *scaffolding*. During the *scaffolding* and *fading* phases, I served as a resource in questions of equipment and materials. Unavailable materials or instruments sometimes precluded an experiment, although students had framed a suitable question for a high school laboratory. In such cases, I helped students shift their focus and do a related experiment. For example, ARR decided to do an experiment on the thermal expansion of solids. Because the necessary metallic and glass rods were unavailable, I suggested an experiment regarding the thermal expansion of liquids or gases.

Task: Analyze the following two episodes (a) through open coding (b) by using the metaphor of apprenticeship.

## Episode 1

| | |
|---|---|
| Ron: | You heat up a gas and insert a test tube and see how many bubbles and |
| I: | But this time you want something quantitatively. |
| Alex: | How could you do the thermal expansion of a liquid? |
| Ron: | How do you do it with a gas? |
| I: | How could you do it? |
| Alex: | You take a flask with a stopper and a tube going to another bottle full of water upside down. When you heat the gas is going to go through the tube and in that other flask. And then the water comes out. (Alex accompanies his talk by gestures which outline the set-up, and the movement of the substances). |
| I: | But quantitatively! And could you do it with different types of gases? |
| Alex: | A tube filled with a bubble, and as the gas expands, the bubble moves along the glass tube (gestures a moving bubble in a glass tube). |
| I: | And very similar with liquids, could you? |
| Ron: | Yeah, just as the water expands it goes up (gestures that water expands along a horizontally oriented glass tube). |

## Episode 2

| | |
|---|---|
| I: | Why does it [the heating curve] stay flat and then go up? Why doesn't it go up immediately as soon as you started heating? |
| Jim: | The latent heat of. |
| Carl: | When the temperature is rising, then there has to be a change in kinetic energy [of molecules] (shows rising temperature with a gesture of his hands). |
| Jim: | Because it takes energy to change state, right here (points to flat section of temperature-time curve) it's changing state to ice, here (points to section of temperature-time curve where it drops of from the flat section to lower temperatures) |
| I: | Where does the energy come from? |
| Jim: | The energy comes from water. |
| Carl: | The ice around (looks at Jim for confirmation) the ice-water-salt mixture. |
| Jim: | Yeah, the salt-ice-water mixture. |

## Interactional Analysis of Classroom Conversations

The following analyses are presented in three episodes. Episode 1 was videotaped as three students (ARR) were designing an experiment and deciding on a focus question. Episodes 2.a and 2.b are consecutive excerpts from a data analysis and interpretation session during which three students (CJP) came to understand the shape of heating and cooling curves in terms of the kinetic molecular theory. In order to do a conversational analysis of the discourse in which students and teacher engaged, I needed to include more detail in the transcripts. Thus, the earlier excerpts are *re*-presented now including the necessary conversational details to conduct a microanalysis of teacher-student interactions.

I used the following transcription conventions

| | |
|---|---|
| // | beginning of overlapping speech for current speaker |
| ] | end of overlapping speech for both speakers |
| = | latching, i.e., no interval between the end of a prior and the beginning of the next piece of talk |
| ? | if utterance was heard as a question |
| (??) | unidentifiable words, approximate number of which are indicated by the number of question marks |
| :::::: | omission of part of the transcript |
| (.) | audible pause but too short to measure |
| (1.6) | pause in seconds |
| (king?) | likely but uncertainty reading of a word |
| *italic* | Italics indicate various forms of stressing, and may involve pitch and/or volume |
| ,.?! | Punctuation markers are not used as grammatical symbols but for intonation |

Task: Analyze the following in terms of turn taking routines.

## Episode 1: Interruptions and Further Inquiry

| | | |
|---|---|---|
| 1.1 | Ron: | You heat up a gas and insert a test tube and see how many bubbles and= |
| 1.2 | I: | =But this time you want something *quantitatively*. |
| 1.3 | Alex: | How could you do the thermal expansion of a liquid? |
| 1.4 | Ron: | How do you do it with a gas? |
| 1.5 | | (1.6) |
| 1.6 | I: | How *could* you do it? |
| 1.7 | | (.) |
| 1.8 | Alex: | You take a flask with a stopper and a tube going to another bottle full of water upside down. When you heat the gas is going to go through the tube and in that other flask. And then the water comes out= |
| 1.9 | I: | =But *quantitatively* (.) |
| 1.10 | | And could you do it with *different* types of gases? |
| 1.11 | Alex: | A tube filled with a bubble, and as the gas expands, the bubble moves along the glass tube. |
| 1.12 | I: | And very similar with *liquids?* could you? |
| 1.13 | Ron: | Yeah, just as the water expands it goes up. |

## Episode 2.a

| | | |
|---|---|---|
| 2.1 | I: | Why does it stay flat and then go up?= |
| 2.2 | | =Why doesn't it go up immediately as soon as you started heating? |
| 2.3 | Jim: | The latent heat of |
| 2.4 | | (0.4) |
| 2.5 | Carl: | When the temperature is rising, then there has to be a change in kinetic energy. |
| 2.6 | Jim: | Because it takes energy to change state, right *here* it's changing state to ice, *here*. |
| 2.7 | I: | Where does the energy come from? |
| 2.8 | Jim: | The //energy comes from water] |
| 2.9 | Carl: | The ice around (.) ] the ice-water-salt mixture. |
| 2.10 | Jim: | Yeah, the salt-ice-water mixture. |

## Episode 2.b

| | | |
|---|---|---|
| 2.11 | I: | In this case, do you lose or gain energy? (.) |
| 2.12 | | In the case of that freezing? |
| 2.13 | Carl: | Lose. |
| 2.14 | I: | In the case of that freezing? |
| 2.15 | Jim: | You lose. |
| 2.16 | I: | You *lose* energy. Where does it go? |
| 2.17 | Jim: | The energy is being lost. |
| 2.18 | Carl: | Into the ice (.) |
| 2.19 | I: | salt-water mixture, that's right. |