Documenting Children's Problem Solving Behaviors: Using Fieldnotes of Participant Observers

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Introduction

Among the many problems confronting those who seek to evaluate changes in children brought about by participation in after school educational activities where their actions are not highly constrained is that behavior in constrained tasks remains the normative source of acceptable data. In fact, a cognitive task is generally understood as a goal and a set of constraints on the achieving of that goal. How, if children are not highly constrained and goals are negotiable, is it possible to provide data that make contact with the norms of experimental, cognitive psychological approaches to data collection and analysis?

Here and in a previous talk (Woodbridge, Olt, and Cole, 1992) we argue that in the semi-structured tasks that make up a large part of the activity of our afterschool systems, fieldnotes written by undergraduates provide a useful source of data for cognitive analysis. We believe that because the undergraduates are legitimate coparticipants in the activity, they have at their disposal excellent resources not only for identifying the tasks that the children are working on, but in diagnosing the strategies they use, and specific areas where they have special difficulties or exhibit special strengths. In addition, undergraduate notes offer evidence of the dynamics of the teaching/learning processes that plausibly can be claimed to play an important role in bringing about cognitive change.

We will present two examples, one from a case where a child is playing a game designed to promote phonetic analysis, the second where the game is designed to build skill in navigating the number line. Our data for each of these cases will be undergraduate fieldnotes. For ease of interpretation we have included visual representations of the computer screen so that the exposition will be easier to follow and placed interpretive comments in brackets within the text where special artifacts and practices of the 5th Dimension are crucial to interpreting the notes. We will comment about each example after presenting it.

A Lesson in Phonics

This fieldnote excerpt describes an interaction involving the game WordMunchers. WordMunchers challenges the players to identify a particular sound within given words, displayed on a 5x6 matrix. The player must manipulate the keyboard effectively in order to move their character up, down, left and right in order to escape a bad guy (referred to as a boggle) that appears intermittently.

/ OU / as in Mouse					
Brow	Chow	Gall	Gown	Drown	Taunt
Raw	Vouch	Owl	Flaw	Flaw	Join
Sour	Boy	Vouch	Fowl	Foul	Mouse
Corn	Gouge	Caulk	Cloud		Boy
Gaunt	Howl	Soil	Cow	Clout	Route

The notes were written by Teri Moore, playing with eight-year-old Aaron Seals.

Aaron got Wordmunchers with no problem and started to play at the first level. Wordmunchers is divided into different categories according to vowel sounds- i.e. "e" as in tree, "ou " as in mouse. The first one was "e" as in tree. He sounded out a lot of the words correctly, but not all of them. Even when he sounded them out right, he often "munched" words that weren't in the same category. It was hard for Aaron to distinguish between long and short vowel sounds and he repeatedly stumbled over close pronunciations. An example was in the category "oo" as in book. I have to admit that the categories can be quite tricky sometimes, with only subtle differentiations between the words. For example, "hook" and "rope" both have a long-ish sounding "o" but they are not the same sound. This case was hard for Aaron, and I think that he is just starting to get the grasp of phonics in school. Between munching the wrong words and not getting them right and his friend Charlie next to him yelling at him to munch certain words, Aaron was unable to finish even 5 levels [It is necessary to complete five levels in the game to complete the beginner level according to the rules of the 5th Dimension. I decided to help him out.

I told him that he had to finish 5 levels to complete the beginner level. By this time, Aaron was frustrated andwas often losing all three men in one level. "I can help you complete 5 levels, "I told him. "I'm an expert". We switched chairs and I started to play.

Instead of just letting him watch me though, I got him and Charlie both to verbalize the target words. This was Aaron's LAST man and I promised him that I wouldn't let it die. I wouldn't munch on the words unless they told me to and for words they were uncertain of, I would linger on it, pronounce it a couple of times and then pronounce the category a

few times. This repetition seemed to work and help Aaron, especially, distinguish between long and short vowel sounds.

An example that I particularly remember [of the difficulty in distinguishing long and short vowels] was in the category "u" as in "mouse." The boys thought that we had munched all the -words, but we hadn't. There were a lot left, with spellings different than "ou" but with the same pronunciation. I went to the word "clown." "Clown?" I asked, and Aaron said "pro." "Listen again: clooowwn. And now mooouunse. They don't have to be spelled the same to sound the same." Aaron eventually accepted this idea, though reluctantly. He assumed that they had to be spelled the same, but I said the words didn't have to. They just had to sound the same. We made it to level 4 with me munching and the two of them giving me feedback on the words.

