Teaching Assistant's Handbook

University of British Columbia, Department of Physics and Astronomy

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We would like to acknowledge all of the many sources that have influenced this course.

- The University of Minnesota: With their gracious permission, much of this handbook has been liberally copied and paraphrased from the University of Minnesota TA training materials. Many activities, such as the problem solving module, were also adapted directly from their course.
- The University of Maryland: For providing the videos and transcripts of TA-student interactions.
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- The Carl Wieman Science Education Initiative: For financial support and advice, and also getting us in touch with most of the people above!

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Chapter 1

Introduction

The Physics and Astronomy Department has adopted the Carl Wieman Science Education Initiative, which means that we are committed to improving the education of our undergraduates through the use of scientifically proven teaching techniques. You, as teaching assistants are the front-line educators in our program, and achieving this goal will be impossible without you. This course will give you the instruction necessary to make you proficient educators. In this course, you will learn:

- About some of the results of physics education research in the past decade and what that means for teaching in our classrooms.
- How to promote an active learning environment in your classrooms.
- To recognize that problem solving skills must be explicitly taught to students, and develop an expert problem-solving strategy to demonstrate for them.
- To develop the ability to diagnose student difficulties and lead them through the problem solving strategy via questioning.
- To develop practical strategies for facilitating group work.
- To create a marking rubric for efficient, consistent and fair marking.
- How to frame a lesson with an introduction and summary in order to maximize students' learning and retention.

Our department has also implemented a mentor TA program. The mentor TAs have an interest in education and previous experience as teaching assistants in our department. The primary role of your mentor TA is to help you develop your teaching skills by observing your lessons and giving constructive feedback, and helping you to reflect on your own teaching practices. Like any learning process, feedback is essential in helping you develop your teaching skills. Your mentor TA will be available to you to help answer any questions you might have regarding issues such as teaching, graduate school, or our department.

You will be assigned a mentor during the first week of classes. Feel free to contact any of the mentors, however, they are here to help! The mentor TAs are:

Mya Warren	mya@phas.ubc.ca
Sandy Martinuk	sandy.martinuk@gmail.com
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1.1 What is Physics Education Research?

Over the last 25 years, a growing number of physicists, educators, and psychologists have been studying just how it is that students learn physics. This movement seeks to apply the tools of science to investigate what happens in our classrooms. Some of the major questions that Physics Education Research (PER) addresses are:

- What previous conceptions do students have about the physical world, and how are these affected by various types of instruction?
- What problem-solving strategies do students use, and how can these be improved?
- What beliefs do students have about physics as a science, and how do those beliefs affect the students' performance?
- How can we improve the quality of physics education?

Researchers have made significant progress in analyzing and improving physics education, and have extended their work to other areas of science. Many results from PER have been incorporated into this workshop. This handbook is designed to be a quick reference for you, and we will not attempt a complete overview of PER results here. However, your reading assignment gives a good introduction to the subject and some valuable references. We also encourage you to learn more about the current research in the field of physics education by visiting the resource library in Hebb 21 or our website (`http://www.phas.ubc.ca/~phas_ta/perrl/`).

Chapter 2

Your Duties

Most of you will be assigned to either Physics 100 (algebra-based course for students without high-school physics) or Physics 101 (calculus-based course for science majors). You will be assigned to a laboratory section and/or a tutorial and marking section. One TA unit represents approximately 6 hours per week, including:

- Preparation time
- Time interacting with students in the classroom or office hours
- Group meetings with your teaching team
- Marking

The exact time you need to spend on your teaching assistantship will vary somewhat week to week, and you may need to spend more time at the beginning as you are familiarizing yourself with the course. If you find that you are spending considerably more time than this on your TA duties, you should ask your mentor TA about ways of becoming more efficient. Your studies should not suffer as a result of your teaching.

Note that failure to fulfill your TA duties in a serious way could result in the loss of your teaching assistantship and associated guaranteed funding during your grad studies. Your mentor TAs are here to help you throughout the term, and to assure that this does not become an issue.

2.1 Teaching a Laboratory Section

1. Prepare yourself
    - Before your laboratory section, make sure that you are familiar with the equipment, and consult the lab manual and experienced TAs to find out what might go wrong and what kinds of mistakes students might make. Your mentor TAs are also available to explain anything in the lab that you do not understand.
    - Review the relevant physics in this lab, and how it fits in with what the students are doing in the rest of the class.
    - If you found any common confusion during your marking of the last lab, decide if you will discuss it with the students.
    - Have a goal for each lab session, something you want your students to learn. This should be decided on in your team meetings with your lab professor and the other TAs.
    - Prepare an introduction to the lab addressing the above points in order to guide your students' learning during the lab.

