Designing the Learning Environments of the Future: Detecting Patterns in Virtual Collaborative Problem Solving Experiences

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Introduction

This project examines the student experience in group problem-solving discussion exercises in a Java class. The exercises are a curriculum innovation in a 2nd semester Java class, designed for learning and reinforcing the concepts of Java as opposed to the programming skills imparted by traditional labs. The research questions of this study are based on the pre- and post-test scores of students, as well as survey questions afterward. Are the better-prepared students reporting the same experience and exhibiting the same learning as the lower-prepared ones? Are the students reporting engagement with the exercises? Does it matter whether you are the best-prepared or worst-prepared person in your discussion?

In the exercises, students collaborate in groups of usually 3 students to analyze Java code, exclusively communicating through the COMPS chat environment. Students are instructed to come to agreement on part of the problem, then submit their answer to a teaching assistant for comment. This protocol is intended to serve two goals: a) have all students participate and to achieve understanding, b) force reasoning to be articulated, out in the open. This protocol also admits of the possibility that different students will experience the exercises differently. A student who is ahead of the others should not be able to simply state the answer and then move on, a student who is behind the others should need to put in the effort to achieve agreement and understanding.

Example Dialogue

In peer-to-peer learning environments, student discussions of the problem can lead to the understanding of information that was previously overlooked. In the example transcript below, Student A seems to be confused, however, by asking critical questions, leads the group to the correct answer.

A	do you guys understand this second problem
B	this one is confusing.
C	yeah this one got me thinking
A	lets try and take it like one output at a time...how are we gong to get this to print Foo_3 first? [ellipses dotsin original]
B	we need to first make foo_2 extend foo_2
A	why
B	because foo_2 starts the main method but it isnt the first thing that prints
A	wait hold on..that cant be right its not a choice bro. so it has to start with foo 3 or 4 or object
B	oh that's what i meant . we have to make foo_2 extend to foo_3 my bad
A	so when you do foo 2 extends foo 3 , the program goes down to foo 3 and prints out "From Foo_3"?
B	yes and then it goes back to foo_2 to print "From foo_2" .
C	so what is the main calling when it says Object foo_2 = new Foo_1? and for the other
A	idk it kinda looks like a swap without the "temp" thing/ example Dr. <prof.> showed us
C	I got answer c
B	i do too.
A	can you explain it to me because i am confused
B	ok , i got it now. (types first part of explanation, 42 words. Subsequent dialogue elicits rest.)

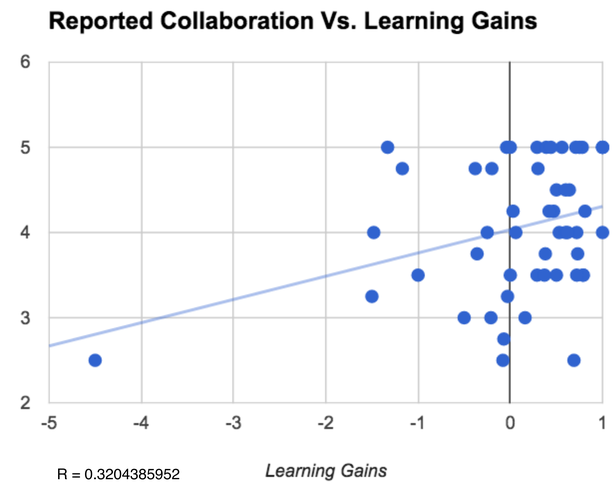
Students are instructed to reach an agreement, then validate answer with the instructor, continue if needed. Repeat the process for each question.