"OK, now YOU have to finish," I told Aaron. "You can make it to level 5." This was the last man. I told him I'd help.

Aaron did OK with prompting from both Charlie and me but he was eaten by a troggle again. Often, Aaron lost control of his man and sent it careening back and forth on the maze. I warned him about boggles, but sometimes they came out of the walls and ate him. Anyway, he lost this man so I assumed it was the end of the game. He thought it was over, too, but then he realized that we had gotten a "free" man. I'm not sure how we got it, maybe because the score was so high now. Anyway, with this man Aaron was able to reach level 7 and complete the beginner level.

He asked about the star and went to Amy who told him that he had to get the task card from me. [The task card is an artifact designed to promote reflection and create opportunities for getting children to generalize principles they had encountered in the game in a different medium]. I told him that he still needed to fill it out. He wrote down the 5 vowels-- almost forgetting "a "- and then he had to distinguish between long and short vowel sounds. This was -what Aaron had been struggling over the whole game, so l was curious to see how he'd do. There were 5 words. Next to them you had to identify the vowel and write next to it "long" or "short." He identified the vowels, no problem. He knew "cake" and "tree" were long, but he stumbled over a word [red] which was clearly a short "e." I helped him out by contrasting the sound to the "en in tree. He saw the difference but after much prompting. He handed the completed task card to Amy to get his star.

Commentary on the Phonics Example

The basic point we want to make about these notes is that despite the presence of two children and the fact that the undergraduate entered into the task, providing help on a flexible schedule that was constructed in the online activity with the children, the notes convincingly pinpoint Aaron's current level of skill in identifying important phonetic contrasts. They locate his biggest problem (vis a vis phonics) as die contrast between long and short vowel sounds. They also reveal a conceptual confusion that could be

expected to prolong Aaron's difficulties if not corrected-- his belief that for sounds to sound alike they must be identically represented in writing.

As a bonus, these notes also illustrate the way in which undergraduates routinely use the flexibility of their roles in the 5thDimension to create new divisions of labor and to encourage the children to continue participating, even when the going gets tough.

Estimation Using Cartesian Coordinates

Our second example describes an instance of Brian, age 9, playing the game 'Shark'. The field notes are written by Emily Rubin.

Figure 1 provides the display confronting children when they reach the third level of the game (on the first level, only the abscissa, labeled "aim" is presented; on the second level, only the ordinate, labeled "distance" is presented).

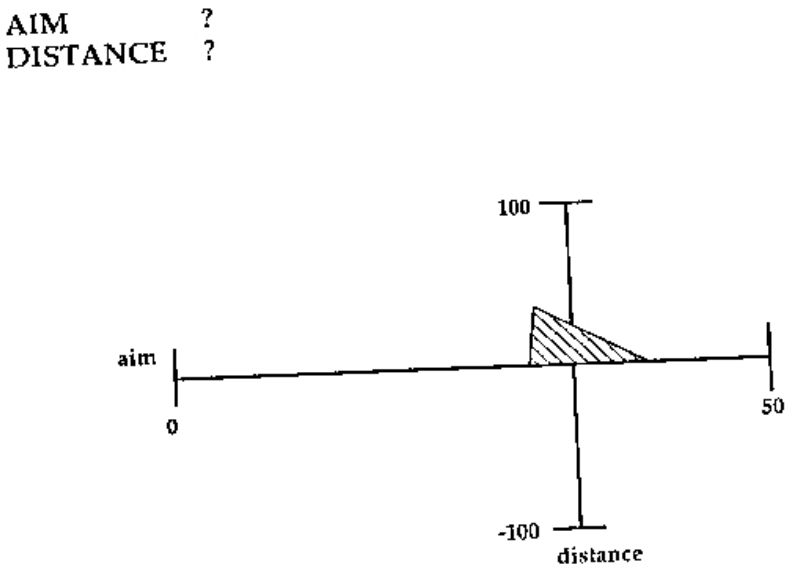

Figure 1: Example of Shark Game Screen: Level 3

He chose "Shark" after a long and debated decision. He was just about to walk off towards the computers without any assistance when I asked him if it would be all right if I played with him....He had not even looked or asked for help and seemed to be planning on playing by himself.

