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Education Initiative
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Measuring Learning Gain in a Transformed Introductory Ecology Course

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Introduction

Conceptual inventories have been developed in numerous science disciplines in order to measure students' learning gain (physics: Hestenes and Wells 1992; genetics and cell biology: Klymkowsky et al. 2003, Khodor et al. 2004; natural selection: Anderson et al. 2002). A conceptual inventory typically contains 10-20 validated multiple choice questions (Adams and Wieman 2010) that test students understanding of fundamental concepts in a discipline. In order to measure learning gain, the questions are given before (pre test) and after (post test) concepts are introduced.

I developed a conceptual inventory in population and community ecology to measure learning in a transformed introductory course in ecology at the University of British Columbia in the winter of 2011.

Methods

The inventory

The conceptual inventory was developed by selecting four fundamental concepts in population and community ecology, i.e. interspecific and intraspecific competition, succession, life history, and population dynamics. Questions were developed using exam and assignment questions.

The questions were validated through about 30 individual “think out loud” interviews where students were asked to reason through questions telling the interviewer how they would answer an open-ended question and later in the validation process why they picked a particular answer on a multiple choice question. This method was used to design questions that would: 1) identify students’ misconceptions, and 2) measure learning gain.

During 2009 and 2010 about 500 students completed 15-30 questions on-line. The student results as well as feedback from interviews and response from instructors were used to finalize the questions.

Methods (cont.)

Data collection

The current version of the inventory contains 10 questions. These questions were given to 112 students as a 20 minute in-class **pre and post-semester test**, i.e. first and last day of class, in a transformed (from teacher-centered to learner-centered instruction) third year introductory ecology course (BIOL 304) .

Data analysis

73 students took both pre and post-semester test. Average pre and post test score were calculated as well as normalized gain (post test score – pre test score)/(total possible score – pre test score).

Results

The **average score** increased from 47.5% (pre-semester test) to 79.6% (post-semester test). High performing students (top 50% on final exam) increased from 52.2% to 82.2%, while low performing students (bottom 50% on final exam) increased from 42.6% to 76.9% (Fig. 1).