2. Prepare the classroom

   - Make sure that you get to your laboratory 5-10 minutes in advance of the class, and do not let the students in until you are ready.
   - Use this time to check that the lab equipment is all there, neatly arranged, and in working order. If your lab has computer equipment, make sure that all computers are working properly.
   - You may also use this time to write on the blackboard anything that will help students understand the learning focus of the experiment, and any background material they may need to know.

3. Teach the lab

   - Give your introduction.
   - Wander about the entire lab and monitor each group before helping any one of them. This will ensure that you can prioritize your interactions with students, and can help them most efficiently.
   - Don't automatically answer the students questions. Sometimes a helpful hint or a guiding question can get them to figure it out on their own.

4. Summarize

   - Before the students leave at the end of a lab, summarize for them the key points that they have learned, referring to the learning goals you've identified.

5. Clean up

   - Make sure that the lab is in order before you leave.

More information on these points can be found in Chapter 6 - Lesson Plans, and Chapter 5 - Interactive Engagement.

2.2 Teaching a Tutorial Section

1. Prepare yourself

   - Solve the group problem in advance.
   - Discuss with your team the parts of the problem your students are likely to have difficulty with.
   - Be prepared to give your students an introduction to the problem, and to tell them what they will be learning with this particular problem.

2. Prepare the classroom

   - Get to your assigned classroom several minutes in advance and tidy up the desks and chairs.

3. Teach the tutorial

   - Remember, your job is to coach students through problem solving. Give the students feedback, a little push or a hint to get them moving if they are stuck. Do NOT solve the problems for them.
   - As in the lab, it's best to wander around the whole room getting a feel for students progress before settling on any one group to help.

- Encourage the students to interact with each other to prevent dysfunctional group dynamics. Call on shy or reticent members to explain concepts, or ask the dominant member to explain his ideas to the group. Chapter 5 has more information on handling groups.

4. Summarize

   - Leave room at the end of the class for a summary. Help the students make connections between what was learned today and the students' existing knowledge and real world experience.
   - Helping them structure and integrate their knowledge will improve their understanding and retention of the lesson.

5. Clean up

   - At the end of class, clean the blackboard and leave the room in a tidy state.

More information on these points can be found in Chapter 6 - Lesson Plans, and Chapter 5 - Interactive Engagement.

2.3 Office Hours

- In the first year physics courses, you will not have office hours, however, at some point in your career you likely will.
- Office hours are often held in your own office. Prepare a clean space for them to sit and to work out problems.
- This is your chance to interact one on one with your students. The problem solving tips in the section on tutorials applies here as well: do NOT do the students' homework for them!

2.4 Meeting with your Mentor TA

- You will formally meet with your mentor TA a few times a year. This will be scheduled for sometime after your mentor TA has had a chance to observe you in class. Take this opportunity to discuss problems with your students, with grading, classroom management, or anything else pertaining to your teaching duties.
- Your mentor TA is also available by appointment on other occasions if you need guidance or are experiencing problems with teaching, or other issues related to being a graduate student.
- There will also be a mid-semester follow-up workshop that will be announced later in the year, where you will be able to discuss your teaching with your peers.

2.5 Grading

- Different teams will make different decisions on how homework and labs will be collected and graded. You may be grading every week, or only a few times a session.
- Grading is vital feedback for our students and is most effective if it is given very soon after they have submitted their work. Try to return homework and labs within one week of collecting it unless otherwise specified by the professor in the course.

- A marking rubric should be worked out with your teaching team to ensure consistency and proper feedback for the students. You should ensure that your students are given the rubric by which they will be marked. This will guide their work, and let them know exactly what they need to work on in future assignments.

