NC STATE UNIVERSITY Computer Science

Learner Characteristics and Feedback in Tutorial Dialogue

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Introduction

- Goal: Mixed-initiative NL tutorial interaction yielding both learning and self-efficacy gains
- Tutoring is complex:
  - Cognitive
  - Affective
  - Student-specific adaptations
- Focus: Cognitive vs. Motivational Tradeoff

Theoretical Foundations

- Motivation plays a key role in the learning process (Keller 1983)
- Components of motivation include (Lepper *et al.* 1993)
  - Challenge
  - Control
  - Curiosity
  - Confidence

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  - Control
  - Curiosity
  - **Confidence**

Praise and *reassurance* are strategies for bolstering confidence (a.k.a. self-efficacy).

Exploratory Research Questions

Objective: Understand relation between…

- Tutorial dialogue structure
  - Cognitive corrective strategies
  - Motivational corrective strategies
- Learner characteristics
  - E.g., low vs. high incoming self-efficacy
- Outcomes
  - Learning gains
  - Self-efficacy gains

Related Work

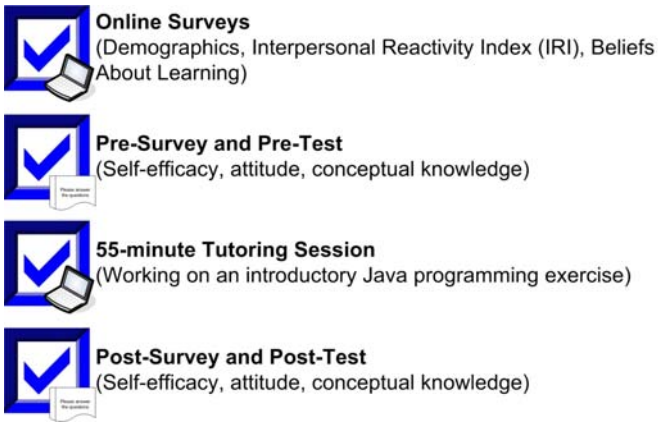
- AutoTutor (Jackson & Graesser 2007)
- Betty's Brain (Tan & Biswas, 2006)
- ITSpoke (Forbes-Riley *et al.* 2005)
- M-Ecolab (Rebolledo-Mendez *et al.* 2006)
- Mayer et. al. 2006
- Boyer et. al. 2007

Approach

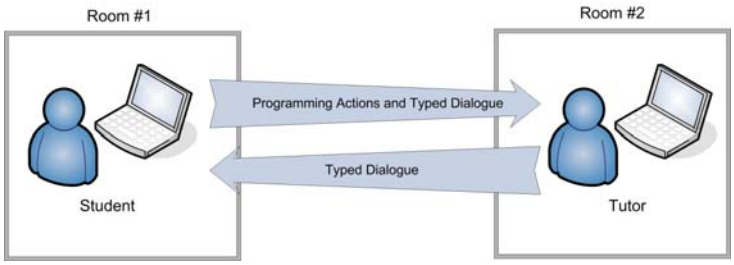
Empirical analysis of human-human tutoring corpus

1. Corpus Acquisition
   Java Tutoring
2. Corpus Annotation
   Cognitive + Affective Channels
3. Predictive Modeling
   Tutorial Strategies → Outcomes

Data Collection



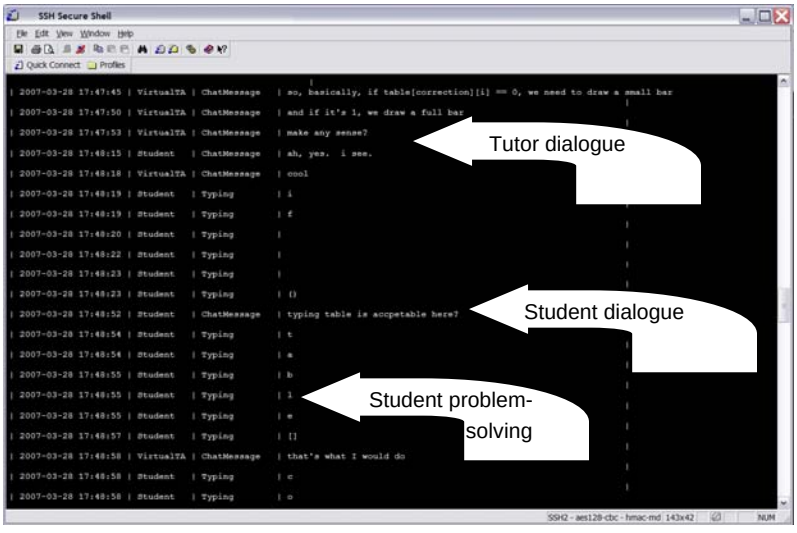
Experimental Setup



43 Students (Enrolled in a University Introductory Java Programming Class)

14 Tutors (2 Undergraduate + 12 Graduate Students in Computer Science)

Tutorial Dialogue Corpus



Corpus Characteristics

- 1,528 student utterances
- 3,336 tutor utterances
- 29,996 student problem-solving keystrokes
- 1,277 periods of student scrolling

Overall Effectiveness Measures

- Cognitive: Learning outcomes
  - Mean 5.9% gain from pretest to posttest
  - Instrument: 10-item pretest (isomorphic posttest), multiple choice and fill-in-the-blank items
- Motivational: Self-efficacy outcomes
  - Mean 12.1% gain from pre-survey to post-survey
  - Measure: Aggregate score on several survey items asking students to rate their confidence from 0-100

