Dialogue Patterns and Feedback Mechanisms during Naturalistic Tutorir

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Abstract

Although it is well documented that one-to-one tutoring is more effective than alternative training methods, there have been few attempts to examine the process of naturalistic tutoring. This project explored dialogue patterns in 44 tutoring sessions in which graduate students tutored undergraduate students on troublesome topics in research methods. We analyzed pedagogical strategies, feedback mechanisms, question asking, question answering, and pragmatic assumptions during the tutoring process.

Introduction

It is well documented that one-to-one tutoring is a better method of training students than the normal pedagogical strategies in classroom settings. The effect size of the advantage of tutoring over classroom has ranged from .4 to 1.0 standard deviation units (Bloom, 1984; Cohen, Kulik, & Kulik, 1982). However, it is difficult to determine the cause of this advantage until there is a better understanding of the tutoring process (Fox, 1992; Graesser, 1993; McArthur, Stasz, & Zmuidzinas, 1990; Miyake & Norman, 1979; Putnam, 1987; van Lehn, 1990).

Ideal tutoring processes have been proposed by researchers investigating the cognitive foundations of complex learning and by developers of intelligent tutoring systems (Bransford, Goldman, & Vye, 1991; Lesgold, 1992; Ohlsson, 1986; Sleeman & Brown, 1982). These researchers have identified several pedagogical methods that the tutor can implement during tutoring, such as the Socratic method (Collins, 1985), inquiry teaching (Collins, 1988),diagnosis-remediation (Anderson & Reiser, 1985; Van Lehn, 1990), the reciprocal training method (Palinscar & Brown, 1984), modeling-scaffolding-fading (Collins, Brown, & Newman, 1989; Rogoff, 1990), and curriculum scripts (Putnam, 1987). However, the extent to which these methods are used in naturalistic tutoring has not been documented. Given that the vast majority of tutors in school systems have received little or no training in tutoring (Fitz-Gibbon, 1977), the sophisticated pedagogical methods presumably are infrequent in naturalistic tutoring.

This project explored dialogue patterns in 44 tutoring sessions in which graduate students tutored undergraduate students on troublesome topics in a research methods course. Analyses focused on pedagogical strategies, feedback mechanisms, question asking, question answering, and pragmatic ground-rules during the tutoring process. The design of effective dialogue facilities and pedagogical methods in intelligent tutoring systems presumably requires a satisfactory understanding of these dialogue patterns in naturalistic tutoring.

Sample of Tutoring Sessions

Graduate students in the psychology department at Memphis State University tutored undergraduate students on troublesome topics in a research methods course. All 25 students in the course were tutored as part of a course requirement so there was a full range of student achievement (i.e., not just underachieving students). The three tutors had received A's in a graduate-level research methods course. Therefore, this sample involved "cross-aged" tutoring, which is the most common type of tutoring in school systems.

There were 44 one-hour tutoring sessions altogether. These sessions were videotaped and transcribed. The sessions covered six troublesome

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topics: operational definitions of variables, graphs, inferential statistics, factorial designs, interactions, and the evolution of hypothesis to design. There was an index card associated with each topic, which contained 3-5 subtopics. The undergraduate students were required to attend a lecture on each topic and to read specific pages in a text prior to the tutoring session. Therefore, the students already had multiple chances to acquire the domain knowledge.

Although the conclusions reported in this study are based on the above sample, most of the results were tested and confirmed in a sample of 22 tutoring sessions involving 7th graders learning basic algebra. In this second sample, there were 10 high school tutors and 13 7th graders who were having problems with particular mathematical concepts.

Pedagogical Strategies

As a conservative estimate, 70% of the tutors' speech acts was guided by curriculum scripts. The tutor asked questions and presented example problems that addressed a list of curriculum subtopics. These subtopics were typically selected from the index card or from excerpts in the textbook. Only 8% of the tutorial interaction was devoted to the correction of student bugs and misconceptions. The fact that the curriculum script method was found to be more prevalent in naturalistic tutoring than the diagnostic-remediation method is compatible with analyses of Putnam (1987). There were virtually no occurrences of sophisticated tutoring strategies, such as the Socratic method, inquiry learning, and the reciprocal training method. There occasionally were vestiges of modeling-scaffolding-fading.