- You may be asked to create a solution key for your students. Research has shown that a well written solution can have a significant impact on your students' problem-solving skills. Ensure that your worked solutions show proper problem solving technique (see Chapter 3)

- Tips for grading problems:

  1. Mark only one question at a time, rather than the entire problem set for each student.
  2. Work out the problem yourself in advance.
  3. Initially, quickly read over many students answers to get a feeling for what they have done wrong. Then categorize each paper into piles of A, B, C, D (the letter grade they'll most likely get on this problem). This is supposed to be a quick procedure! When you look at the solutions in detail you'll figure out if you misplaced one of them, so don't worry too much about it.
  4. Mark each pile separately and in detail. It is usually easiest to start with the A pile. Some of the criteria to use in grading are:
     - Communicates reasoning
     - Uses correct concepts, major equations, vector analysis, diagrams
     - Non-physics approaches where the student makes a major conceptual mistake, or is obviously fishing for equations should get no more than 20%.
  5. It might seem like some of these steps are redundant, but a little preparation is guaranteed to save you the time and embarrassment of going back and changing marks after the fact.

- Tips for grading labs:

  1. All of the tips for grading problems hold true for grading labs as well, but in addition, the lab report may also be graded for written communication. An essential part of being a scientist is being able to communicate your results clearly.
  2. Criteria for marking for writing:
     - Content: has the student included technical or scientific content accurately and thoroughly? Does the student address accurate information such as definition, formulas, theorems, explanations, or data?
     - Context: Has the student communicated in a way appropriate for the situation of context in which the document/presentation/visual will be received? Have the requirements of the assignment been met?
     - Audience: Has the student addressed the audience with appropriate language and technical content, vocabulary, level of knowledge, and register (informal or formal)?
     - Purpose: Has the student identified the purpose of their communication, such as to inform, persuade, instruct, or demonstrate?
     - Support: Has the student included appropriate support in the form of documentation, facts, statistics, formulas, illustrations, or evidence?
     - Design: Does the student use effective design, both for page design and for the integration of verbal explanations and visual illustrations? Does the student display neatness and cross-references at appropriate points?
     - Organization: Has the student organized the communication into logical sections, paragraphs, topic sentences, and headings?

  - Expression: Has the student expressed written work clearly, efficiently, and effectively, and has the student used correct grammar and mechanics?

- You will be responsible for keeping the class scores, possibly until the end of term or whenever the professor asks for them.

Go over common errors in class to avoid seeing them again!

2.6 Plagiarism

Plagiarism is a form of academic misconduct where an individual submits the oral or written work of another as his own. Determining what constitutes plagiarism, however, is not always straightforward in practice. Working on homework assignments in groups is encouraged in physics, and may sometimes result in work that appears very similar. The rule of thumb for group work is "work together, write separately". On the other hand, copying work from another is always plagiarism. Some examples of plagiarism you may encounter are:

- Students copying assignments from one another. This usually occurs right at the beginning of a class where the assignment is handed in. Be vigilant!
- In the lab, it happens sometimes that a student uses someone else's data for their analysis. In this eventuality, it is the student's responsibility to reference their partner's work.
- Copying from solutions found on the web. This is a serious problem these days. Especially for questions asked out of the textbook, it is often possible to find the solution on the web. If you notice that the solution is readily available, you may want to bring this to the attention of the professor of the course to have that question discontinued.

Plagiarism is a serious offense and the university has procedures in place to deal with it. You are never to confront a student about suspected plagiarism on your own, your job is simply to present the class professor with the evidence for plagiarism.

2.7 Invigilating

You may be required to invigilate an exam. The schedule for invigilating will be given far in advance of the exam date. Do not make plans for vacations until you have seen the schedule. Your duties will be to:

- Answer questions from students during exams (the types of questions it is appropriate for you to answer should be worked out with the professor in advance).
- Ensure that there is no cheating. If you suspect cheating is occurring, do NOT confront the student yourself. Let the supervising professor know, and give him/her any evidence that you can provide.

2.8 Team Meetings

The timing of your team meetings may vary depending on your course, but you should expect to attend a team meeting weekly or bi-weekly. The purpose of the team meetings is good communication between the members of the teaching team. The important issues are:

- The professor describes what's going on in the lecture and why.
- Discussion of what to emphasize in the next discussion or lab section.

- Trading information on what students understand. This is where you are the most important member of the team, as you have the most direct contact with the students. Make notes of your observations of the students for this meeting.
- Now is also a good time to bring up any issues you are having with the students or the course, or to share ideas you have about teaching.

