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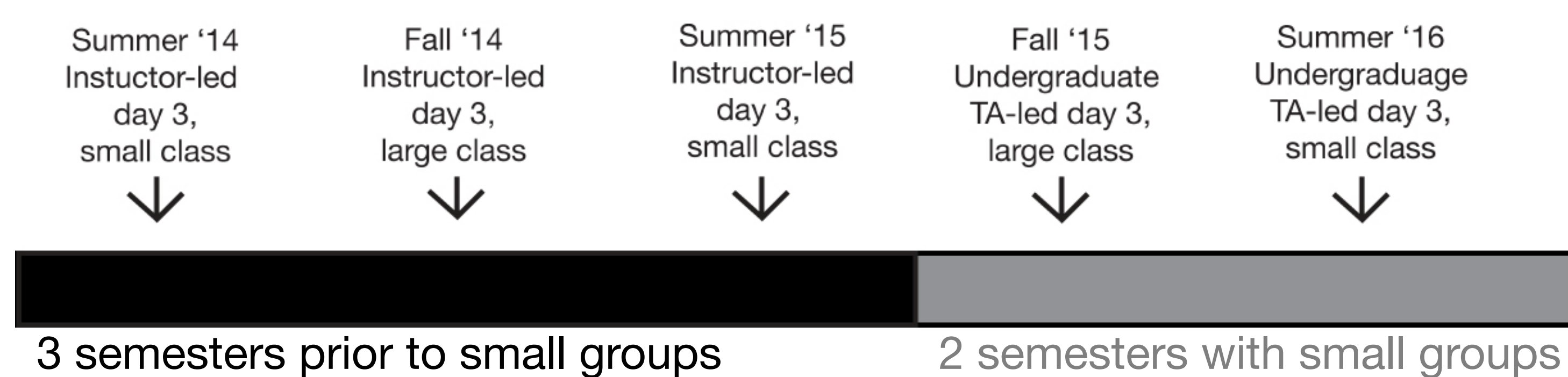
Small-group, undergraduate-lead discussions substantially increase the value of a primary-literature module

In our introductory biology course for majors and non-majors, we present historical models that reigned for 60 years and the revolutionary discoveries that overturned them. Students see data from experiments for historical models, confront experimental results that contradict historical models, and discuss a revised theory that explains past and present data (see Hoskins 2008).

Project Design

- Course: introductory biology for majors and non majors (Modern Biology): Summer 2014 (21 students), Fall 2014 (193 students), Summer 2015 (28 students), Fall 2015 (169 students), and Summer 2016 (14 students)
- Day 1: Textbook background on development
- Day 2: Evidence that without a signal from “mesoderm”, cells in “ectoderm” become skin by default
- Day 3: Evidence that without local signals from other ectoderm cells, isolated ectoderm cells default to neurons
 - Summer 2014, Fall 2014, and Summer 2015: Instructor-led discussion with two 5 minute think-pair-share activities
 - Fall 2015 and Summer 2016: 40-minute undergraduate TA-led group discussions
- Day 4: Comparison between models and reconciliation (NOTE: 4x50 minute day schedule from Fall is condensed to 2x80 minute days in all 3 Summer terms)

Timeline of interventions



Project Evaluation

Exam performance on questions asking students to apply experimental methods to analogous situations and/or distinguish between results and interpretations behind old vs. new models

