

# Students under the microscope: learning, metacognition and attitudes

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## INTRODUCTION

Metacognitive development, the ability to be aware of one's own cognitive processes, is linked to students' ability to better monitor and regulate their learning<sup>(1), (2)</sup>. It is hence a strong predictor of academic success.

In this study of students in a non-majors biology course, we:

- investigate the correlation between students' self-reported abilities (metacognition) and their actual ability measured through a scored problem (learning).
- explore differences in students' attitudes towards peer discussions and group work as means to reinforce their learning of biology.

Our primary goal is to understand whether metacognitive development and students' attitudes towards biology (as shaped by group work in the course) influence their learning.

## METHODS

- Pre- and Post-Surveys;** Reflections; Focus groups.

### Metacognition

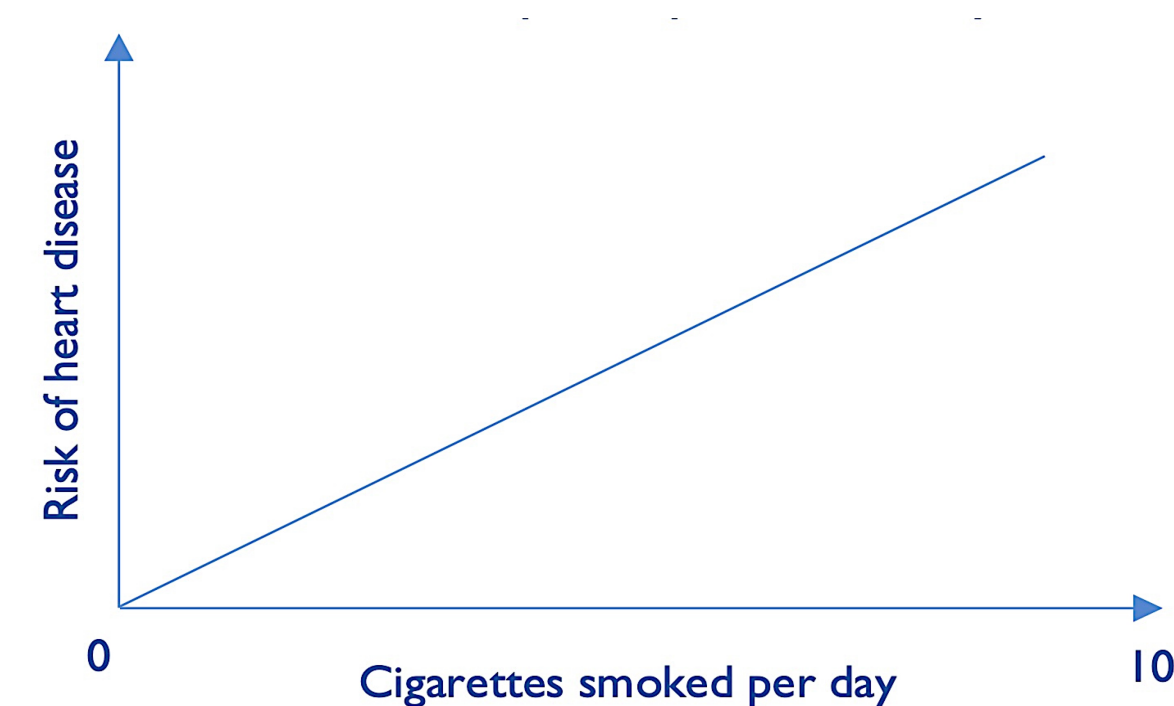
Q8. On a scale of 1 (not confident at all) to 5 (very confident), how confident are you at being able to come up with an experiment to test a hypothesis based on an observation around you?

1 2 3 4 5  
 (Not confident at all) (Very confident)

### Learning

Q2. Develop and write a testable hypothesis on the topic of heart disease, stating the independent and dependent variable in a controlled experiment. Include a brief sketch of your results.

Frequent smoking increases the risk of heart disease  
 IV: frequency of smoking, measured by number of cigarettes smoked per day.  
 DV: risk of heart disease  
 Control: non-smoker participants in study



### Attitudes

Q4. To understand biology it helps to discuss concepts with peers.

Q5. I value group work and group assignments within and beyond the classroom to reinforce my learning of biology.