Chapter 3

Problem Solving

Learning to solve problems is a major goal of introductory physics classes, even though this will typically not be found on the syllabus. It is generally assumed that this is a skill that our students pick up on their own through practice problems that we give them. However, research has shown that if the students are practicing bad problem solving technique, they continue to be bad problem solvers. Our students predominantly solve problems though a process of pattern-matching the question type, and equation hunting in the end of chapter summaries. Most of you became adept problem-solvers on your own, however it is a good idea to remember that physicists are the exception rather than the rule!

3.1 Problem Solving Strategies

What does it mean to be a good problem solver? Researchers have come up with several general problem solving strategies for physics. At UBC, we will follow one such strategy. An expert problem solver will:

1. Interpret the problem
    - Visualize the events described
    - Sketch a picture
    - Identify your goal
2. Model the Problem
    - Identify the physical principles that are relevant to this situation
    - State any simplifying assumptions
    - Draw one or more physics models, including:
        - Special diagrams (free-body diagram, energy bar-chart, motion diagram etc.)
        - Graphs of physics quantities
        - Statement of limitations or constraints
        - List of given information, including definitions of relevant symbols
3. Plan a solution
    - Translate the physics model into equations which represent the problem mathematically
    - Assess how to solve these equations, and whether there is enough information present to give a solution
4. Solve

- Insert the relevant quantities and solve for the answer

5. Check Your Answer

   - Check that the formula gives the correct units
   - Compare the answer to existing experience
   - Check for reasonableness and completeness

Now how do we teach this technique to our students? One way is to demonstrate the full technique when we work out problems for them in lecture or in homework solutions. If the students know the problem solving technique, they are more likely to use it. We can also help them practice good problem solving technique through the use of guided questions when they come to us for help. Some questions we can ask are detailed in Section 5.1.

3.2 Characteristics of a Good Problem

Another way we can help our students to learn problem solving is to give them good problems to practice with. We distinguish between problems and exercises. If you know the outline of your solution soon after reading the problem, then it is an exercise. If applying the single right formula is sufficient to solve the problem, then it is an exercise. Problems force you to try to reach the goal step by step, not in one step, and to make subjective decisions about the appropriateness of your approach along the way. Long division is an exercise once one is taught how to do it. When we ask students to derive F, m or a given that the other two variables are known after they are taught $F = ma$, we are giving them an exercise. When students tell you they don't now how to get started, it is a problem for them. Many perfectly good problems for undergraduate students are exercises to you, and differentiating between the two takes experience and observation of your students. However, good problems should encourage students to

1. Consider physics concepts in terms of real objects in the real world.

   - This helps students practice connecting "physics knowledge" with the real world.
   - Avoiding physics cues such as "inclined plane" and "frictionless surface" also prevents students from using a memorized solution pattern to solve the problem.
   - Taking out some relevant numbers and making the students estimate the quantity from their own experience will reinforce their real-world intuition.

2. View problem solving as a series of decisions

   - This can be accomplished by making the students decide which information is relevant and which is not by, for example, including excess information that isn't needed in the problem or replacing terms like frictionless and massless by slippery and light.

3. Use their conceptual understanding of the problem to analyze the situation before the mathematical manipulation of formulas.

   - Making the problem difficult to understand without drawing a diagram, and making the situation as real as possible helps students in the visualization process.
   - Students are forced to practice visualization if no picture is given to them! Removing all diagrams in the problem will reinforce this.
   - The problem should require at least two equations to solve. This can be done by changing the target quantity (i.e. velocity to time or acceleration to force), or the initial conditions for example.

As a TA, you may not have much control over the questions asked in assignments and tutorials, but it is very simple to change a text-book exercise into a good problem and your professor will often appreciate suggestions. Also, when helping your students one on one, you can rephrase questions in terms of real-life problems to make them more interesting and easier to connect with their experience.

3.3 Other Teaching Tools

In a tutorial, we can encourage proper problem solving rather than equation hunting by giving the students the equations we want them to use. For example, you can provide for your students the fundamental equations and principles for mechanics problems and separate them from (or simply omit) the equations that apply only under certain conditions. This list can grow as the students learn more concepts.

Chapter 4

Formative Evaluation

Formative evaluation is a form of classroom assessment that provides both you and your students with useful feedback on the teaching-learning process. The more you know about what and how students are learning, the better you can plan learning activities to structure your teaching. Formative assessment differs from summative assessment in that it is aimed at course improvement, rather than at assigning grades. The primary goal is to better understand your students' learning and so to improve your teaching. To maximize the benefit of formative evaluation, it is important to let the students know that you have reviewed their feedback and that you will incorporate it into future lessons.