These analyses of tutoring strategies at the macro-level support the claim that the effectiveness of tutoring cannot be attributed to the implementation of sophisticated pedagogy. The tutor typically grills the student with preconceived questions and examples rather than tailoring the interaction to the student's knowledge and misconceptions. This finding underscores the potential value of intelligence tutoring systems that implement ideal tutoring strategies and student modeling: These sophisticated mechanisms are rarely operating during normal tutoring between humans.

Most of the tutorial interactions were embedded in example problems. Tutor questions were examined in order to estimate the incidence of tutors using examples. The results revealed that 38% of the tutor questions were embedded in concrete examples and 29% in abstract examples; 33% of the tutor questions addressed generic knowledge that was not embedded in examples. This finding is compatible with tutoring systems that emphasize the use of examples and case-based reasoning. However, ideal tutoring systems presumably select better examples than those in naturalistic tutoring.

A Five-Step Dialogue Frame

An extremely pervasive dialogue pattern consisted of a five-step dialogue frame in which a question was initiated by the tutor.

1. Tutor asks question
2. Student answers question
3. Tutor gives feedback on answer
4. Tutor improves quality of answer
5. Tutor assesses student's understanding of answer

An example of this frame is provided below:

1. TUTOR: Now what is a factorial design?
2. STUDENT: The design has two variables.
3. TUTOR: Uh-huh.
4. TUTOR: So there are two or more independent variables and one dependent variable.
5. TUTOR: Do you see that?

The tutors normally pumped the students for information (iterating steps 2 and 3) before improving on the quality of the answer (step 4). The tutors implemented several tactics while completing step 4, such as adding information, succinctly summarizing a complete answer, introducing an example, providing a hint, or asking the student an embedded question to prompt the student for more information. The tutors were lax in their diagnosis of student understanding in step 5; they simply asked whether the student understood a subtopic (which ended up being incorrect feedback) rather than asking a discriminating follow-up question.

In classroom settings, steps 1, 2, 3, and 5 are very pervasive (Dillon, 1988; Mehan, 1979). In contrast, step 4 is either skipped or minimally elaborated. Perhaps one advantage of tutoring is that the tutor can spend some time improving the quality of an answer by elaborating the reasoning and procedures in an explanatory answer (Chi, Bassok, Lewis, Reimann, & Glaser, 1989).

How Does The Tutor Gauge the Student's Knowledge?

Designers of most intelligent tutoring systems assume that there are payoffs in inferring the student's knowledge, misconceptions, and reasoning strategies. What sources of information permit the system to accurately compute the knowledge of the student? Three sources of information were examined: the student's questions, the student's answers to comprehension-gauging questions (i.e., step 5 in the five-step frame), and student answers to questions.

Student questions did not appear to be a reliable source of information for inferring student knowledge. The incidence of student questions was rather low compared to tutor questions, 21 versus 96 questions per hour, respectively. The rate of student questions in tutoring was approximately 100 times the rate of student questions in classrooms (.2 question per student per hour, Dillon, 1988), but most of the student questions were shallow rather than deep. We found that the number of student questions was only weakly related to student achievement (as measured by examination scores), r = -.22. There was a significant positive correlation (r = .44) between achievement and the proportion of student questions that were classified as "deep reasoning questions" (i.e., why, how, what-if) in the question taxonomy developed by Graesser, Person, and Huber (1992). Student questions are a poor information source for gauging student knowledge because (a) this correlation is modest, (b) a small proportion of student questions are deep reasoning questions (.22), and (c) the rate of student questions is low or moderate.

Another unreliable source of information was the students' answers to the comprehension-gauging questions asked by the tutors (e.g., "Do you understand?"). There was a positive correlation (r = .42) between student achievement and the likelihood of a student answering "No" (I don't understand); this somewhat counterintuitive result is compatible with the findings of Chi et al. (1989). The likelihood that the student answered "YES" (I do understand) had a curvilinear relationship with achievement level; the poor student and good student said YES less often than the intermediate student. Therefore, the students' answers to these comprehension-gauging questions were very misleading. Tutors need to be more discriminating while probing students during step 5 of the five-step dialogue frame.