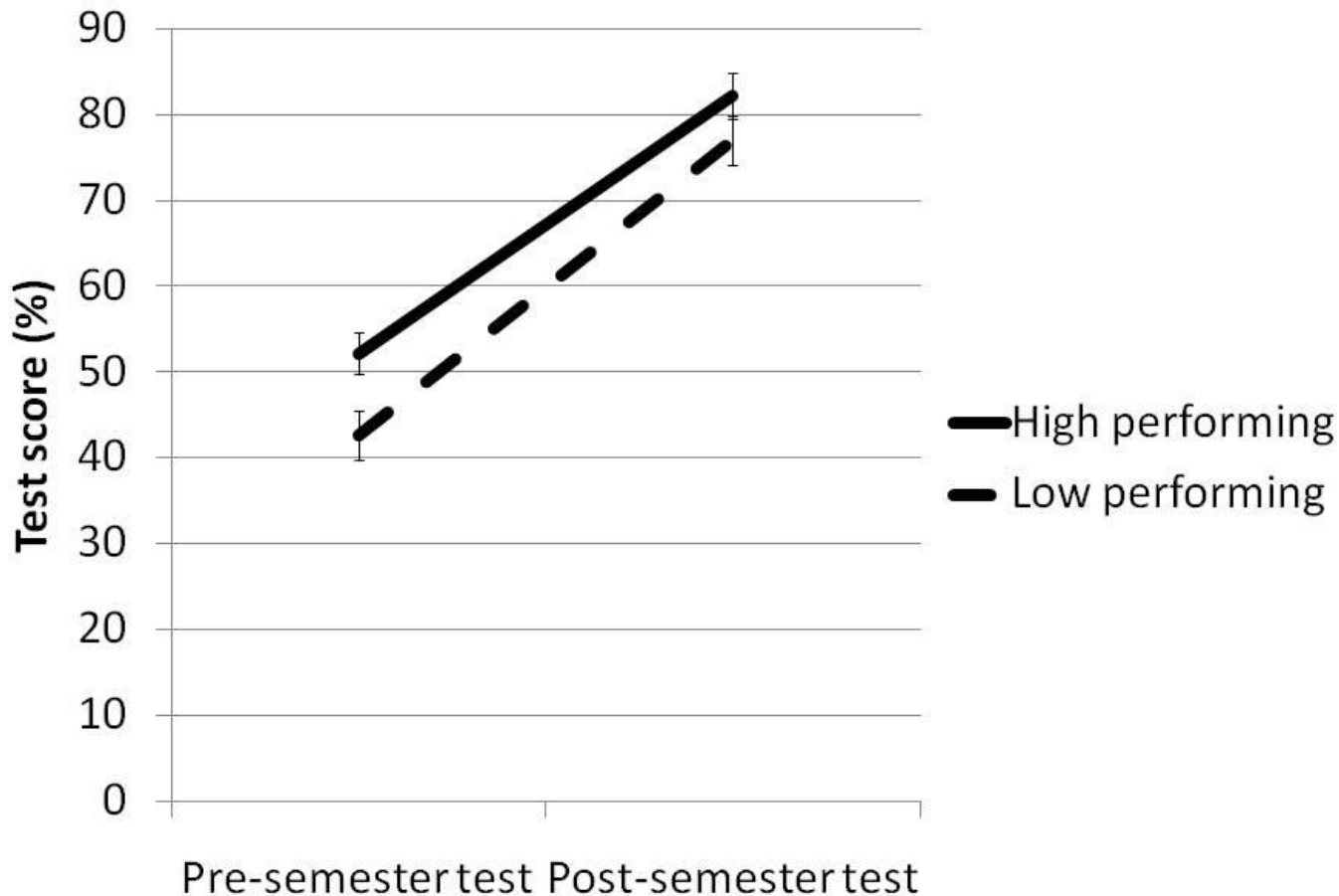


Fig 1

Results

The **average normalized learning gain**, i.e. (post-test score - pre-test score)/(total possible score - pre-test score) was 0.61. The average learning gain did not differ significantly for high and low performing students (high performing: 0.60; low performing: 0.62; Fig. 2).