This is a small list of formative feedback techniques that are easy to use in the physics and astronomy classroom, laboratory or tutorial section. Descriptions of the formative feedback techniques below were taken from [4] and the following online resources, which have many more techniques you might like to try when you are teaching:

`http://www.ntlf.com/html/lib/bib/assess.htm`
`http://www.flaguide.org/cat/cat.php`
`http://www.siue.edu/~deder/assess/catmain.html`

- **Minute Paper** During the last few minutes of the class period, ask students to answer on a half-sheet of paper a question such as: "What is the most important point you learned today?"; or, "What point remains least clear to you?". The purpose is to elicit data about students' comprehension of a particular class session. Afterward, review responses and note any useful comments. During the next class periods emphasize the issues illuminated by your students' comments.

- **Stop-Start-Continue** Like the minute paper, this is a very quick and simple form of formative evaluation. It is based on the traffic light and consists of you asking the students to answer the following three questions on a small piece of paper:
  - What would you like me/us to stop doing in class because it is not helping your learning?
  - What would you like me/us to start doing because you believe it would be beneficial to your learning?
  - What would you like me/us to continue doing because it is working?

- **Self-Confidence Survey** This technique is used to help the students identify and communicate their academic anxieties by rating their confidence in understanding specific concepts, performing specific tasks or using specific laboratory equipment. For example:

  How confident do you feel that you can achieve the following (circle one response for each statement)?

  - Use an oscilloscope to measure the switching frequency of an AC voltage supply: Very, Somewhat, Not Very, Not At All
  - Explain Newton's laws to a friend that has never studied physics: Very, Somewhat, Not Very, Not At All

- **Directed Paraphrase** Ask the students to summarize a concept or idea and direct this summary toward a specific audience. Asking them to paraphrase requires them to generate a new way to express the concept. Asking them to direct it toward a specific audience reveals whether the student understands the concept within the specified framework. An example is to ask them to explain Newton's third law to a friend that has never studied physics.

Chapter 5

Interactive Engagement

This chapter deals with how you actually interact with your students, the physical act of teaching the lesson.

5.1 Effective Questioning

Effective questioning seeks to get the student to answer their own questions by making them think and drawing out the answer from them. When a student asks us a question our first impulse is often to simply answer them in a straightforward way. However this is not always the most effective way of building their understanding. Skillful questioning will instead lead students to engage with their questions and find the answers. It can also help the student learn to refine their questions and to explicitly consider their own reasoning processes. The following guidelines will help you develop your questioning skills, but the best way to learn is by practicing.

Good teachers help students clarify their thinking by:

- posing thought-provoking questions
- rephrasing or asking additional questions
- keeping the discussion focused
- encouraging students to explain things to each other
- ensuring that students consider each view; no views should be cut off, ignored, or unfairly dismissed
- breaking big questions or tasks into smaller, more manageable parts
- helping students to identify what they need to know

Make sure to:

- Phrase the questions clearly and specifically.
- Wait silently for at least 5 to 10 seconds for students to respond.
- Be sure to identify and reinforce the students correct thinking
- Draw attention to aspects of their explanation that are unconvincing
- Don't bother with yes/no questions; they do little to promote thinking or encourage discussion.
- Avoid questions that are vague, ambiguous, or beyond the level of the students.

5.2 Types of Effective Questions

These four types of question stems can help you develop thought provoking questions.

1. **Questions of Clarification**
   These questions help you to diagnose the students' current thinking, a necessary step before you can formulate a plan for teaching them.
   - What do you mean by that?
   - Could you elaborate on that?
   - What is your main point?
2. **Backward-Thinking Questions**
   These probe assumptions or reasons that have led to a present impasse or misconception.
   - What are you assuming about this question?
   - Can you think of an alternate assumption that might be reasonable?
   - What are your reasons for saying that?
   - Do you have any evidence for that?
   - How did this come about?
3. **Forward-Thinking Questions**
   These probe implications, consequences, or goals.
   - What are you implying?
   - What effect would that have?
   - What does this question ask us to evaluate?
   - Will that step move you closer to your goal?
   - Can you think of a strategy we could follow to answer this question?
   - What experiment or measurement could we do in order to answer this question?
4. **Problem Solving Questions**
   These questions encourage the use of the problem solving methodology.
   - Which step of the problem-solving method / lab instructions are you working on?
   - Did you successfully complete the earlier steps?
   - Interpret the Problem
     - Can you describe the problem in your own words?
     - Have you tried to draw a picture to visualize the situation?
     - What do we know about this problem?
   - Identify the relevant physics concepts
     - What physical effects are relevant to this situation?
     - What's the goal of this problem? Are there particular types of physics that are relevant to that goal?
     - What forces are acting on this object?
     - What additional information do you wish you knew? Why?
   - Define physics assumptions and relationships
     - Do you think that all of the given information is relevant to solving this problem? Why or why not?