I found the task card and joined Brian at the computer. I had noticed his name when he wrote it on the journey logs on the wall. When I wrote his name on the task card, he was

very surprised. "How did you know my name?" he asked. I told him that I saw him write it under the game "Shark" on the wall. He laughed and put the disk into the computer and shut the latch. I told him that he could turn the computer on and gestured to the corner that the switch was on. He turned on the computer and I turned on the monitor, because he said he couldn't reach. The first question that the computer asked was "Who wants to play this game?"

He asked me if there was a way to tell the computer that two people were playing. I told him it was a one-person game and that he should type his name in. He typed his name slowly while mouthing the letters out loud, "B-R-1-A-N". I told him that I had only briefly played this game, so we should probably read the directions on the task card.

I read the description of the game from the task card. Before I had finished, he had begun the first level. For the first five levels or so, I kept track of the guesses he made at harpooning the shark on the task card. He wasn't very aware that I was doing this until I told him that he had only made 2, 3, 2 and 1 misses and he was well on the way to becoming an expert at this game. He then began paying attention to what I was writing dawn. Every now and then he even asked me what his last guess had been.
During the first level of Shark, he was fumbling with the concept of the number line. He had not grasped the concepts of "aim" and "distance" yet, rather he was just filling in the numbers which befell corresponded to the lines on the screen. The first level was just an "aiming" level. He noted the numbers on either end of the number line and said, "This is huge!", referring to the distance between O and 50. He did much of his thinking out loud. "I'm gonna put " he mumbled out loud, "I'll put 45". I would explain to him how his shot was too far to the right and he needed a lower number. He quickly shot the shark within two tries.
The second level was more difficult. It included distance as well as aim. He typed in a number for the first line and pushed return. He sat back in his chair expecting the harpoon to fly, but instead the computer read, "Type a number?". "Type a number!!!???", he read aloud. "I just did..." I told him that he would have to guess the distance as well. I motioned to the second number line on the screen. "You not only have to type where the shark is, but how high to shoot the harpoon," I said. He guessed the distance incorrectly. He was about to guess the second distance lower than the first when the shot had been too low. I remarked, "Remember last time? You guessed 33..." He quickly changed his input to 30 and harpooned the shark within three tries.
By the third level, he was prepared to enter both aim and distance. His first shot, which he made without my assistance, he exclaimed was "Too high!!!" (Referring to the distance number line). He began making the observations that I had previously made in the first two levels. On his next shot, he commented, "It was too high again! and too far that way!!" These directional comments were similar to the ones I had made on the previous levels.
As we made our way through the next few levels, he became more independent when making the decisions. For instance, when we were narrowing down a shot, I suggested that the aim should be 17, but he quickly responded by saying, "No, I'll do something....(He was thinking of what to type)....I'II do 16" He was right on the dot with the aim, but the distance was still off. "So, I'll change the distance..." This was the first

time I had heard him refer to the number line by saying "the distance", rather than pointing to the line and guessing. Although he clearly was becoming more independent with his decisions, the game was getting harder and he was more than willing to accept my advice. On level 5, for instance, he said out loud, "I'm gonna do 16". I told him that the number line was from 0 to 50 and that 16 would be too far to the left. "OK," he said, "25, no 29 and (for the distance). He shot the harpoon and it was a little off line. He analyzed it without my help. "Oh, its perfect (referring to the distance)... Ooops just a little to the right. It has to be 26!!" He had harpooned the shark and we were now on level six. "I'm on level six," he screamed as he examined the task card, "Sheesh!".
The number lines were becoming more difficult as they began to incorporate more negative numbers and smaller gradients. He seemed very enthusiastic about the game and the increasing difficulty did not slow him down at all. His knowledge of the number lines was superb. Even when the line went from -100 to +100, he was able to adjust. In one circumstance, he even explained to me -why a shot must be corrected. I told him that my guess would be 30. When he entered this into the computer it responded, "Smaller...." "Smaller!!!!" he yelled, "Oh, its negative 32!!! It -would have to be -40, because that's getting lower (he was pointing to the distance line)" He was able to notice the negative gradient before I did.
By level eight, Brian was really excited, "I can't believe how far I've -was able to narrow the shots down with relatively little help. "A little bit higher, a little got!!!". He had become very comfortable with using the terms aim and distance and to the left," he mouthed out loud, "Let's see... I had 39 that time, so 40 (for the aim) and I had 39 (for the distance)... so let's see...49! This might be close." Although his deductions were not adequate to harpoon the shark, he did not lose hope. "[The] aim is closer and so is the distance. " he said. He quickly finished level 8 and 9 and we had finished the game. I told him that he had completed the computer levels and should be an expert at the game.
He jumped up to choose another game, before I had a chance to encourage him to finish the task card. Teri helped me motivate Brian to finish the card and become an official expert. One of the first questions on the task card was "What is the difference between aim and distance?" I wrote his Andover down as a way of easing him into the task card. He replied, "Aim is where the shark is, and distance is how high" I then had him draw some pretend number lines for the aim and the distance. He especially enjoyed guessing the numbers on the number lines towards the back of the task card. He counted the marks between the numbers out loud. One number line was from 10 to 80. He counted, "10, 20, 30, 40, 50....(all the -away to 80)" to be sure that the gradient was by 10. He then said the answer was 50. He had already developed a mental strategy for solving the problems and it was only the second one.