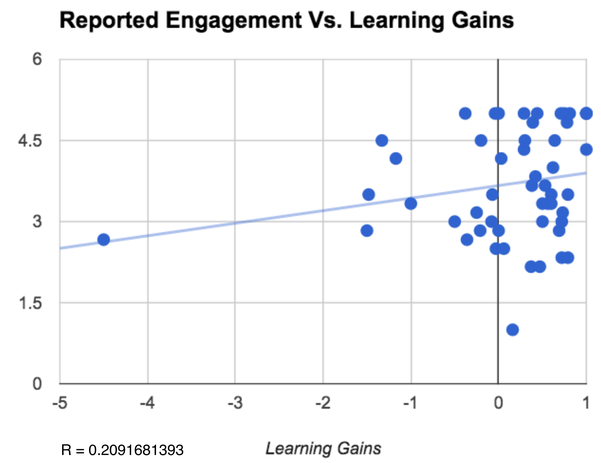
Learning Gains

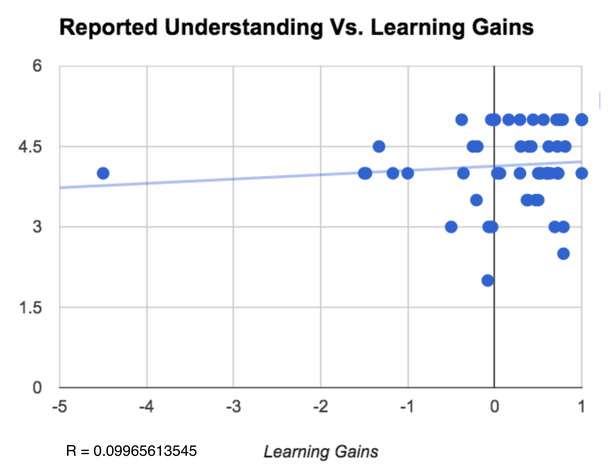
We analyzed learning gains according to the relative position of each student in a discussion group (highest, middle, lowest), based on pre-test score. The high student in each discussion lost ground on average, the other two gained.

Table 1. Average Learning Gains

	Highest Stratum	Middle	Lowest	Class average
Lab3 (n=54)	-0.05	0.34	0.40	0.26
Lab4 (n=49)	0.16	0.57	0.73	0.55



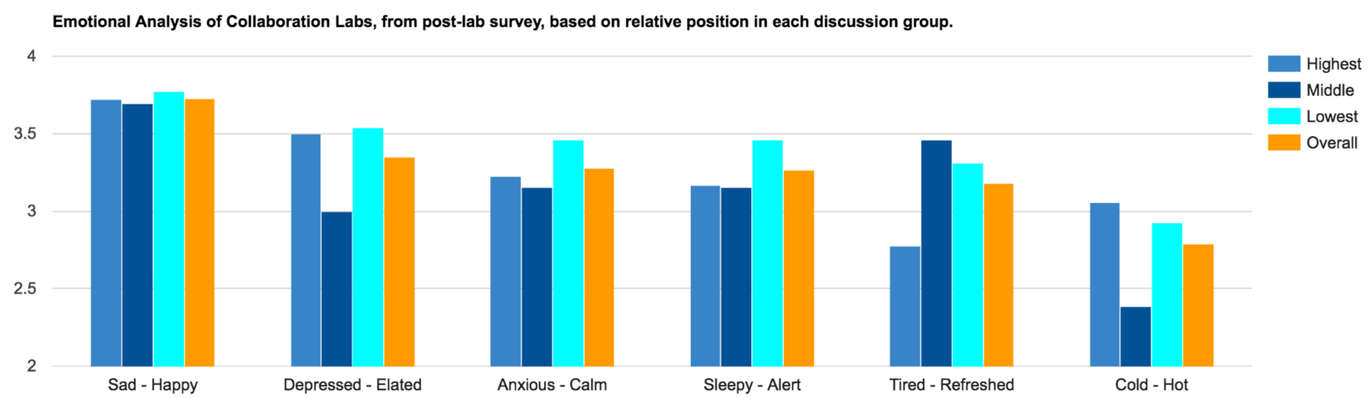




These graphs show slight correlations in student-reported engagement, and understanding, with respect to learning gains, and a larger correlation between reported collaboration and learning gains.

Emotional Analysis

In order to gauge whether students are having a positive or negative experience, they are surveyed on a range of emotions at the end of a collaborative session. Below we compare the emotions of students in terms of their pre-test ranking within the group. “Highest” represents the students who scored the highest on the pre-test, with in their groups, “Middle” represents the middle scoring students, and “Lowest”represents the students who scored the lowest.



Future Work

Data Analysis:

- Compare student-reported results with results garnered through transcript analysis
- Apply Machine Learning techniques to extract patterns in communication, behavioral and emotional attributes.
- Use NLP techniques such as text classification and topic modeling to extract features from the transcripts that can be used in analysis.

Data Collection:

- Have the pre-test question overlap the discussion exercise (the students will be primed).
- Work with education experts to increase reliability of test scores

Motivation:

- Relate semester-level student enthusiasm to situational interest in the labs and study how to match students into groups based on their interest levels and scores.

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