1 2 3 4 5  
 (Strongly Disagree) (Strongly Agree)

## REFERENCES:

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- Why People Fail to Recognize Their Own Incompetence - David Dunning, Kerri Johnson, Joyce Ehrlinger, Justin Kruger, 2003.
- Dunning D. 2011. Chapter five - The Dunning-Kruger Effect: On Being Ignorant of One's Own Ignorance, p. 247-296. *In* Olson, JM, Zanna, MP (eds.), *Advances in Experimental Social Psychology*. Academic Press.

# Students accurately predict their scientific ability.

Self-reported confidence (=metacognition) in ability to use the scientific method and demonstrated ability in a scored problem (=learning) are correlated.

# Students consider peer discussions important but are divided on the value of group work to reinforce learning.

Students' attitudes to group work shift over the semester.

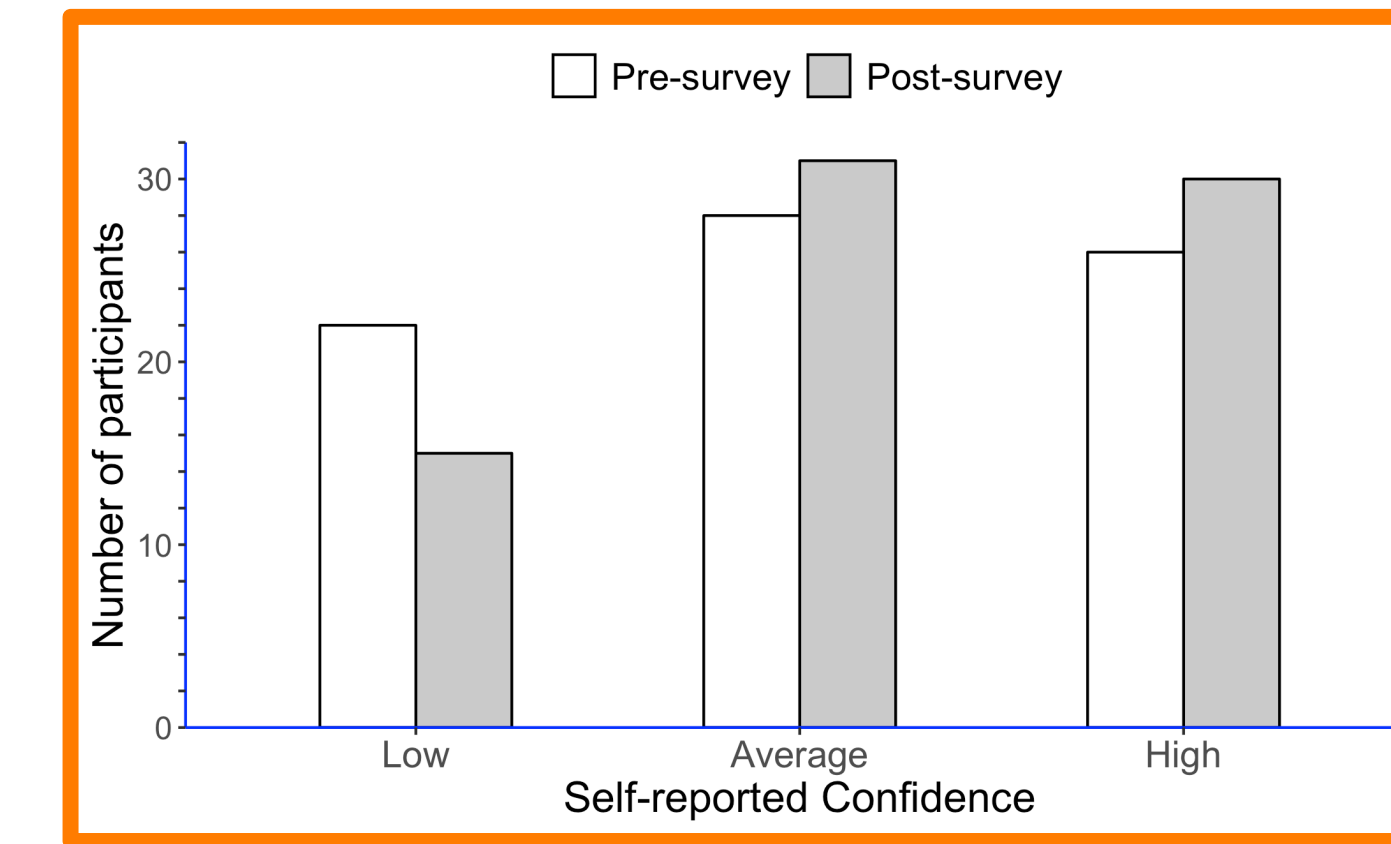
Your turn. Feedback, please.

