

Alternative Lesson Plans for Problem Solving Learning Activities

Many of the lesson plans for this course involve in-class problem solving. If you use this type of activity often (I do in my teaching), it can become boring if the activity is performed the same way every time. This set of generic lesson plans is therefore provided to add some variety in the way these activities are conducted. Each time a lesson plan includes a problem-solving learning activity, you can conduct that activity using any one of these generic plans.

Every problem-solving learning activity will include at least the following items: (1) the problem statement as a .pdf file (this will be in the student handouts for the class), (2) the problem solution as a .pdf file (students will have access to this, but encourage them not to look at it until after the class has ended) and (3) slides (within the in-class slides that are provided) including at least the problem statement and points to review. In some cases additional materials are provided such as input files for computer solution of the problem.

The lesson plans presented here assume the students will set up the problem as if they are taking an exam. That is, they formulate all the equations needed to solve the problem and describe how to solve them numerically (see Exam_Info.pdf), but they don't actually do the calculations. Once they have set the problem up in class, you can show them the solution in class, tell them to download and examine it along with any computer files needed to solve it or complete it as homework.

1. Independent Problem Set Up followed by Instructor Solution

1. Tell the students to get out the problem statement while you display the problem statement slide.
2. Instruct the students to work independently to set up the problem (write all equations that are needed to solve the problem, identify which quantities are known and which are unknown, identify N equations and N unknowns (if the equations are algebraic) or identify initial conditions and integration stopping criterion (if the equations are differential) and state how they would be solved (e. g. what computer program, what methods within that program, etc.).
3. Tell them to raise their hands if they get stuck; assist them when they do so.
4. Give them sufficient time to set the problem up (walk around the room and observe them as they work; if you observe a common mistake, misconception

- etc., pause the activity and discuss it; when most appear done or nearly done, move on to the next step).
5. Work through the solution at the blackboard, on an overhead projector, etc. (You can simply go through it or do it interactively asking them to tell you the next step, the next equation, etc.).
 6. Show them the result (all they have done is set up the solution) and discuss the meaning of the result, if appropriate. Go over any points to review on the provided slides.
 7. Optionally ask them what they think would happen if some parameter of the problem was different and then discuss their responses.
 8. Optionally have them use the solution to explore (either in class, if they have access to solution tools, or as homework) what would happen if some parameter was changed.

II. Independent Problem Set Up followed by Pair-wise Discussion/Evaluation

1. Follow steps 1 through 4 as in lesson plan I.
2. Tell the students to pair with a partner and compare their set-ups. Tell them to discuss any differences they detect and to try to reach agreement on which is correct. Tell them to raise their hands if they can't resolve a difference.
 - a. When hands are raised you can either help the pair individually to identify the correct choice, throw the issue out to the whole class to help identify the correct choice or stop the whole class and explain to them the difference that was encountered and the correct resolution
3. After the students have had time to compare and resolve differences, proceed from step 5 from lesson plan I.

III. Independent Problem Set Up followed by Student Presentation of Solution

1. Follow steps 1 through 4 as in lesson plan I.
2. Ask for a volunteer or call upon a student to present their set-up at the blackboard, on an overhead projector, etc. The student should be told to explain each step in their solution, and the class should be told to stop the presenter if they believe an error has been made.
 - a. If someone in the class indicates they believe the presenter has made an error, have the entire class discuss and resolve the issue.
 - b. If the class resolves the issue incorrectly, ask questions that cause them to re-think the resolution and reach the correct one.
 - c. If there is an error that no one catches, let it go to see if anyone discovers it as the solution progresses.
 - d. Optionally have the student who caught the error take over with the presentation of the solution, assuming resolution was in their favor.
3. If the "final" solution contains one or more errors, announce to the class that the current solution has that many errors and see if they can then find them. If errors are not found, ask questions that will cause them to find the errors; then let them correct them.

4. Once a correct solution has been set up, proceed from step 6 of lesson plan I.

IV. Group Problem Set Up at their Seats followed by Instructor Solution

1. Follow the steps in lesson plan I except have the students work together in small groups of 2 to 4.
 - a. Walk around the classroom while they are working and make sure they are staying on task.

V. Group Problem Set Up at their Seats followed by Group Presentation of Solution

1. Follow the steps in lesson plan III except have the students work together in small groups of 2 to 4 and have a group volunteer to present their solution.
 - a. Walk around the classroom while they are working and make sure they are staying on task.

VI. Group Problem Set Up at Blackboard followed by Class-wide Comparison/ Discussion

1. Divide the class into small groups of 2 to 4 and assign each group a section of the blackboard at which to work.
2. Encourage them to work within their group, but if they get stuck to discuss with a nearby group.
3. As the groups complete their solutions, have them return to their seats and identify differences between their solutions and those of other groups.
 - a. As differences are identified, have the groups resolve the differences and correct the responses accordingly.
 - b. Eventually, all the solutions should be correct.
4. Proceed from step 6 of lesson plan I.

VII. Group Relay Race Set Up at Blackboard

1. Divide the class into small groups of 3 to 6 and assign each group a section of the blackboard. Tell them they are to cycle through the members of their group one at a time until they believe they have the problem set up properly
 - a. The next group member can go to the board as soon as the one before them sits down
 - b. Upon getting to the board, the group member can do **one** of the following things: correct an existing equation, add one additional equation, or write how to use the equations on the board to solve the problem.
2. When the group believes they are done, the next person up to the board should write DONE and the time.
3. When all groups are “done,” proceed from step 3 of lesson plan VI.

4. Optionally award some kind of bonus to the group that correctly set up the problem in the least time

VIII. Group Problem Set Up using Scribe at Blackboard with Second Group

Monitor/Challenge

1. Divide the class into an even number of small groups of 3 or 4 and assign a section of the blackboard to each pair of groups. Tell one group they are to cycle through the members of their group one at a time until they believe they have the problem set up properly
 - a. The next group member can go to the board as soon as the one before them sits down
 - b. Upon getting to the board, the group member can do **one** of the following things: correct an existing equation, add one additional equation, or write how to use the equations on the board to solve the problem.
2. If the other group believes a mistake has been made, they may challenge the group that is working on the problem.
 - a. The two groups should attempt to resolve the issue; if they can't, you should resolve it
 - b. If the challenge is upheld, the groups switch roles at that point
3. As the groups complete their solutions, have them return to their seats and identify differences between their solutions and those of other groups.
 - a. As differences are identified, have the groups resolve the differences and correct the responses accordingly.
 - b. Eventually, all the solutions should be correct.
4. Proceed from step 6 of lesson plan I.

IX. Whole Class Problem Set Up at Blackboard using Scribe

1. Ask for a volunteer or call upon a student to serve as the class scribe. This person should go to the blackboard or overhead.
2. Instruct the class that they must direct the scribe to set up a solution to the problem, and that they also must check instructions being given to the scribe by others.
 - a. If they disagree with an instruction, the class should work out a resolution
 - b. If the class resolves the issue incorrectly, ask questions that cause them to re-think the resolution and reach the correct one.
3. Once the problem set-up is complete, proceed from step 6 of lesson plan I.

X. Mix and match components from the lesson plans above to create your own variants