  - What kind of assumptions could we make to simplify this situation? Do you think those would be reasonable to make?
  - Does the physics of this problem imply any relationships between variables?
- Solve
  - Could we check this algebra somehow?
  - Are you using consistent units?
- Check your Answer
  - Does the magnitude of this answer make sense?
  - Can you think of a similar situation that might give you a clue about how big the answer should be?
  - Can you think of a simple way to test this answer?
  - So did your output increase or decrease? Does that make sense considering the given change in the input?

5.3 Techniques for Working with Groups

If the course assigns groups, be sure to explain to the students why this is done. It may take the students a while to get used to group work, as they likely have little (or negative) experience with group work so far. Many will resist at first, but persevere! The rewards of learning in groups are well documented.

We tell our students that:

- We want you to get to know everyone in the class, so we will change groups often. By the end of the term, you will have worked with a substantial fraction of the students in this section.
- No matter what career you enter, you will have to work cooperatively with many different kinds of people (not just your friends). This class will give you an opportunity to learn how to work comfortably and successfully in groups.

Setting up groups:

If you are responsible for assigning groups, use the following guidelines to ensure good group functioning.

- Choose groups of three to minimize the tendency of one student to "drop out" and participate minimally
- Assign group of mixed ability levels: the resulting discussions will be mutually beneficial for all group members. (Groups of uniformly strong students tend to over-complicate things.)
- Assign groups of mixed major (i.e. avoid putting three arts students in one group and three biology students in another).
- Don't put only one female in a group. Studies have shown that when there is a single woman in a group, the other group members tend to ignore her, even if she is the strongest member of the group.

Encouraging group communication / participation:

- Persuade groups to resolve disagreements, rather than simply voting.
- Encourage them to discuss with each other rather than working independently and checking answers.

- Inquire if groups have reached consensus.
- Remind students of their individual and group accountability (i.e. what they do and learn here counts for marks!).
- Convince students that teaching each other is the best way to learn something.
- If they only need to turn in one assignment, ask them to put away all but one pencil. Only one person needs to be writing; the others should be discussing.

Diffusing group conflict:

- Encourage group members to agree on standards of behaviour (this is a preventative measure).
- Ask them explicit questions about how their group is functioning and why they are having problems.
- Encourage them to consider how they might improve their group functioning in the future.

Conducting whole-class discussions:

- Ask an open-ended question.
- Listen for the answer.
- Paraphrase, or ask the same student or another student to elaborate.
- Periodically summarize (e.g., on blackboard or overhead projector) what has been discussed.
- Draw as many students as possible into the discussion.

Working the room: (for tutorials or labs)

1. Circulate through the room, listening to students' conversations
2. Diagnose difficulties with physics concepts
3. Diagnose difficulties with group functioning
4. Is the entire class confused on the same thing? If so, stop the class and discuss.
5. Does a group has the same problem that you've already worked through with another group? Get the first group to explain it to the second. Everybody will benefit from interacting with their peers, and it will free up more of your time.
6. Coach the group that needs the most help first.
7. If you spend a long time with one group, circulate around the class to diagnose before you intervene again.

Chapter 6

Lesson Plans

As a teaching assistant, you will probably not be actually designing the lessons for the labs or tutorials; however, it is your job to frame the lesson in such a way that the students get maximum benefit from the planned activities. The essential elements of a lesson are:

- Introduction
- Activities
- Summary

In addition, at all times in the lab or tutorial it is important to make it clear to your students what the students should be learning in the lesson: *the learning goals.* The activities portion is prescribed by the lab manual or the tutorial problem, in which your main responsibility will be to coach the students individually and in groups using questioning (described in Chapter 5). In this chapter we'll complete the picture and discuss the learning goals, the introduction and the summary.