## DISCUSSION:

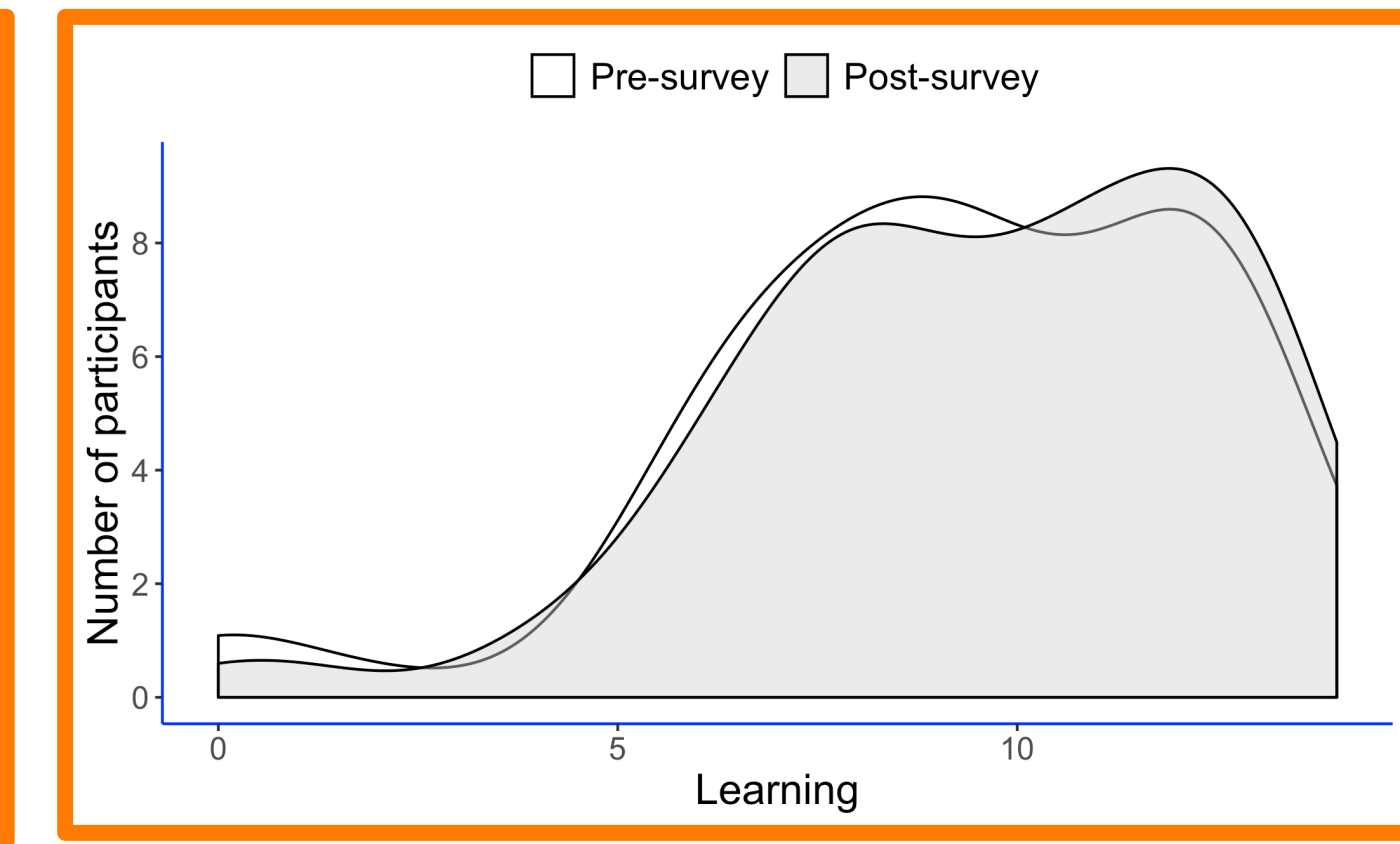
- We do not see evidence for the Dunning-Kruger effect<sup>(3),(4),(5)</sup> in our analyses: students accurately rate their learning abilities, even as they shift between the pre- and post-surveys.
- Students in the lowest quartile scores on the pre-survey scored problem show the largest learning gains in the post-survey.
- Students highly value peer discussions and this attitude remains the same in pre- and post-surveys.
- Students' rating of the value of group work in reinforcing learning shifts to a lower medium and shows more variability in post-surveys.

