

Using ESSEA Modules With K–12 Students

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ESSEA
Earth System
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Alliance

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ESSEA is a project of the Institute for Global Environmental Strategies (IGES) through funding by NASA and the National Science Foundation. Started in 2000, the project seeks to improve the quality of geoscience instruction for pre-service and in-service K–12 teachers through online courses, which are offered by colleges and universities across the U.S.

The knowledge and tools that teachers gain through ESSEA courses are directly transferable to their classrooms. They experience instructional strategies—problem-based learning, jigsaw or group investigation—that they can in turn use with their students to build content knowledge, increase student engagement, and develop critical thinking skills. ESSEA course modules are also resources that can be taken directly or adapted for K–12 instruction. The modules that IGES has adapted for middle and high school instruction use problem-based learning.

Problem-Based Learning (PBL)

The world is full of complex problems. We do students a terrible disservice by letting them believe that these problems have simple solutions. Through problem-based learning students acquire and apply not only new content knowledge, but also the skills, attitudes and behaviors needed to become lifelong learners, effective problem-solvers and responsible decision-makers. Our job as teachers is to facilitate the process by gathering together the tools, creating the environment and giving them the opportunity to grow and shine.

Problem-based learning (PBL) is designed to “simultaneously develop both problem-solving strategies and disciplinary knowledge bases and skills by placing students in the active role of problem-solvers confronted with a problem that mirrors real-world problems.” PBL models may be implemented using a variety of strategies but are generally characterized by the following steps:

- 1) Presenting a problem to a small group of students;
- 2) Discussion of the problem among the students which produces tentative explanations of the problem; and
- 3) An attempt to solve the problem.

Students are presented with a problem in which they can find personal relevance. The problem is ill-structured or “messy,” which is defined as:

- a) More information than is initially available is needed to understand the problem;
- b) The problem definition changes as new information is added to the situation;
- c) Many perspectives can be used to interpret information; and
- d) No absolutely right answer exists.

Well-structured problems, those most commonly presented to students, provide all the necessary information including the appropriate formula needed to arrive at a single correct answer. Student motivation to solve the problem revolves around finding the answer desired by the teacher. This is likely to lead to inert, unusable knowledge. When students work as teams to solve ill-structured problems, they are working toward learning general procedures for problem solving that will transfer to new situations.

In a PBL model classroom, the teacher acts more as a coach in helping students investigate the problem. Students become the experts who contribute to the knowledge and understanding of other students.

The Rubric for Evaluating Earth System Science Analyses (on the back side of this page) is a working guide that can be used by both teachers and students. In addition to being used as an evaluation tool by teachers, it helps guide students to do their best work and can also be used by students for self-assessment or peer assessment. The rubric should be provided to students before they begin their work.

RUBRIC for Evaluating Earth System Science Analyses

QUALITY OF UNDERSTANDING: Accuracy of ideas, facts and statements (assertions) about interactions and causal chains					
4 Rating Response is complete and correct.	3 Rating Mostly correct with no major errors, misconceptions or omissions. May contain up to 3 minor inaccuracies.	2 Rating Partially correct with one or two significant omissions, content errors or more than 4 minor errors.	1 Rating Includes misconceptions about key content and/or several significant content errors.	0 Rating Not present.	Rationale*
DEPTH OF REASONING: Clarity and focus of supportable ideas, interactions and systemic relationships					
4 Rating Explains complex, interdisciplinary causal chains (e.g., E>S>S>S>E); predicts future effects, transfers understanding to evaluate other situations or to make recommendations.	3 Rating Explains the processes responsible for causal chains (e.g., E>S>S>S or S>S>S) from a scientific perspective.	2 Rating Describes interactions using cause and effect connections, including secondary effects that unfold over time (e.g., E>S>S).	1 Rating Describes what is happening in the system, including characteristics and direct effects of the event or context (e.g., E>S).	0 Rating Not present.	Rationale*
EVIDENCE: Scope, detail and accuracy of the evidence supporting the relationship statements					
4 Rating All assertions are supported with data (quantitative and descriptive) from multiple, reliable sources; uses data to create charts, graphs, maps, etc., that support claims or refute opposing positions; discusses limitations of the data.	3 Rating All assertions are supported with data (quantitative or descriptive) cited from reliable sources.	2 Rating Most assertions are supported with data (quantitative or descriptive) cited from reliable sources.	1 Rating Uses data from sources that are not credible, lacks support for some statements, or lacks citations for some data sources.	0 Rating Not present.	Rationale*
PRESENTATION: ESS analysis is clearly and well communicated					
4 Rating Exemplary writing style that is particularly vivid, compelling, and/or creative. Excellent organization that uses multimedia (diagrams, graphs, pictures, video, etc) effectively to support the text. Text is free from grammatical errors and typos.	3 Rating Well-written and organized text. Builds ideas across paragraphs and sections to support the main ideas. Text is generally free of grammatical errors/typos (no more than 1–2 minor grammatical errors and typos).	2 Rating Text supports the main ideas. Sentence structure sometimes interferes with meaning. A few (3–4) minor grammatical errors and typos.	1 Rating The thesis/main ideas about the interactions are clearly stated. Several (5+) grammatical errors and typos.	0 Rating Not present.	Rationale*

* Explain rating with specific references to the ESS analysis as evidence.