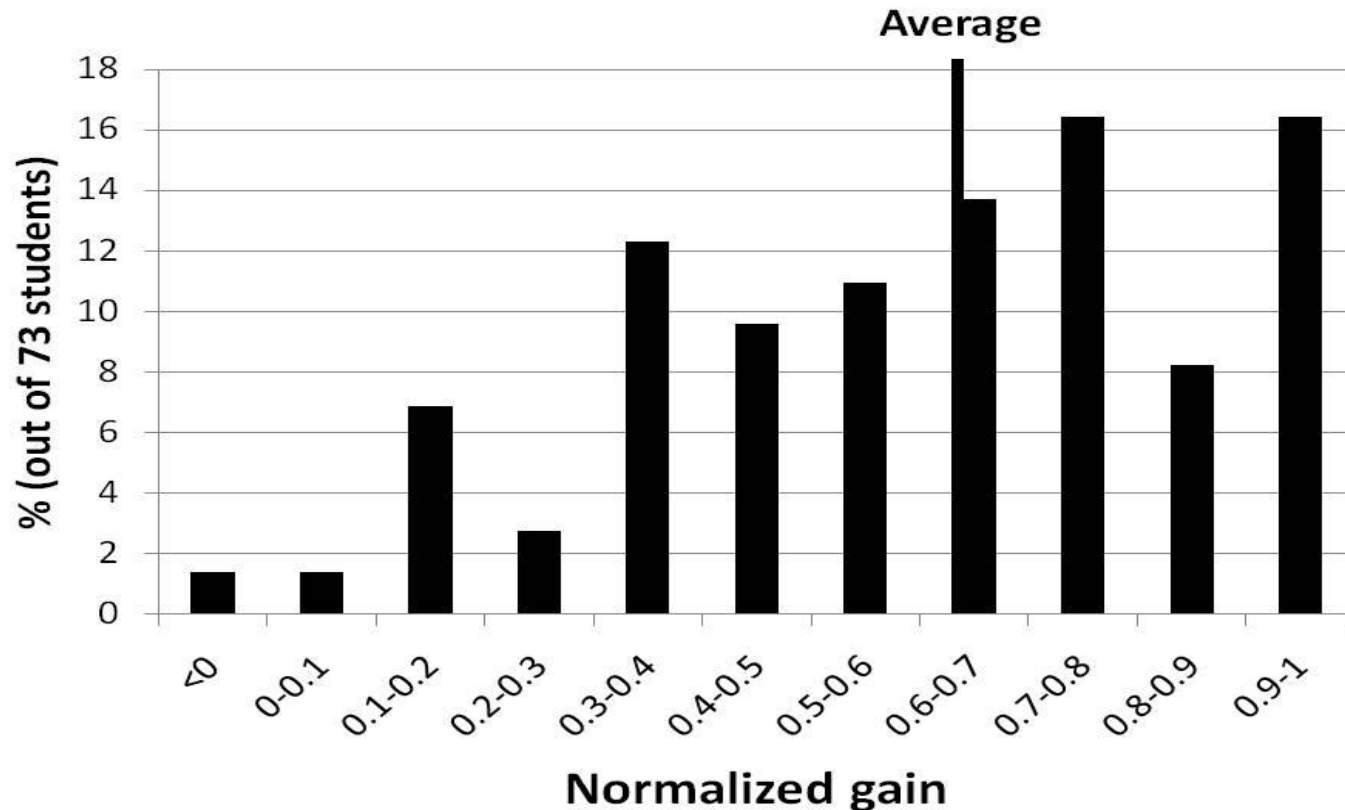
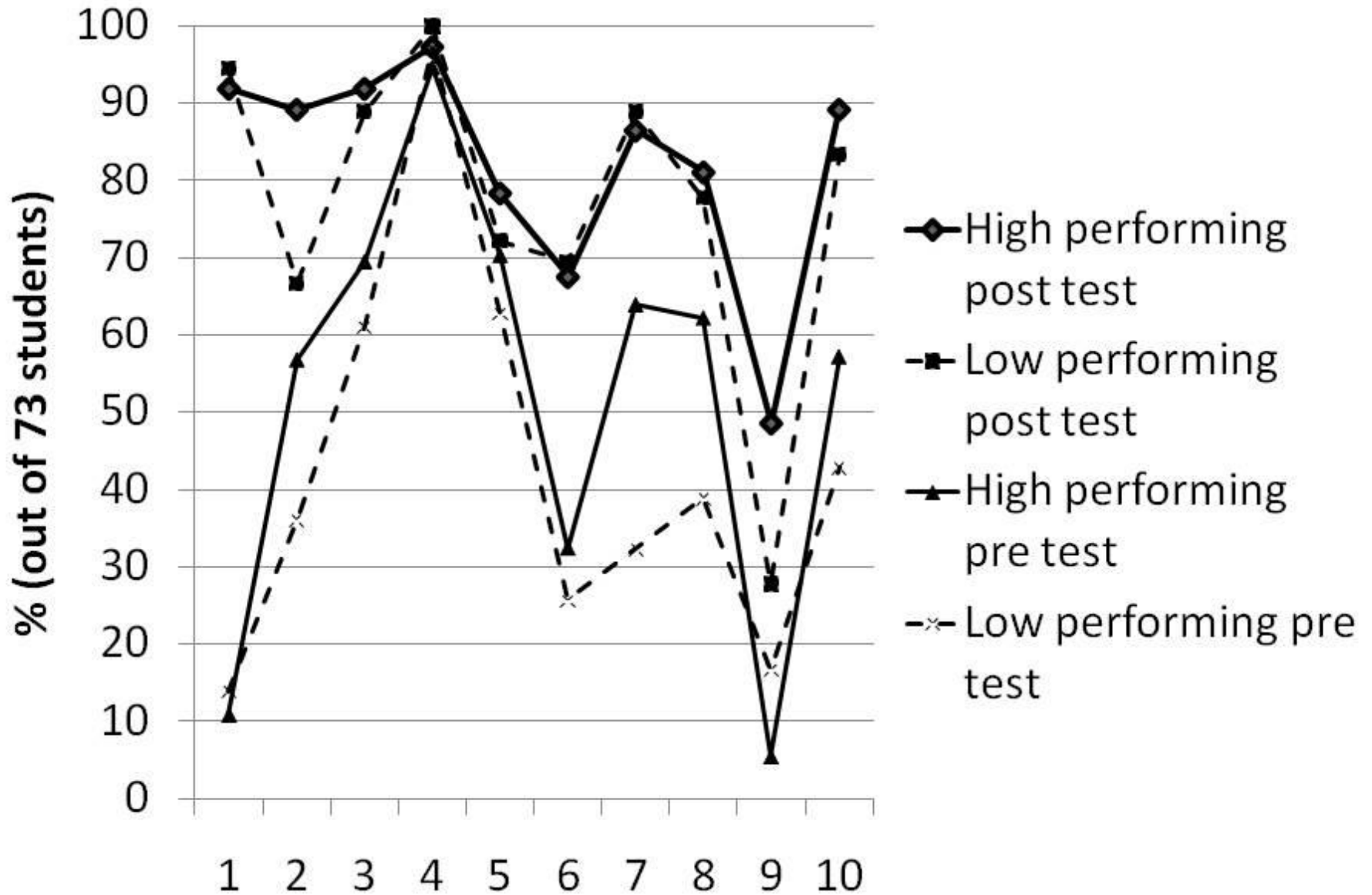