## RESULTS

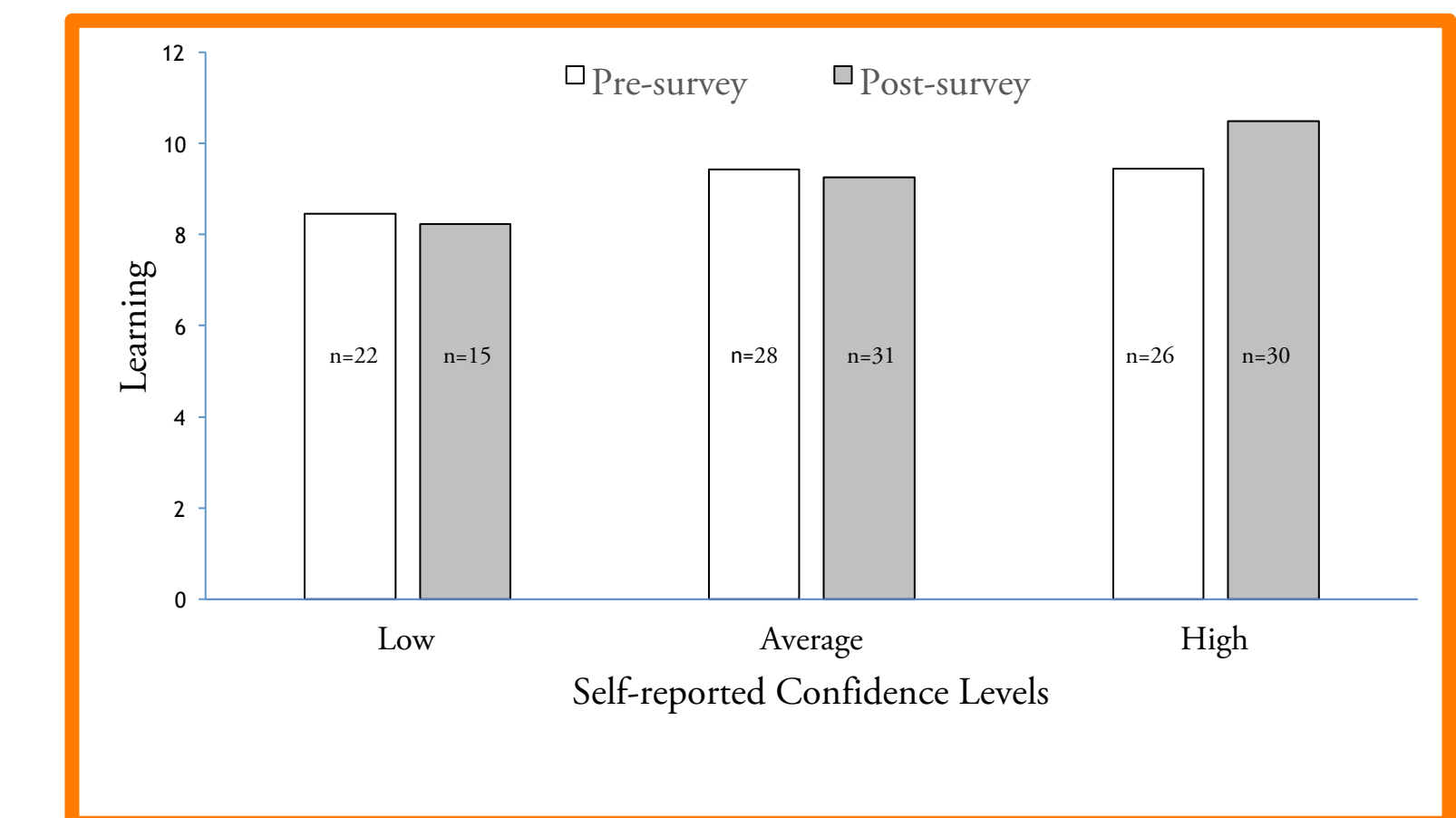
The total number of participants for the pre-survey was 129, post-survey was 94 and the overall study population was 76 students.



