

PEDAGOGICAL AND INSTRUCTIONAL ANALYSIS

Problem-based Learning with Multiple Representations

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Criteria	Evaluation						
1. Development of student autonomy in learning	Passive	1	2	3	4	5	Active
2. Organization of the group	Individual	1	2	3	4	5	Team
3. Degree of interdisciplinarity	Monodiscipl.	1	2	3	4	5	Multidiscipl.
4. Preferred line of reasoning	Deductive	1	2	3	4	5	Inductive
5. Systematic approach to problem solving	Minimum	1	2	3	4	5	Maximum
6. Implementation of a method to produce scientific knowledge	Minimum	1	2	3	4	5	Maximum
7. Development of effective written communication skills	Minimum	1	2	3	4	5	Maximum
8. Development of effective oral communication skills	Minimum	1	2	3	4	5	Maximum
9. Development of logical reasoning	Minimum	1	2	3	4	5	Maximum
10. Development of critical thinking skills	Minimum	1	2	3	4	5	Maximum
11. Development of attitudes that are useful for scientific work	Minimum	1	2	3	4	5	Maximum
12. Definition of the students' systems of values	Minimum	1	2	3	4	5	Maximum
13. Use of information technologies	Minimum	1	2	3	4	5	Maximum
14. Creation of connections between science, technology and social progress	Minimum	1	2	3	4	5	Maximum
15. Familiarization with the context in which scientific concepts are discovered and developed	Minimum	1	2	3	4	5	Maximum
16. Application of student learnings to new situations	Minimum	1	2	3	4	5	Maximum

Comments

This activity has many qualities: the subject is exciting, out of the ordinary and should thrill students. Solving this problem allows students to make connections between theory and practice, and I think that it helps make physics more accessible.

Students are in action and directly affect the outcome. They thus develop problem-solving skills and must absolutely use a rigorous scientific approach to achieve the end result.

The supporting documents provided are of remarkable pedagogical quality.

Personally, I enjoyed this project and would have liked to take part in solving the problem. I think I finally would have understood something about physics!

Louise Ross, Educational Advisor, Cégep André-Laurendeau

DESCRIPTION OF CRITERIA

1. Development of student autonomy in learning

The activity fosters the development of student autonomy in learning in that students must:

- locate, organize and use pertinent information;
- plan their own learning process, setting realistic goals and choosing appropriate means of attaining them;
- evaluate the effectiveness of their strategies, adapt to different situations and readjust their objectives and behaviour.

2. Organization of the group

The activity may require students to work alone or in teams, either in or out of the classroom. If it encourages teamwork, it should bring students to:

- interact with others;
- assume various roles (leadership, collaboration, support) in disciplinary and multidisciplinary teams oriented toward the pursuit of common goals and objectives;
- understand and respect the diversity and interdependence of individuals.

3. Degree of interdisciplinarity

The activity is considered as being multidisciplinary if it uses processes, concepts, principles, and factual information derived from various disciplines or fields of knowledge

(biology, chemistry, mathematics, sociology, ethics, etc.) to solve a problem or complete a project.

4. Preferred line of reasoning

The activity uses a deductive approach if students cover the theoretical aspects in class, and then illustrate these principles or theories through practical activities. On the other hand, the activity uses an inductive approach if experimental results or information retrieval are aimed at making students realize or understand principles or theories.

5. Systematic approach to problem solving

We will define synthesis problems as being written problems (e.g. at the end of a chapter), where previously learned rules must be reorganized in a much wider scope than that of proposed exercises to learn techniques or apply algorithms.

The activity brings students to solve synthesis problems systematically if they:

- frame a problem and construct a representation of it;
- analyze a problem, identifying its elements and the relationships among them and their structure and organization to provide a solution.

6. Implementation of a method to produce scientific knowledge

Through this activity, students are able to carry out the various steps of the experimental method if they:

- observe and gather data;
- draw inferences from data and construct hypotheses;
- set up experiments, use measuring instruments correctly and carry out experiments;
- summarize their observations, estimate their degree of certainty, draw conclusions from them, and interpret and critique them.

7. and 8. Development of effective written and/or oral communication skills

The activity develops communication skills if students are, for instance, required to:

- read scientific or literary texts, as well as texts on current issues;
- write scientific, literary and other types of texts;
- express themselves orally during class presentations, demonstrations or large or small group discussions.

The activity fosters the development of effective communication skills if students are required to:

- correctly use the language of instruction or second language;
- make proper use of the various languages (terminology, symbolism, conventions, etc.) specific to the scientific disciplines covered in the program.

9. Development of logical reasoning

The activity develops logical reasoning if students:

- identify a certain number of ideas related to the subject area, and compare, classify and evaluate them;

- organize relevant ideas into a logical sequence;
- construct a coherent argument, a rationale and a proof.

10. Development of critical thinking skills

To develop critical thinking skills, the activity should require students to:

- search for information from various sources;
- judge the relevance, adequacy and credibility of this information;
- become aware of knowledge-building processes, and their limits as well as their own biases.

11. Development of attitudes that are useful for scientific work

The list of attitudes and qualities science students must demonstrate is long, and no student can be expected to develop them all to a high level.

The activity fosters the development of these attitudes and qualities if students demonstrate, among others:

- a liking for sustained effort;
- perseverance;
- curiosity;
- creativity;
- flexibility;
- a desire to help others;
- a critical spirit.

12. Definition of the students' systems of values

Science students should be encouraged to define their own systems of values and to choose the values they will promote as scientists.

To this end, the activity fosters the development of the students' systems of values if they:

- identify and choose personal values;

- refer to ethical considerations and to their systems of values when making decisions and adopting conduct.

Courses in experimental disciplines may address, for example, questions related to pollution, the environment or biotechnology, thereby providing students with the knowledge and skills on which to base the positions they take.

13. Use of information technologies

Science students must attain a certain level of competence in the selection and use of available technological tools.

In other words, the activity uses information technologies if students:

- use a computer and its main peripherals;
- use the main types of data processing software: word processing, data processing and graphics programs, specialized software, etc.
- receive an introduction to the programming of algorithms (students headed more specifically toward applied sciences and engineering).

14. Creation of connections between science, technology and social progress

The activity fosters the creation of connections between science, technology and social progress if students:

- confront the power and limits of science and technology;
- discuss the influence of society in building scientific knowledge or its implications for social progress.

15. Familiarization with the context in which scientific concepts are discovered and developed

The activity fosters the familiarization with the context in which scientific concepts are discovered and developed if students:

- place the emergence and evolution of the concepts taught in the context of the development of human thought;
- recognize how knowledge is constructed and transformed when it is subjected to discussion and the validation of hypotheses through research.

16. Application of student learnings to new situations

The activity fosters the application of student learnings to new situations if students:

- see the connections among courses in the same discipline;
- establish links among the various disciplines in the program;
- integrate what they have learned and apply it to solving problems in new situations.