

A Comparison of Three Modes of Reflective Dialogue

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Goals

- To determine if reflective dialogues following problems in the Andes physics tutoring system support **robust learning**—that is, transfer of conceptual knowledge learned through dialogues to new qualitative and quantitative problems.
- To compare the effectiveness of three modes of reflective dialogue.

“In Vivo” Experiment

- Conducted study in an introductory physics course at the US Naval Academy
 - 7 sections, taught by 4 instructors
 - 123 students, block-randomly assigned to 4 conditions
- We couched our manipulation as a “reflective follow-up” activity to Andes work-energy problems:
 - Qualitative Reflection Questions (RQ’s) + Canned text as feedback
 - Reflection Questions + standard, tutor-led Knowledge Construction Dialogues (KCDs)
 - Reflection Questions + Mixed-Initiative KCD’s
 - students can ask questions, via menus

- Control condition: problem-solving only (no RQs)

Hypotheses

- Students who engage in one of the three forms of reflective dialogue will outperform the no-dialogue control, with respect to:
 - Pre-test to post-test **performance gains** on a test that measures conceptual knowledge and related problem-solving ability
 - Problem-solving performance on course exams
- The more **interactive** the reflective dialogue, the better students will do, specifically:
 - Mixed initiative KCDs > Tutor-led KCDs > Canned text feedback

The Bad News: Low Student Participation

- Among 123 participants:
 - Only 50 (41%) did all 9 target Andes problems prior to the post-test
- Among the 93 treatment subjects:
 - Only 13 (14%) completed all 22 reflective dialogues
 - 42 (45%) did **no** reflective dialogues
- Among 31 subjects in the Mixed-Initiative condition, only 9 subjects ever asked a follow-up question

→ No significant difference by condition on pre-test to post-test gain score, after we:

- reclassified treatment subjects who didn’t do any dialogues as control subjects
- reclassified Mixed-Initiative subjects as standard KCD subjects

The Good News: The more reflective dialogues students did, of any type, the better they did.

- “Yoked Pairs” Analysis: chose “matched” pairs of subjects such that
 - both students had identical pre-test scores and major
 - the disparity between paired subjects’ QPAs was minimal
 - one subject completed no reflective dialogues, the other completed 5 or more dialogues

- Mean gain score from pre-test to post-test was significantly higher for treated than untreated subjects**
 - tests focused on *conceptual knowledge*

- Similar result for regression analysis:
 - Regressed post-test scores on: number of problems completed, number of reflective dialogues completed, QPR, and pre-test score
 - The number of dialogues a student completed had a significant positive effect on post-test score ($p = .03$), independent of the number of problems he or she completed.**

Reflection Questions After Andes Problems + Canned Feedback

A screenshot of the Andes physics tutoring system interface. It shows a problem description: "A rock climber of mass 50 kg slips while scaling a vertical face. Fortunately, her carabiner holds and she is left hanging at the bottom of her safety line." Below the text is a diagram of a climber hanging from a rope. The diagram labels the climber's mass as m , the rope as "Tension", and the climber as "climber". There are also labels for "Tension" and "Weight" with arrows pointing up and down respectively.

Sample Reflection Question:

Why does the tension equal the weight in this problem? What would Sir Isaac Newton say?

Student: that is the amount of force being exerted on the bungee

Canned feedback: There is no acceleration (in any direction) since the climber has a constant velocity (of zero). Newton would say since the acceleration in this problem is 0 then that means that there exists no net force. the sum of all those forces must add up to 0. ...

Reflection Questions + Standard Tutor-led Dialogues

Same problem and Reflection Question as above.

T: Why does the tension equal the weight in this problem? What would Sir Isaac Newton say?

S: that is the amount of force being exerted on the bungee

T: Is the bungee jumper accelerating?

S: no

T: Good. Then what is the net force in this system?

S: I don't know.

T: Newton would say that since the acceleration is zero, the net force in the system must be 0.

What forces act on the bungee jumper?...

Mixed-initiative Dialogues: Student can ask Follow-up Questions

T: Why does the tension equal the weight in this problem? What would Sir Isaac Newton say?

S: that is the amount of force being exerted on the bungee

T: Is the bungee jumper accelerating?

• What is acceleration?

• **What is the relationship between acceleration and the net force on an object?**

T: Newton’s Second Law says that if an object is not accelerating, it’s net force must be zero.

So, why does the tension equal the force in this problem?

• What is Newton’s Second Law?

• **What does Newton’s Second Law have to do with acceleration?**

