Scientific process in practice, an activity based seminar for beginning ocean science majors

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Summary:

Explicit instruction of scientific process skills, meeting students' and curriculum needs

Teaching transferrable skills via an inquiry-based approach has been increasingly emphasized in science classrooms (1). Such inquiry skills are **essential for succeeding in rigorous college classes** and making critical decisions in their daily lives (2,3).

"Scientific Process in Practice" was **a 2 hour long, weekly seminar** designed to complement a field course for incoming oceanography majors (sophomores and juniors). Students conduct mini research projects in Puget Sound for the field course. However, they often struggle to master the data collection and analytical skills they acquire in this class with more basic skills and understanding about the scientific process.

Through hands-on activities, the "Scientific Process in Practice" seminar aimed to help students succeed in the field course and later science courses by:

1. **developing information literacy skills**
2. **practicing articulating testable hypotheses**
3. **studying the scientific format of presentation**

Inquiry-based, skill focused seminar created a safe learning environment and helped student learning:

> "A little lecture and then a group activity that is fun and easy-going – help us connect to what we need to know and give us a stress-free environment to learn and expand".
>
> Quote from student evaluation

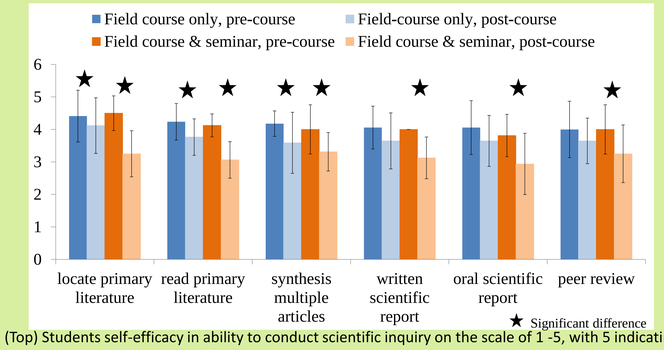
Assessments:

In addition to the traditional course evaluations (mid and end of quarter), we employed several assessment techniques to monitor students' learning progress.

Weekly quick write

Students spent 3 min at the beginning of class to reflect on "What have you learned last week?" This approach helped students improve metacongintion and made possible timely intervention.

Pre and post course surveys



(Top) Students self-efficacy in ability to conduct scientific inquiry on the scale of 1 -5, with 5 indicating they strongly agree that they can efficiently carry out the task listed (Mean and standard deviation).

Students completed the Student Understanding of Science and Scientific Inquiry survey (SUSSI, 4) and a self-efficacy survey on ability to conduct scientific research (5).

Significant decrease in self efficacy in ability to conduct scientific research suggested that both classes created a great dissonance in students' understanding of scientific inquiry (paired t- test, $p<0.05$). This decrease is likely an indicator of students being more reflective and therefore more self-critical.

Activities that introduce common scientific skills

Figure speed dating

The objectives of this activity are to help students:

- understand essential components in a scientific figure
- practice designing a scientific figure that conveys their message
- practice giving constructive feedback

Story board preparation (Homework assignment)

Students sketched a series of figures by hand and wrote their captions.

In class role playing on giving constructive feedback

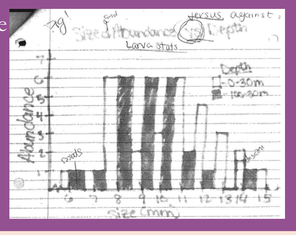
Students acted out what it would be like to give bad advice, and the absurdity of their actions made it clear what good advice should be like.

Figure speed dating

Students rotated to meet each other in a series of 4 min. "dates" in which they presented the key message of their figures and solicited feedback. Students completed the class by re-sketching their story boards.

Example of students' work
Day , night vertical distribution of larval and adult euphausiids
Student learned to present data in multiple panels for meaningful comparison and formulate an appropriate figure caption

Before



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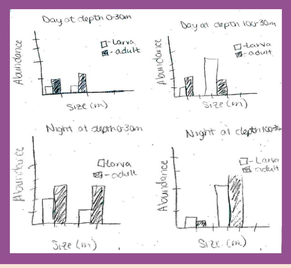
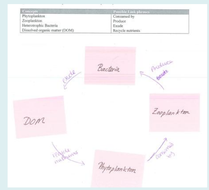


Concept mapping research projects

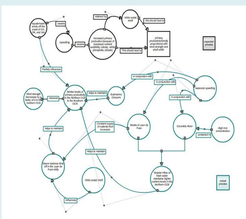
Concept mapping is a graphical tool for organizing and representing knowledge(6). We introduced this tool to help students with:

- Organizing their ideas regarding their mini-research projects
- Visualizing the connections between elements of a scientific article



Introduction to concept mapping techniques

Key concepts and link phrases are provided on Post it notes, students created individual concept maps regarding the microbial loop.



Concept mapping a scientific article

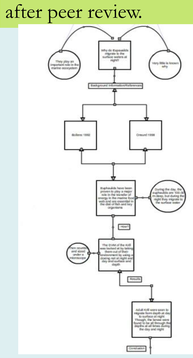
Students create individual concept maps of an article on the California Current System.

Concept mapping students' mini research projects

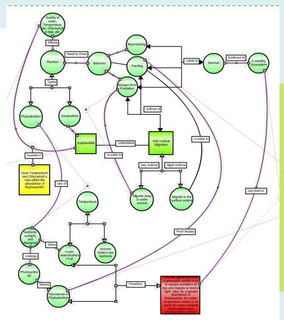
1. Students created a draft concept map of their projects using CLIMB tool from COSEE-OS.
2. In class review panel on the concept maps
3. Students revised their concept maps and presented their projects to the class orally

Mini-research project on diel vertical migration of krills.

Student developed better use of nodes, linking phrases and understanding of connections after peer review.



Draft



Final work, after peer review

"Going over everything **really made it easier for me to understand what I was doing with my project.** Thank you ! It helped out in the end."

Excerpt from minute paper of the student who prepared the concept maps shown

Statistics carousel

Statistics carousel

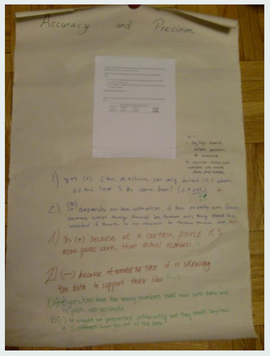
1. Working in pairs student responded to case study questions on chart papers with their unique color markers.
2. Groups rotated around and commented on their classmates' responses and noted if they agreed (++), partially agreed (+), partially disagreed (-), or disagreed (--).

Facilitated Class Discussion

Case Studies

Working in groups students identified the correct statistical test and sketched a figure for sample data sets.

This activity aimed to address common statistic misconceptions. For example, the difference between precision and accuracy, and discarding outliers.



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