Confidence in ability increases from pre- to post-surveys.  
 Overall shift in confidence significant (p=0.02, sign test in R).

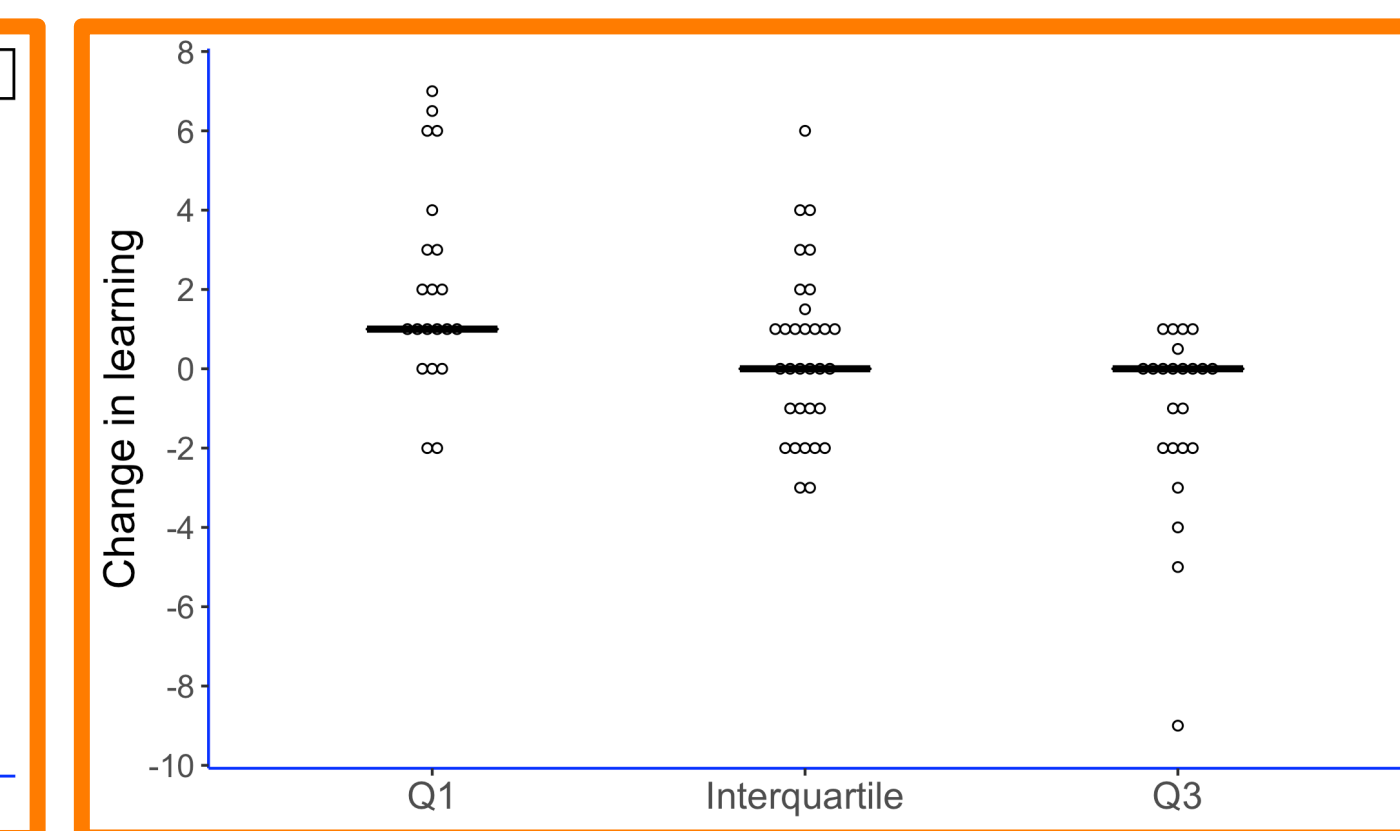
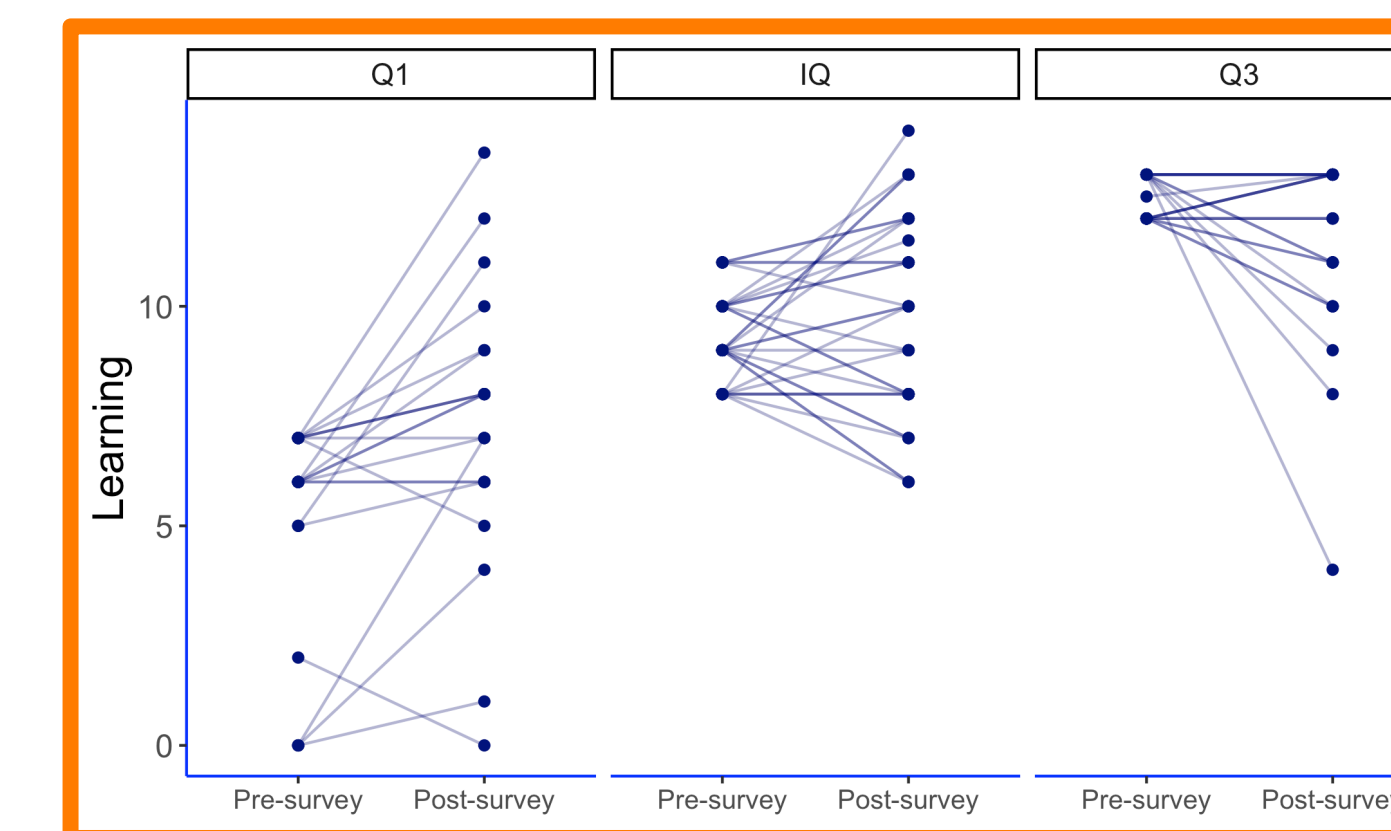