Corpus Annotation

- Automatic problem-solving action tagging
  - Applied rough heuristic measure for correctness
  - *Questionable* vs. *Promising*
- Dialogue act tagging
  - Cognitive channel
  - Motivation channel

Correctness

- Automatic problem-solving action tagging
  - Applied rough heuristic measure for correctness
  - *Questionable* vs. *Promising*

Cognitive Dialog Acts

	Act	Description	Tutor and Student Example Utterances	Average Count Per Session (Standard Deviation) Student	Tutor
Cognitive Channel Acts	Question (Q)	Questions about goals to pursue, domain concepts, etc.	"Where should we start?" "How do I declare an array?"	6.5 (4.2)	0.6 (0.8)
	Evaluative Question (EQ)	Questions that explicitly inquire about student knowledge state or correctness of problem-solving action.	"Do you know how to declare an array?" "Is that right?"	9.7 (7.1)	7.0 (5.0)
	Statement (S)	Declarative assertion.	"You need a closing bracket there." "I am looking for where this method is declared."	4.9 (4.1)	46.2 (21.0)
	Acknowledgement (ACK)	Positive acknowledgement of a previous statement.	"Okay." or "Yeah." "Alright."	3.8 (5.0)	2.5 (1.9)
	Extra Domain (EX)	A statement not related to the computer science discussion.	"Hello" or "You're Welcome" "Can I use my book?"	1.0 (2.1)	1.1 (2.4)
	Positive Feedback (PF)	Unmitigated positive feedback regarding problem solving action or student knowledge state.	"Yes, I know how to declare an array." "That is right."	2.7 (2.5)	12.0 (7.6)
	Lukewarm Feedback (LF)	Partly positive, partly negative feedback regarding student problem solving action or student knowledge state.	"Sort of." "You're close." or "Well, almost."	0.7 (1.2)	2.3 (2.5)
	Negative Feedback (NF)	Negative feedback regarding student problem solving action or student knowledge state.	"No." "Actually, that won't work."	2.1 (1.8)	1.3 (2.1)

Motivational/Affective Dialog Acts

	Act	Description	Tutor and Student Example Utterances	Average Count Per Session (Standard Deviation) Student	Tutor
Motivational/Affective Channel Acts	Confusion (C)	Explicit expression of confusion. Indicates disorientation beyond that indicated by negative feedback (which indicates the student lacks a particular piece of knowledge).	"I have no idea what to do." "I'm lost."	0.8 (1.2)	-
	Frustration (F)	Explicit expression of frustration.	"Grrr!" "This is so frustrating."	0.1 (0.4)	0.0 (0.3)
	Excitement (E)	Explicit expression of excitement.	"Sweet!" "Cool!"	0.4 (0.7)	0.3 (0.6)
	Praise (P)	Statement intended to emphasize a student's success. This goes beyond positive feedback, which serves as factual confirmation of correctness.	"Great job on that part!" "That's perfect."	-	4.2 (5.7)
	Reassurance (R)	Statement intended to minimize a student's failure.	"That part was hard." "Don't worry about it."	0.4 (0.6)	1.3 (1.6)
	Other Emotion (O)	Utterance that conveys affective or motivational content but for which there is no pre-defined tag.	"Ha ha." "I'm sorry."	0.7 (1.0)	1.5 (2.1)

Kappa Statistics

- Cognitive channel: 0.76
- Motivational channel: 0.64

Tutor Response Analysis

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Tutor: Question
Student: Answer
Tutor: Positive cognitive feedback
Student: Questionable problem-solving action
Tutor: Negative cognitive feedback plus reassurance
Student: Promising problem-solving action
Tutor: Neutral cognitive feedback
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Analysis Goal

Want to Predict:

- Learning gain group (high vs. low)
- Self-efficacy gain group (high vs. low)

Using as Predictors:

- Pretest score
- Incoming self-efficacy rating
- **Tutorial strategy (dialogue act tag) immediately following questionable student problem-solving action**

Result 1: Presence of Encouragement

Explicit tutorial encouragement following questionable student problem-solving action

56% *less* likely to result in high learning gain (p = 0.001)

57%* *more* likely to result in high self-efficacy gain (p=0.054)

Compared with no explicit tutorial encouragement

* Weak statistical relationship

Result 2: Cognitive Feedback "Plus"

Purely cognitive feedback

40% *less* likely to result in high learning gain

No statistically significant difference in self-efficacy gain

Compared with cognitive feedback plus praise

Result 3: Standalone Encouragement

Tutorial standalone motivational act (i.e., no cognitive feedback component)

- No statistically significant impact on learning gain
- Initial low self-efficacy, 300% as likely to have high self-efficacy gain
- Initial high self-efficacy, 90% lower odds of having high self-efficacy gain

Compared with all other tutorial acts

Result 4: Positive Cognitive Feedback

Positive cognitive feedback (no explicit motivational component)

- No statistically significant difference in learning gain
- 190% increased odds of high self-efficacy gain

Compared with lukewarm, negative, and neutral cognitive feedback as well as tutorial questions

Future Work

- Expand affective/motivational dialogue acts under consideration
- Broaden window from pairs to triples and beyond, to investigate higher-level tutorial strategies
- Refine automatic tagging for correctness of student problem-solving actions
- Examine impact of other student characteristics

Conclusions

- Tutorial strategies can be chosen to focus on specific cognitive or motivational outcomes during tutoring
- Results reinforce findings that there are tradeoffs between cognitive and motivational outcomes in tutoring.

  (Jackson & Graesser 2007, Tan & Biswas 2006, Kelly and Weibelzahl 2006, Wang et al. 2005, Rebollendo-Mendez *et al.* 2006, Mayer *et al.* 2006)