6.1 Learning goals

The most important element of an effective lesson is the formulation of clear, well-defined learning goals. It is essential that both you, the instructor, and your students have a clear idea of what they are supposed to be learning. Research has shown that novices do not have the organizational structure to differentiate between what is important to know in a lesson and what is just an interesting aside. You can provide that structure for them by communicating to them the learning goals. In general, the learning goals will be decided by the faculty in charge of your course and will be communicated to you in the team meetings. They should be formulated as a statement of what the student should be able to accomplish at the end of the lesson. For example:

- At the end of this lab, you will be able to use an oscilloscope to measure the period of a wave.
- At the end of the tutorial, you will be able to mathematically describe the properties of simple harmonic motion.

6.2 Introduction

The introduction has many purposes:

1. **Motivate the lesson**
    - Why should the students care about this lesson?

- How does it relate to the real world?
- How does it relate to what they have already learned?
- Keep your audience in mind: an effective motivation may be different for life-sciences students and for engineers

2. **Focus the lesson**
   - Introduce the learning goals
   - Let them know what they will be doing (an outline)

3. **Give introductory information**
   - How does this piece of equipment work?
   - What are the fundamental equations and concepts to focus on?

4. **Find out what they know or don't know**
   - It is unwise to assume that the students know something because they have seen it in the lecture!
   - Asking the students about what they know in advance can save them much confusion during your introduction and lesson

Prepare your introduction in advance and practice until you are comfortable giving it.

6.3 Conclusion

The closure of the lesson is as important as the beginning. Instructors who pay relatively little attention to closure of a lesson have endings such as the following:

- Oh-oh, it looks like we're out of time. See you tomorrow.
- That's it for today!
- Gee, there goes the bell!

Statements like these do end the session but they do little else. Just as your introduction must gain the learners' attention and focus it to prepare them for learning, it is important for your conclusion to summarize, review or highlight the learning goals in order to draw the lesson together. In a sense, the opening helps the students prepare themselves for the learning that will take place, while the closure helps them organize the material so they can retain it.

Important aspects of a conclusion are:

1. **Review Learning Goals** The students have experienced many things during the previous activities, and now is the time to refocus their attention on the learning goals.

2. **Organize Students' Knowledge** Make reference to how this lesson fits with what they already know. If possible, also link it with future tasks they will be expected to perform.

3. **Formative Evaluation** The end of the lesson is a good time for you to assess how well the students have actually learned what you intended. Formative evaluation (see Chapter 4) will let you know if your lesson has succeeded.

Although often overlooked as students rush to finish on time, a conclusion is very important to help the students construct knowledge out of the lab or tutorial in which they have just participated. Make sure your students leave the lab with a clear idea of what they learned, or they may soon forget.

Chapter 7

First Day Checklist

1. Meet with the course coordinator
   - Go over the material covered in the course
   - Get materials such as assignments, lab manuals, text book, and syllabus
   - Find out about their grading expectations: when the homework will be returned, if there is a set grading rubric for the course, the policy on accepting late work, and procedures for grades appeals
   - If there is no pre-made grading rubric, you may want to discuss the focus of the grading and present the professor with a grading rubric of your own
   - Discuss their expectations for team meetings
   - Find out what you should do if you need to miss a session
2. Meet with professors or TAs who have taught the course before
   - Find out who your students are, their majors (if decided), what they like or dislike about the course
   - What content was most challenging
3. Check out the classroom
   - You do not want to be late for your first class! Visit the class ahead of time, make sure your keys work.
   - Do you have an overhead projector available to you for presentations?
4. Plan your first session
   - You need to let the students know who you are and what are the expectations for the class, such as
     - Be on time
     - Submit work on time
     - Be prepared for the session, do pre-labs and readings
     - Participate in class discussions
     - Respect the opinions of others
   - Consider making a handout with your contact information, office hours, expectations and policies on late work, and what they can be expected to take from this course
5. First day of class

- Your attitude on the first day sets the tone for the course, be enthusiastic!
- Introduce yourself, and maybe something about your interests in physics
- If the class is not too large, you can get them to introduce themselves. If it is very large, you should visit each of them personally and spend a few minutes getting to know them. This lets them know that you care about them and are open to their questions and feedback.
- Express your expectations for the class, and let them know how they will be evaluated

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