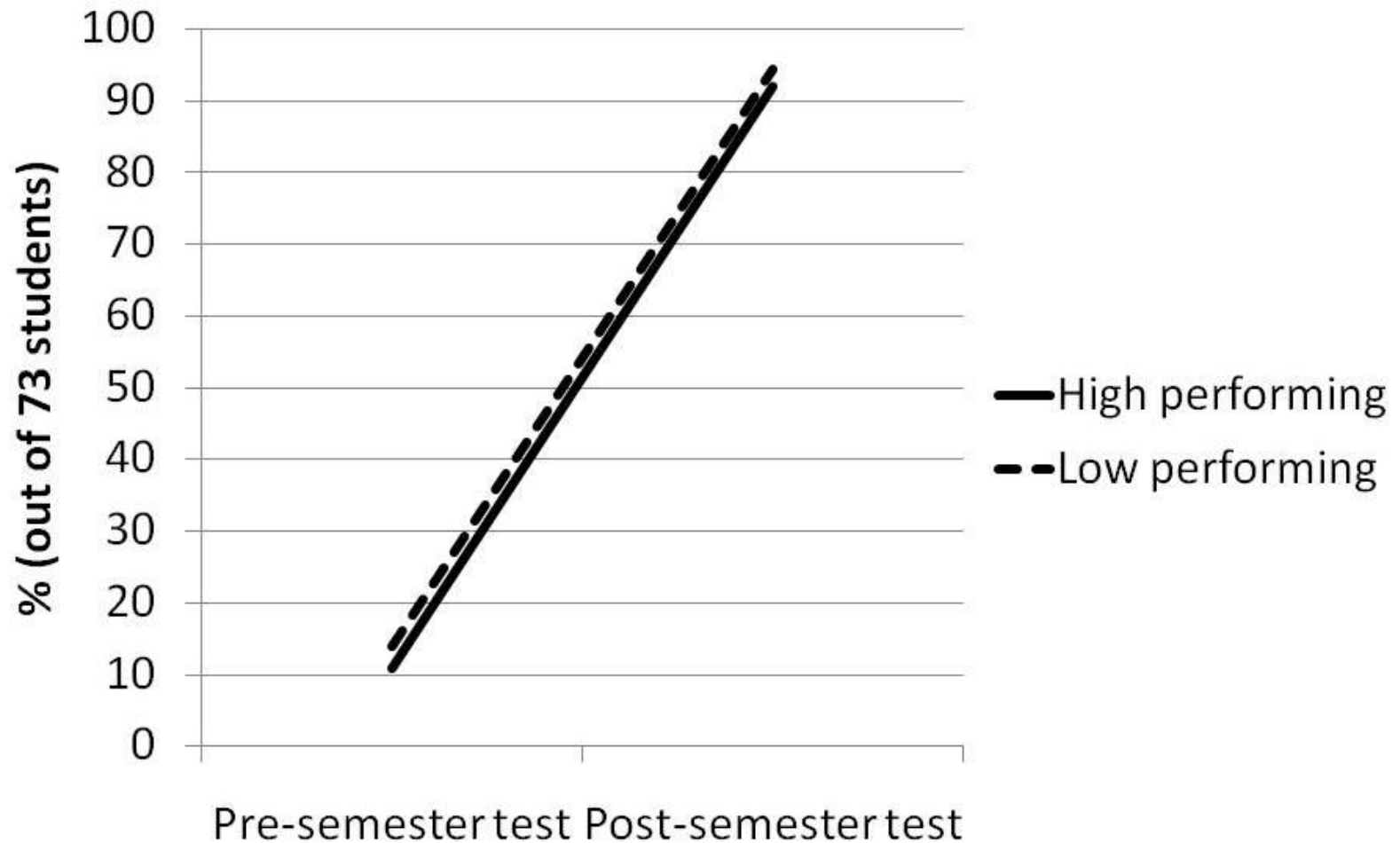
Fig 2

Results



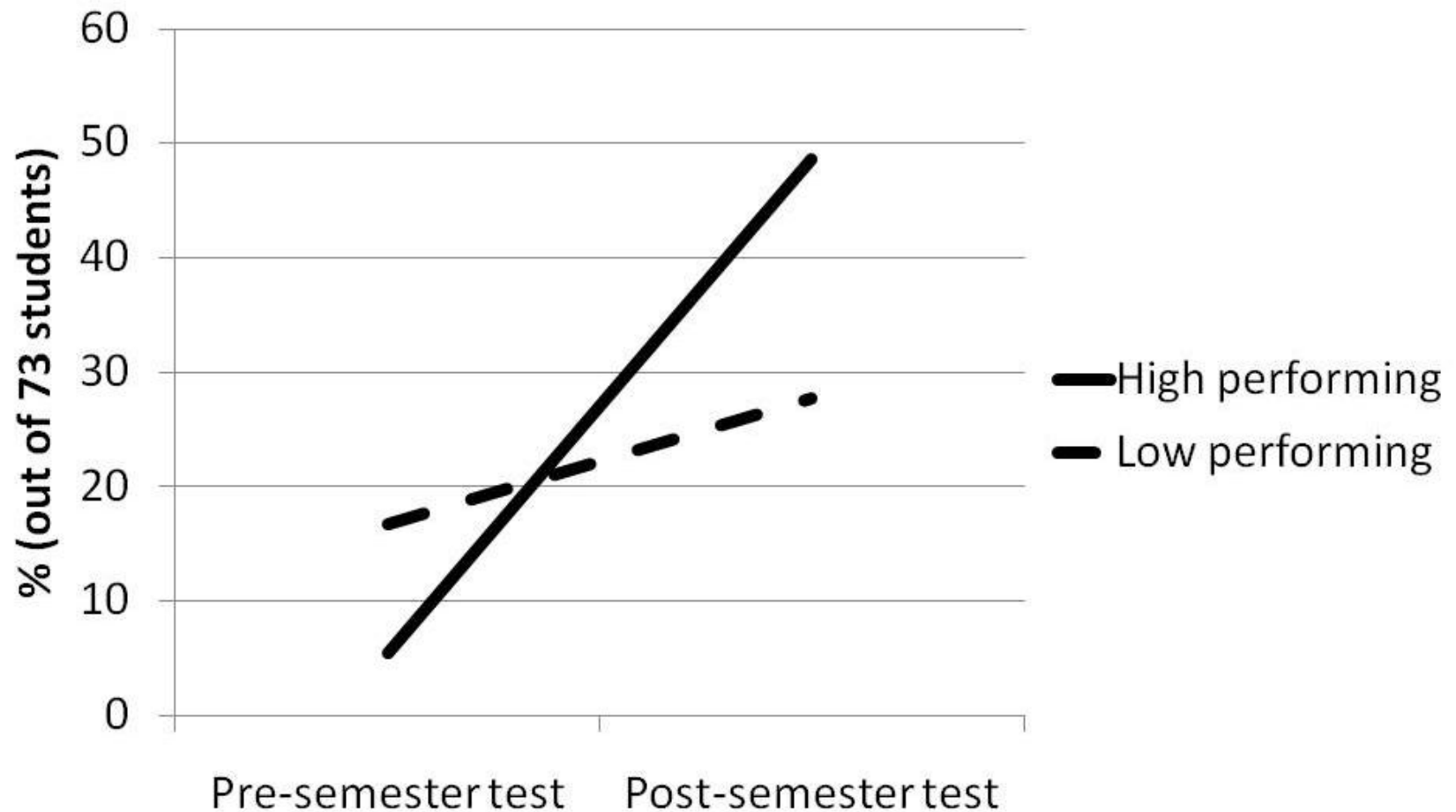
Results

Q1: What determines a species presence in a community?