Commentary on Number Line Example

This example is somewhat less explicit about the child's difficulties with the number line, which do not seem particularly acute. But it provides an excellent account of the how he comes to master the increasingly complex sub-tasks that the game sequence present as part and parcel of his interactions with his undergraduate companion. (The fact that the child spontaneously talks aloud is an important resource for analysis of this example).

Several moments stand out in this account:

--Initially the child takes no note of the adult keeping a record of progress, but then he starts to use the adults' contribution to mark his progress.

--Initially the child has difficult understanding the specialized vocabulary of the game, but soon picks it up.

--As the game progresses, the child overtly appropriates the special pointers and adult verbal formulaic speech patterns

--The adult comments on the fact that the child becomes more independent as the game progresses despite the increasing difficulty of the subtasks.

--Eventually the child adopts the role of "more competent peer," instructing the adult in how to interpret the meaning of larger negative numbers.

--The child's increasing excitement and satisfaction are evident throughout the fieldnotes.

General Comments

We do not want to give the impression that fieldnotes always reveal properties of children's knowledge and properties of their problem solving as dearly as do these. We are often frustrated by the lack of detail in student notes at what we consider to be crucial junctures in an interaction. However, these examples are by no means unique. We routinely obtain notes with this level of detail both about what children (and the undergraduates) do and do not know and about the dynamics of the interactions. Assuming for the moment that field notes such as eve have presented are an adequate reflection of the interactions from which they revere drawn, what makes such analyses possible? We believe that the answer lies several factors. First, there is a good deal of structure in the tasks that the children engage. In the cases we have presented the tasks are structured around two systems, mathematics and the sounds, for which are shell known as highly structured domains that enable the analysis of "everyday problem solving." Many of our tasks are structured according to logical principles by those who have created the programs. But there is also structure to be found in the rules of play, turn taking conventions. In addition, our task cards and the cultural conventions of the 5th Dimension provide additional sources of structuration. The result is that the environment is rich in conceptual pegs upon which to hang one's memories, right down to particular bits of dialogue.

A second important resource for analysis is the special relationship of child to undergraduates. The 5th Dimension is recognized by all as a friendly place where people come to play. The undergraduate has a role in the 5th Dimension akin to that of an older

friend or sibling. To be sure, there is a division of labor, but it is based upon authentic competence, and co-participation in playing, not on bureaucratic dictates.

The rule of thumb that undergraduates are urged to adopt in deciding hoist much help to provide while they play the games with the children is to "give as little help as you can, but as much as you need to so that you and the children have a good time." This orientation seems to provide a conceptual framework that aids their overall grasp of the changing dynamics of the interaction. They get deeply involved in the games with the children and take genuine pleasure in the children's achievements. But these achievements are not someone else's "out there." They are, simultaneously, the undergraduate's achievements, so they remember them zenith pride in which pride of self and pride for other are intermixed.

In the next round of our research we plan a systematic check on such accounts by comparing fieldnotes with videotape recordings of the same interactions. Undoubtedly the videotapes will pick up details that the undergraduates have either failed to notice or to remember at the time they write up their notes (a time delay that can extend to several days, but which probably averages about 24 hours). Some distortion is inevitable. But we do not anticipate disenchantment with the method of using field notes. When combined with other forms of record keeping, they provide us a way to track children's performances through levels of difficulty built into the tasks by the computer programmers, which we check with similar tasks built into the task cards by us. It is a system that seems to work.