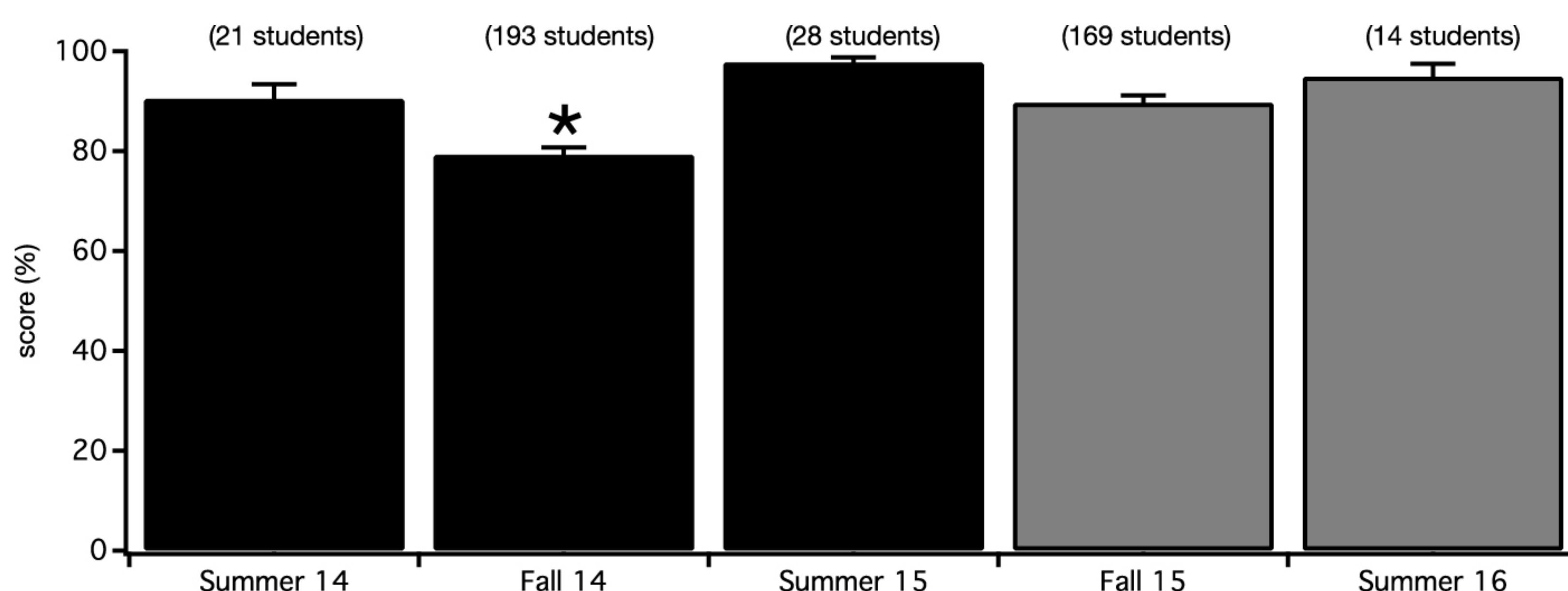


FIGURE 1. Score on literature-based exam questions across all terms. Black bars: terms which had 50 minute instructor-led discussion with 2x5 minute think-pair-share activities on “day 3”. Grey bars: terms which replaced “day 3” with a 40 minute TA-moderated discussion period (5-8 students in each discussion group). Students performed significantly lower in Fall 2014 (large section without small undergraduate TA-led groups) than in all other terms on questions asking students to distinguish data and interpretations and/or apply ideas to new situations. No other comparison is significant.

Questions Asked and Answered

- Did the theory-revision approach succeed in small, summer classes with instructor-led discussion?
 - Yes, see Summer 2014 and Summer 2015
- Did this approach work equally well at a larger scale?
 - No, compare Fall 2014 vs. Summers ‘14 & ‘15
- Why? Is this because of smaller class?
- Is student participation and engagement in discussion of the critical data that overturned the previous theory?
- In order to answer these, we asked: “If the revision of the model is developed in a small, collaborative discussion facilitated by advanced undergraduates, does that allow this approach to succeed at a larger scale?”
 - Yes, compare Fall 2015 vs. Fall 2014
 - NOTE: the strongest gains here were seen in 2nd and 3rd quartiles of students (not shown)
- Do small group discussions work well in a smaller class setting? Yes, see Summer 2016
- Conclusion: Undergraduate-led 40 minute discussions (5-8 participants) significantly improve understanding of surprising data and a major theory revision in biology.



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