Results

Q 9: Interpretation of data to determine if a process regulates or limits population growth.



Discussion

Courses with traditional lectures typically measure a learning gain of 0.2-0.3, while courses that have been transformed (from teacher-centered to learner-centered instruction) often measure a significantly higher learning gain, i.e. 0.5-0.6 (Physics: Hake 1998). Our data therefore compare with that of other studies of transformed courses.

Further research

To avoid a ceiling effect five questions will be added to the inventory for future semesters. These will test concepts on the island biogeography theory, functional response of predators and carrying capacity.

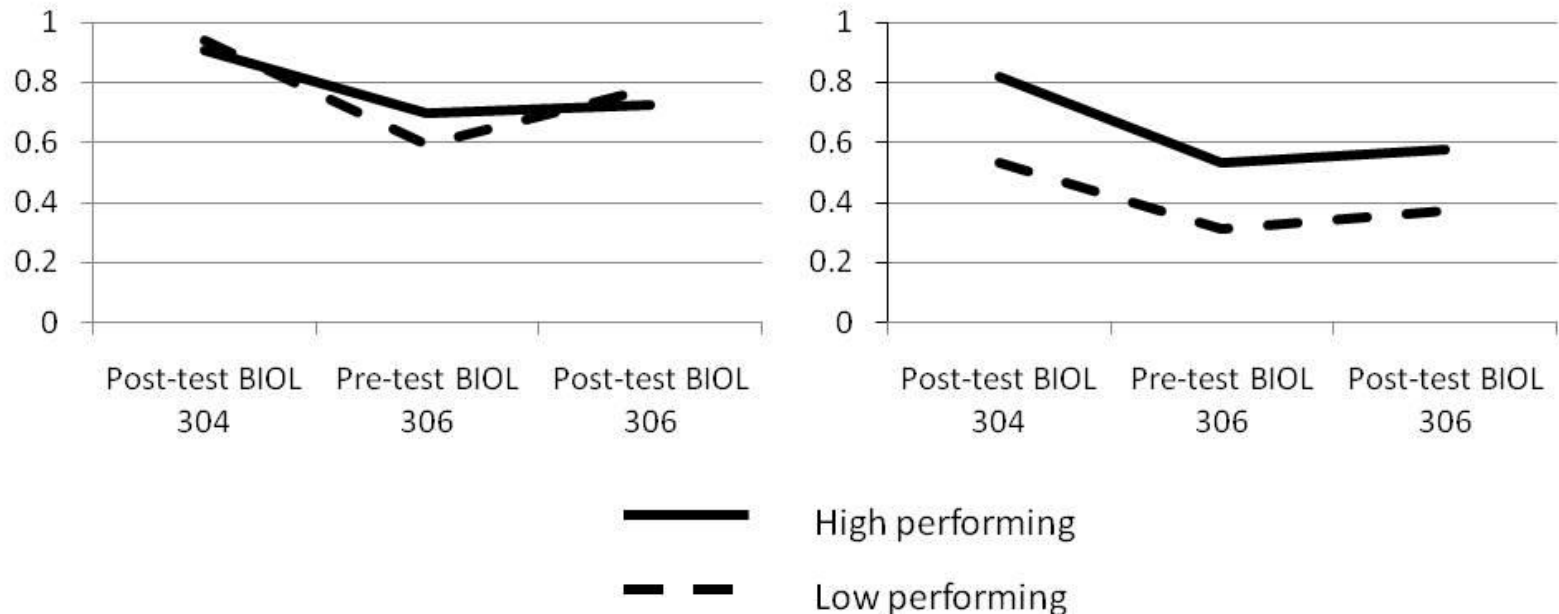
The inventory will be shared with instructors at other universities for use in ecology at different levels. Questions to measure learning at lower and higher levels may be added.

Discussion

Implications for teaching

The results from conceptual inventories can be used to design new activities and evaluate and modify existing ones in order to increase learning gain for both high and low performing students.

The conceptual inventory can be used to track student learning and retention from introductory to advanced courses.



References

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