The most reliable information source for inferring student knowledge was the students' answers to questions. There was a negative correlation between achievement level and the proportion of student answers that were vague or error-ridden (r = -.52). Tutor questions were frequent and this correlation was high, so student answers constitute the best information source for computations of student modeling. Perhaps these data provide one explanation of the earlier finding that curriculum scripts are prevalent during tutoring. The questions generated by these scripts uncover much of the student knowledge for evaluation and remediation. In contrast, it is not feasible to wait for the student to ask questions and to expect the student to accurately calibrate his or her own understanding.

Tutor Feedback to Student Answers

A good tutor presumably adjusts the feedback in steps 3 and 4 to the quality of students' answers. We segregated student answer contributions into four quality levels: error-ridden, vague (or none), partially correct, and completely correct. The likelihood of a tutor giving positive feedback increased with answer quality, .31, .45, .51, and .62, respectively. The likelihood of giving negative feedback was extremely low, but sensitive to answer quality, .15, .04, .02, and .01, respectively. The tutors' use of hesitations or pauses in their feedback was not related to the quality of student answers, .08, .13, .15, and .13, respectively.

It should be noted that tutors were more likely to give positive feedback than negative feedback to a students' error-ridden answers and vague answers. Tutors apparently are reluctant to give negative feedback, perhaps because they are following the politeness conventions of normal conversation (Brown & Levinson, 1987) or because they fear it will reduce the willingness of students to supply information.

Tutors normally "spliced in" correct information when a student error was detected. Tutors rarely acknowledged the error as an error, or pursued the implications of an error-ridden statement. It is quite possible that students were unaware that these contributions were error-ridden. These findings in our tutoring sample are compatible with the conclusions of McArthur et al. (1990) who analyzed a sample of tutoring sessions that were explicitly devoted to error remediation.

Answers Are Collaborative Exchanges

When a tutor asked a question, there was a collaborative exchange between the tutor and the student that converged on an answer. The collaboration took a median of 8 conversational turns for deep reasoning questions (i.e., why, how, what-if) and 6 turns for short-answer questions (e.g., concept completion, feature specification). The tutor ended up supplying most of the information that contributed to the answers.

Analyses were performed on the evolution of an answer to a question. We examined the quality of contribution N+1, given that the tutor and tutee had together achieved a particular level of quality via contributions 1 to N. The results of the analyses can be captured by the following three production rules:

1. IF [mutual cumulative contribution is vague or nothing]
   THEN [tutor pumps student for more information]

2. IF [mutual cumulative contribution is error-ridden]
   THEN [tutor supplies completely correct answer]

3. IF [mutual cumulative contribution is a completely correct answer]
   THEN [tutor supplies a summary recap]

According to production rule 1, the tutors did encourage the students to supply information by pumping them ("uh-huh", "what else?") rather than the tutors engaging in monologues. Production rule 2 captures the finding discussed earlier that tutors splice in correct information when students produce errors; there was no attempt to be a Socratic tutor by asking questions that lead students to discover their own misconceptions. According to rule 3, the tutor typically supplied a succinct, complete, summary of the answer to the question rather than shifting the burden to the student to construct an organized articulate answer.

Conversational Pragmatics as a Barrier to Effective Pedagogy

The pragmatic constraints of normal polite conversation have been identified by Grice (1975) and by Brown and Levinson (1987). These pervasive, automatized, conversational strategies present a barrier to effective pedagogy. A good tutor needs to learn how to violate conversational maxims in service of pedagogical goals. For example, rather than following the Gricean maxim of quantity, tutors may need to be redundant and repetitious to ensure understanding by the student. Instead of being polite and "face saving" when a student makes an error, the tutor may need to directly acknowledge that the student has made an error. We are currently examining the pedagogical consequences of the conversational postulates and maxims of polite conversation, as well as violations of these pragmatic constraints.

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