

Activity **3**



Problem-based Learning with Multiple Representations

Activity developed at John Abbott College
By **NATHANIEL LASRY**

Award-winning activity in the *Getting Off the Beaten Path 2005-2006* contest, organized by the Saut quantique in collaboration with Merck Frosst Canada.

Levers and Muscle Action

Date Last Tested

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Scientific Discipline

Physics

Average Age of Students

17-18 years old

Course Title and Number

Mechanics (203-NYA-05)

Duration of Activity

**2 laboratory periods
(2 hours/week)**

NOTE

In this document, the masculine is used without discrimination and solely to make the text easier to read.

Appendices are available in PDF and Word format on the CD provided with this document.

In addition, an instructional analysis of the activity is available in the pedagogical treasures section (*Trésors pédagogiques*) on the Saut Quantique Web site at:

<http://www.apsq.org/sautquantique>.

Use of this text is authorized for instructional purposes, provided that author's name and college are mentioned.

Adherence to these recommendations will encourage authors to share their experience.

Problem-based Learning with Multiple Representations

Description of Activity

OVERVIEW

Problem-based learning (PBL) is a collaborative approach that allows students to learn through authentic situations. However, the usual presentation format of these problem situations often remains unauthentic.

To optimize authenticity, this activity presents a real-life problem situation that also involve several representation modalities (e.g. verbal, visual, spatial, kinaesthetic, intrapersonal, etc.).

Students take on the role of a crime scene investigator to solve a murder. To this end, they must gather information from the scene (measure the calibre of the bullet, which allows them to find the muzzle speed, angle at which the bullet entered a block, etc.) and learn about two-dimensional kinematic motion.

RELEVANCE AND ORIGINALITY OF ACTIVITY

The *Crime Scene Investigation* problem situation is more authentic than so-called traditional laboratory assignments as it requires students to extract information from an emulated environment. Furthermore, students are not stymied by unfamiliar sophisticated devices since only familiar instruments such as rulers and watches are used.

Moreover, since some approximations are required to solve this problem, students realize that a real physics problem is often a matter of making the right educated guesses.

In addition, this activity helps to demonstrate that physics is not merely the work of men and women dressed in white lab coats, but a field of knowledge of several public-interest professions.

Objectives and Relation to the Program

PEDAGOGICAL OBJECTIVES OR TARGETED COMPETENCIES

To analyze various situations and phenomena in physics using the basic principles of classical mechanics (competency 00UR).

To develop the ability to adapt and learn from new situations by planning one's own learning process.

LINK BETWEEN THE ACTIVITY AND THE PROGRAM

General Program Goals Targeted

This activity targets the following general goals of the *Science* program:

- To reason logically;
- To communicate effectively;
- To work as members of a team;
- To adopt attitudes that are useful for scientific work;
- To apply what they have learned to new situations.

¹ To learn more about this pedagogical approach, please refer to the section *Apprentissage par problèmes* (problem-based learning) on the *Saut quantique* Website at www.apsq.org/saut-quantique/doss/d-app.html.

Link with Course

Two-dimensional kinematic motion is studied using a concrete ballistics problem.

Link with Other Courses

This activity requires the use of a number of math methods and techniques.

Number of Students and Educational Support

APPROXIMATE NUMBER OF STUDENTS IN CLASS

20-24 students

NUMBER OF STUDENTS PER TEAM

3-4 people

EDUCATIONAL SUPPORT

The teacher circulates among students and facilitates discussions, giving frequent feedback (without providing exact leads to solve the problem).

Conducting the Activity

CONDUCTING THE ACTIVITY AND TIME REQUIRED TO COMPLETE EACH STEP

Before

The teacher explains and distributes roles (facilitator, sceptic, scribe and verifier) to each member of the group. (See Appendix T.1 for further information on these roles.) (5 minutes)

The teacher distributes and presents the *Crime Scene Investigation problem* situation (Appendix S.1) to students: written description, items retrieved from the scene (block of wood with bullet inside, etc.) (See Appendix T.1) (10 minutes)

During

Students, in groups of 3 or 4 people, try to determine which of all the information they gathered is relevant. They plan their approach to arrive at a solution. (1.5 hours)

The teacher circulates among the groups. He gives frequent feedback in order to minimize futile efforts and bring students to reflect on the core concepts that may lead to a solution. (1.5 hours)

After

Students submit a report to be graded based on a summative evaluation.

Evaluation and Required Material

SUGGESTED EVALUATIONS

This activity is graded at two levels: the group's reflection, and the final report.

The group's reflection is graded using a portfolio that includes:

- The group's discussion report;
- The definition of the problem situation;
- Known variables, variables to be determined;
- The protocol used to measure the bullet's angle of entry.

The report includes all the processes that were used in arriving at a solution. Due to the approximations involved, there may be several correct answers. All processes are valid as long as they are logical. The evaluation is based on the solution process rather than on the end result (numerical answer).



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REQUIRED MATERIAL

A bullet with a measurable calibre, and a block of wood in which a hole of the size of the bullet has been drilled at a given angle.

APPENDICES

Teacher

Appendix T.1: Pedagogical Guide

Students

Appendix S.1: *Crime Scene Investigation*
Problem Situation

(You can contact the author by e-mail to obtain other problem situations.)

Note:

Appendices are available in PDF and Word format on the CD provided with this document.

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MEDIA DIRECTORY

Books:

HELLER, P. and K. HELLER (1999). *Cooperative Group Problem Solving in Physics*, University of Minnesota. [Online]. URL Address: <http://groups.physics.umn.edu/phised/Research/CGPS/GreenBook.html>

Magazine Articles:

ALLEN, D. E., et al. (2002). *Scaling Up Research-Based Education for Undergraduates: Problem-Based Learning*. [Online]. URL Address: http://www.cur.org/publications/AIRE_RAIRE/delaware.asp

BARRON, B. (1998). "Doing with Understanding: Lessons from Research on Problem- and Project-Based Learning", *The Journal for the Learning Sciences*, vol. 7, no. 3-4, p. 271-311.

CRONIN, F. (1993). "Four Misconceptions about Authentic Learning", *Educational Leadership*, vol. 50, no. 7, p. 78-80.

HELLER, P., R. KEITH and S. ANDERSON (1992). "Teaching problem solving through cooperative grouping. Part 1 Group versus individual problem solving", *American Journal of Physics*, vol. 60, no. 7, p. 627-636.

HELLER, P. and M. HOLLABOUGH (1992). "Teaching problem solving through cooperative grouping. Part 2 Designing problems and structuring groups", *American Journal of Physics*, vol. 60, no. 7, p. 637-644.

KOZMA, R.B. and J. RUSSELL (1997). "Multi-media and understanding: Expert and novice responses to different representations of chemical phenomena", *Journal of Research in Science Teaching*, vol. 34, no. 9, p. 949-968.

WILLIAMS, B. A. (2001). *Introductory physics: A problem-based model*. In Duch et al., "The power of problem-based learning: A practical 'how to' for teaching courses in any discipline", Sterling, VA, Stylus, p. 265

Web Site:

Problem-Based Learning Clearinghouse (page viewed on September 15, 2005). [Online]. URL Address: <https://chico.nss.udel.edu/Pbl/>