Learning increases from pre- to post-surveys.

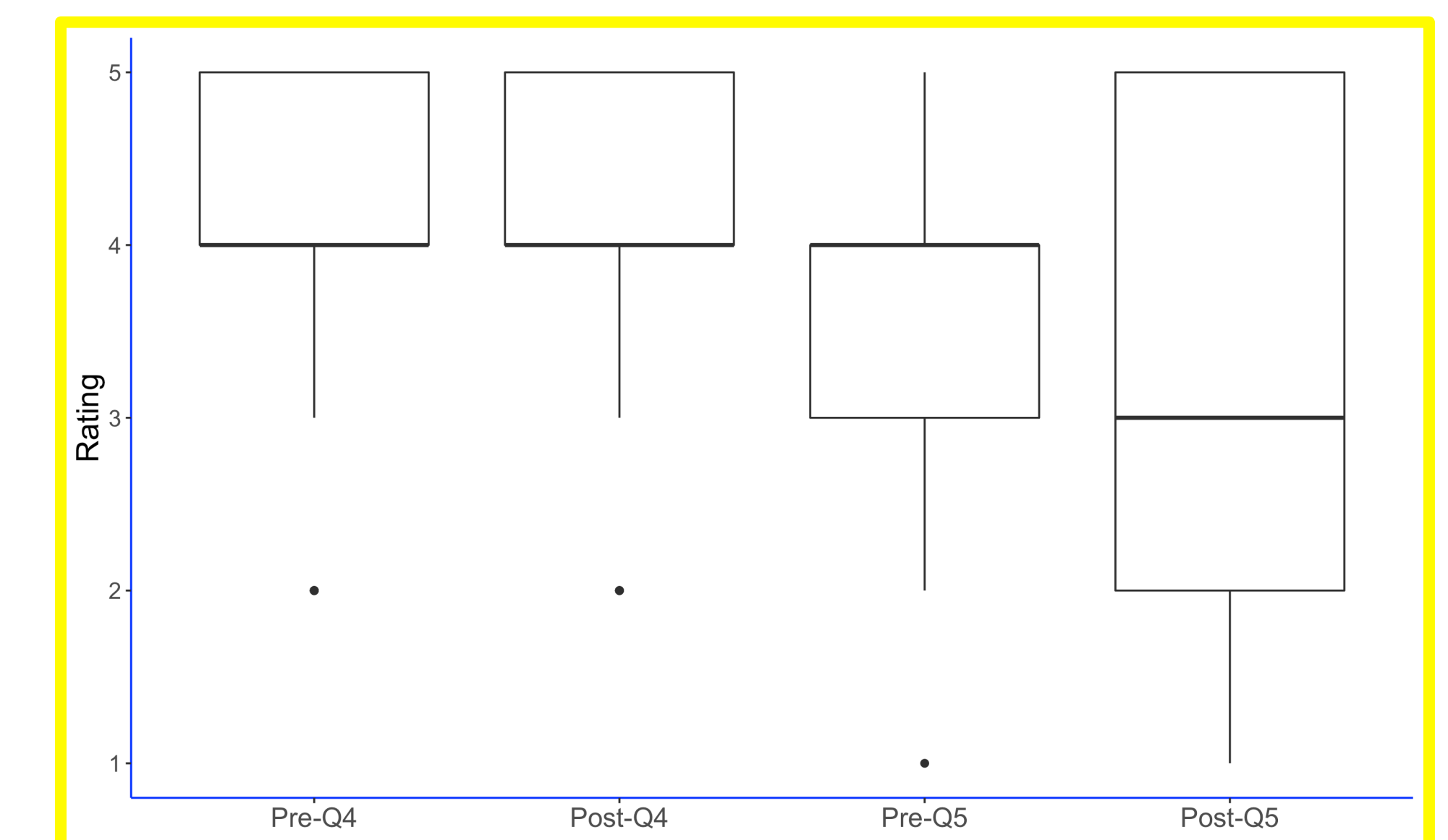


Differences in learning ability not significant (t-test in R). Increase in confidence is significant (p=0.02, sign test in R).

Students accurately rate their learning abilities, even as they shift between the pre- and post-surveys. No evidence for Dunning-Kruger effect<sup>(3),(4),(5)</sup>: a cognitive bias in which people incorrectly overestimate their abilities.



Learning gains are highest for students in lowest quartile (Q1) of pre-survey scores.  
 Learning gain for Q1 significantly different from Q3 (p<0.01, Mood's median test in R).



Q5: difference in median almost significant (p=0.09, paired t-test in R).

Q4: Value associated with peer discussions remains high in pre- and post-surveys.

Q5: Value associated with group work in reinforcing learning shifts in post-survey (lower median, more variability).

## FUTURE WORK:

- Correlate learning gains in survey with academic performance (course grades).
- Analyze reflections on group work & focus group transcripts – qualitative evidence to explain students' attitude shift?
- Re-design course's group work assignments based on findings.