Designing PBL Cases Around Classroom Objectives
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Background
- Problem-based learning (PBL) techniques are being used in the classroom to promote critical thinking, self-directed learning, and hands-on experience with scientific concepts (Herreid, 1994).
- These techniques can also be expanded to meet additional classroom objectives, such as introducing PBL, designing experiments, critically evaluating media sources and assessing student knowledge.

Study Objectives
- In this study, we designed and implemented PBL cases to meet the classroom objectives of:
  - Introducing the process of PBL
  - Giving students tools to critically evaluate sources of data
  - Assuring student understanding of chemical concepts

Methodology
- Setting:
  - Introductory high school chemistry (grade 10)
  - Honors Chemistry (grade 10)
  - Classroom size: 28 students (maximum)
  - Demographics: Suburban Atlanta, Georgia high school

- Implementation:
  - Groups of 3-5 students
  - Average of 5.55-minute class periods (range from 2-7 class periods)
  - 3 cases/semester
  - 3 facilitators per class (teacher, graduate student, undergraduate student)

- Classroom Objectives Addressed Through PBL:
  - Introduction to PBL
  - Introduction to topics in general chemistry
  - Laboratory methods
  - Critical assessment of media/internet sources
  - Evaluation of understanding of chemical concepts
  - Scientific writing and communication skills

Case 1: Spring Break Gone Wild
Topic: Students are trapped in a cave and must decide whether there is another oxygen to survive
Classroom Objective: Introduction to PBL process
Learning Objectives: dimensional analysis, percent composition, scientific notation, chemical reactions, stoichiometry, and moles
Student Outcomes: Students worked in groups to determine the amount of oxygen in the cave, turned in study questions and presented their results in a narrative case epilogue.

Case 2: Chemical Spill at Milton High School
Topic: A mysterious chemical is dispersed at MHS and students must identify and separate the chemical.
Classroom Objectives: Methods research and laboratory experiment design
Learning Objective: separation techniques, percent yield and physical vs. chemical properties
Student Outcomes: Students took the perspective of hazardous materials chemists and wrote how to identify and contain the material.

Case 3: Ungulates and Gases Case
Topic: Cows are trapped in a trailer and must figure out how to displace gas to survive
Classroom objectives: Exam assessment of student knowledge of chapter topics.
Learning objectives: gas laws, Boyle’s law, Charles’ Law, dimensional analysis and gas constants
Student Outcomes: Students solved case as part of the end of chapter exam. Students worked in groups of three to solve the case problem during the exam, using PBL methods.

Case 4: Mystery in Loveland, CO
Topic: Students are hospitalized after passing out and students must identify the cause of their illness.
Classroom Objectives: Critical assessment of media and internet resources
Learning Objectives: acid/base chemistry and solution chemistry
Student Outcomes: Students took the role of health care workers to diagnose the symptoms. Students discussed sources of medical information on the internet and assessed information sources for reliability.

Findings
- Students were able to demonstrate an understanding of the PBL process, design their own laboratory experiments, assess media sources, and answer exam questions based on PBL cases.
- Students were most receptive to the cases that involved hands-on, laboratory experiments and these cases allowed them to more fully appreciate the chemical concepts.
- From a teacher’s perspective, PBL can be designed around learning objectives and can meet classroom needs, but does require planning for the assessment of these goals.
- Student Evaluations:
  - “Case work is better than the normal lecture classes.”
  - “We get to be creative in what we’re doing.”
  - “The cases were very useful because we got to do research for ourselves and find stuff out for ourselves.”
  - “When I’m doing case work and I’m having to figure out learning issues and which are pertinent to the case and figure things out, I am a lot more attentive. When I find out which, learning issues are the important ones that I need, I seem to remember them a lot better.”

Conclusions
- PBL cases can be designed to apply to many different high school classroom objectives.
- PBL cases can be used to introduce students to scientific methods and improve communications skills.
- Cases helped to stimulate student interest in these areas as well, by making chemical concepts relevant to the students’ experience.

Literature Cited

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